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PRODUCTION FACILITY LAYOUT DESIGN USING BLOCPLAN ALGORITHM

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PT Dwi Indah has two divisions i.e. core paper division and plastic division. The two divisions experienced backtracking on its production process. Backtracking may have impact on more material movement moment. The more the backtracking is, the more operational cost that occurred at PT. Dwi Indah. This paper discuss the implementation of the BLOCPLAN algorithm to improve the production facility layout. This algorithm works by developing and change the layout arrangements with the parameter total distance travelled and each option is done by exchanging facilities/ workstations. Layout selection is based on the comparison of total movement moment and the *Benefit-cost ratio* (BCR) between *existing layout* and proposed *layout alternatives*. The result show that the movement moment for the final layout is 2.739,1 meters/ day and the efficiency of 55% with the BCR 9,47. There will be an additional benefit of Rp 359,592,854.88 in the second year, compared to the option of not improving the layout.

Keywords: layout, blocplan, benefit cost ratio.

1. INTRODUCTION

Facility layout is a scheme to arrange facilities within the space provided to support the production process. [1]. The goal of the layout design is to optimize the arrangement of the area and every production facilities by minimizing movement moment and simplify manufacturing process by shorten the distance between production facilities. [2].

This paper explain the facility layout design at PT. Dwi Indah. The company experienced the shortage of the space while on the other hand it also need to add its production machines. They also experienced backtracking and crosstracking. The situation happen on the *core paper* department and *plastic* department. *Backtracking* may resulted in long distance that the material need to travel at the production floor. This may lead to the increasing of total material movement.

Some of the reason why re-layout is need to be done are the occurrence of backtracking, additional machines, and ineffectiveness of the production floor [2]. A good layout design can give advantage for the production process [3]. An effective facility planning may reduce material handling cost for 10-30%, thus will resulted in a lower production cost. [4].

The method of this study is BLOCPLAN one of the heuristic improvement method. It is used to find a layout solution by minimizing material movement moment. BLOCPLAN is a hybrid algorithm, i.e. it can be used for construction or improvement algorithm. [4].

2. Literature Review

2.1 Facility Planning Process

The Facility Planning Process is explained as follow[5]:

1. *Define and Redefine The Objective*
   At this phase, the objective of the facility is determined. It is related with the products that is going to be produced and also the production process. It is also related with the choice whether to build new facility or redesign the existing facility.
2. *Specify the Primary anf Support Activity*
   At this stage all of the activities that is going to be conducted at the facility is specified.
3. *Determine the Interrelationship*
   At this stage, the relationship between departments is identified. Should the departments have strong relationship, it is a good option to locate them closely.
4. *Determine the Space Requirement*
   This is the phase where the space needed is calculated. It is based on the equipment, workers, and materials.

5. *Generate Facility Plan*
   A facility plan is consist of of layout design, structural system design, and material handling system design.
6. *Evaluate Alternative Facility Plan*
   At this phase, several plans are evaluated to search for the best benefit the organization can get.
7. *Select Facility Plan*
   At this phase, a plan is selected after considering its benefit. The plan with least backtracking and best depreciation cost is preferable.
8. *Implement Facility Plan*
   The implementation of the plan
9. *Maintain and Adapt*
   The whole plan may need modification and it may also need adaptation to fit with the real situation. Factors such as energy consumption or improvement on equipment also need to be considered.

2.2 BOCPLAN

BLOCPLAN is a layout design system that developed by Donghey and Pire from Industrial Engineering Department at Houston University. The program will evaluate types of layout. BLOCPLAN has similarity with CRAFT algorithm in a way of arranging departments. The difference between BLOCPLAN and CRAFT algorithm is that BLOCPLAN can use Activity Relationship Chart (ARC) as the input and CRAFT can only use From To Chart (FTC). Number of lines for BLOCPLAN usually consist of two or three lines.

The analysis of layout is conducted by changing the departments. BLOCPLAN can also use FTC as its input. But the usage of ARC and FTC can only be done one at a time during the evaluation [4].

2.3 Benefit Cost Ratio

Benefit Cost Ratio is one method to analyze investment feasibility. It is based on the benefit that can be obtained by investing on something (can be a business or a project) [6]. Mathematically speaking, benefit cost ratio is an equivalent value for all benefit compared to equivalent value of all cost. The mathematical expression is as follow:

$$\frac{B}{C} = \frac{PWbenefit}{PW\ cost} = \frac{FWbenefit}{FWcost} = \frac{AWbenefit}{AWcost}$$

For decision making on one alternative, it is done by analyzing the value of B/C; whether it is more than 1 or not.

-If B/C ≥ 1 , then the alternative is feasible

-Jika B/C < 1 , then the alternative is not feasible

3. Method

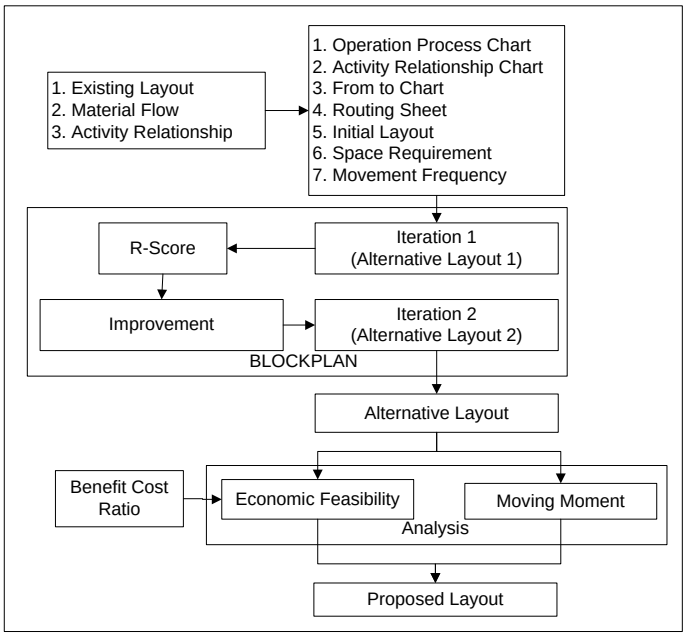

Fig.1. Research Methodology

Figure 1 shows the data that is used to perform the layout planning. The data is processed using BLOCPLAN to generate 2 layout alternatives. The alternatives then analyzed using the benefit cost ratio. This is done so that the alternative can be implemented to give the benefit.

4 RESULT

The layout before the design of layout is as follow:

Table.1. Departments on Production Floor

1. Splitting Machine	7. Rewinder Machine
2. Rolling and Cutting Machine	8. Wrapping Machine
3. Bundling Cutting Machine	9. Product Warehouse
4. Oven	10. Recycle Rejected LLDPE Machine
5. Caster Machine	11. Recycle Sack LLDPE Machine
6. Work in Process Warehouse	

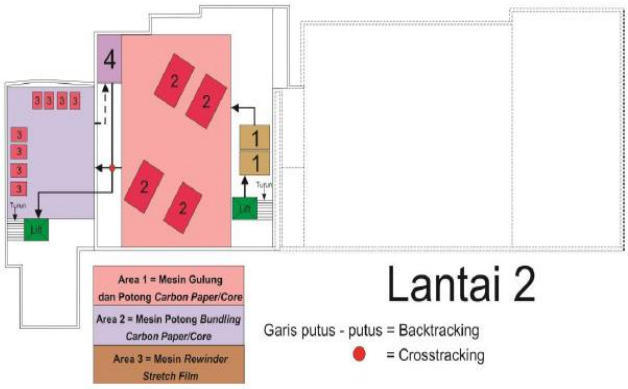

Fig.2. Existing Production Floor

Initial layout then produced and it will become the reference for layout exchange on BLOCPLAN. The output of BLOCPLAN is produced iteratively, the layout that have the largest R-score and the smallest Rel-Dist Score.

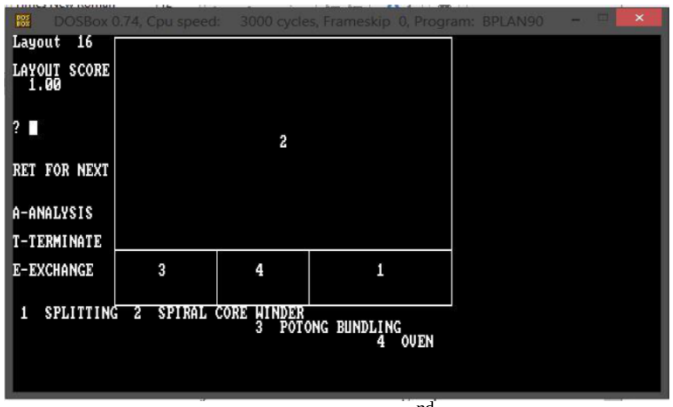

Fig.3. Iteration 1, 2nd Floor

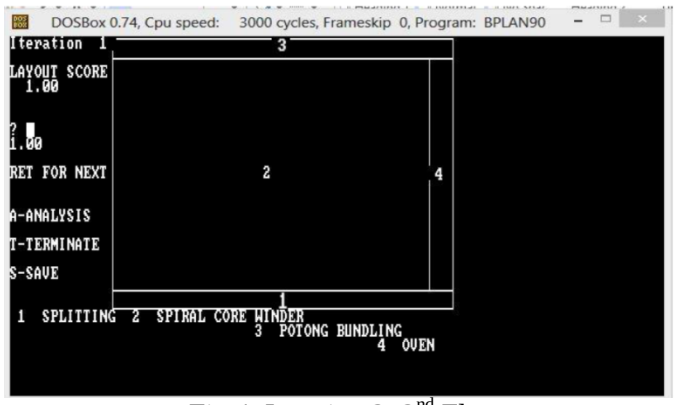

Fig.4. Iteration 2, 2nd Floor

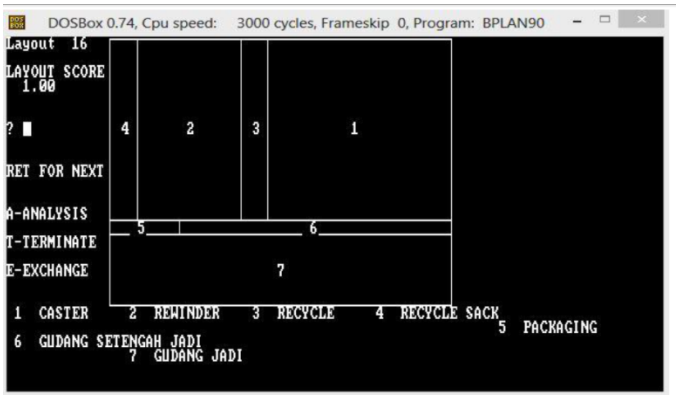

Fig.5. Iteration 1, 1st Floor

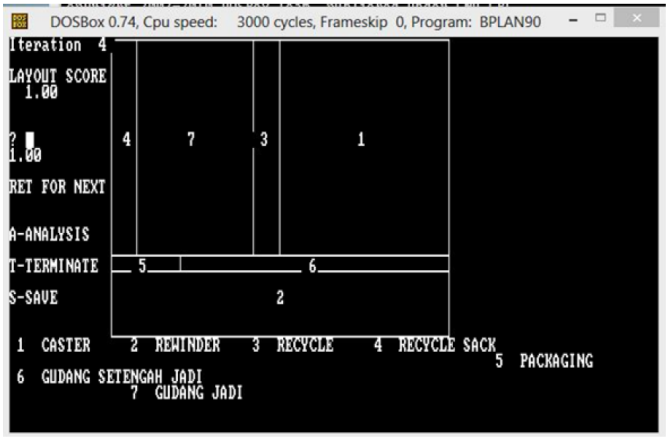

Fig.6. Iteration 2, 1st Floor

Iteration 1 become layout alternative 1 and Iteration 2 become layout alternative 2. These layout alternatives, which is the result from BPLAN90 software, then calculated the movement moment (distance x frequency) resulting total movement moment as shown in Table.2.

Table.2. Total Movement Moment

	Initial Layout	Layout Alternative 1	Layout Alternative 2
Total Movement Moment	6224.26	2914.8	2739.1
Reduction on Movement Moment	0	3309.42	3485.12
Reduction Percentage	0%	53%	55%

Table.3. Comparison of Investment Cost

	Layout Alternative 1	Layout Alternative 2
Total re-allocated space	816.54 m^2	667.29 m^2
Department re-allocation cost	Rp 224,548,500.00	Rp 183,504,750.00
Cost of new material handling equipment	Rp 260,250,000.00	Rp 260,250,000.00

Opportunity lost during re-allocation	Rp 91,656,000.00	Rp 91,656,000.00
Total Investment Cost	Rp 576,454,500.00	Rp 535,410,750.00

Table.3 shows the comparison of the space that needed to be exchange for layout 1 and layout 2, it lead to a difference in the exchange cost of every alternative. Material handling used for layout alternative 1 and layout alternative 2 is the same. The production loss is a cost that occurred because the plant cannot produce the jumbo roll for 6 working days. This is due to the time needed to perform the re-layout, and the production plant cannot produce the product so there's an opportunity lost for 72 jumbo roll at the price of Rp. 91,656,000.00.

By performing layout improvement, PT. Dwi Indah can produce 12 jumbo rolls per day. There is 1 jumbo roll addition compared to the production without layout improvement. Table.4. shows the analysis from the economic aspect. Layout 1 and 2 is feasible economically to be implemented as shown by its BCR that have the value of >1. Both of the alternative layout will give benefit on the second year. Layout 2 will give more benefit compared to layout 1.

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Table.4. Feasibility Analysis using Benefit Cost Ratio

		(F/P,7%,12)	(F/A,7%,12)	(F/A,7%,24)	(F/A,7%,35)
Equivalent		17.888	17.888	58.177	138.237
			Year – 1	Year – 2	Year – 3
Initial Layout					
Benefit	Benefit/ month	Rp 134,428,800.00	Rp 240,466,237.4	Rp2,404,662,374.40	Rp7,820,664,297.60
cost	Material Handling Cost	Rp 23,362,714.56	Rp 417,912,238.0	Rp 417,912,238.05	Rp1,359,172,644.96
B/C			**5.75**	**5.75**	**5.75**
Alternative 1					
Benefit	Benefit/ month	Rp 146,649,600.00	Rp2,623,268,044.80	Rp2,623,268,044.80	Rp8,531,633,779.20
cost	Material Handling Cost	Rp 16,474,086.24	Rp 294,688,454.66	Rp 294,688,454.66	Rp 958,412,915.18
	Investment	Rp 576,454,500.00	Rp1,298,751,988.50		
B/C			**1.65**	**8.90**	**8.90**
Alternative 2					
Benefit	Benefit/ month	Rp 146,649,600.00	Rp2,623,268,044.80	Rp2,623,268,044.80	Rp8,531,633,779.20
cost	Material Handling Cost	Rp 15,481,051.74	Rp 276,925,053.58	Rp 276,925,053.58	Rp 900,641,147.24
	Investment	Rp 535,410,750.00	Rp1,206,280,419.75		
B/C			**1.77**	**9.47**	**9.47**

5. CONCLUSIONS

Based on the analysis of movement moment and benefit cost ratio, layout alternative 2 is selected as the layout that proposed to be implemented. The benefit that can be obtained is Rp 2,346,342,991.22 per year and this benefit will be obtained on the second year. Propsed layout is shown on Fig.7.

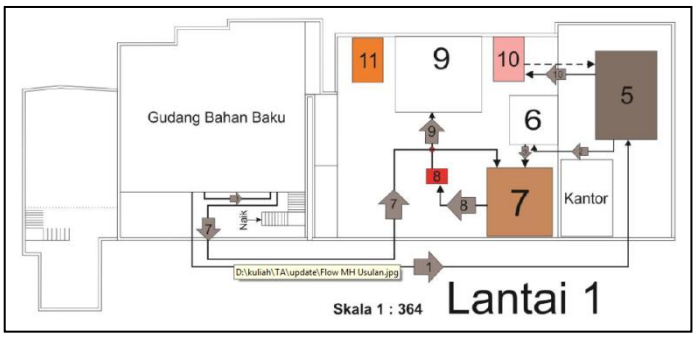

Fig.7. Proposed New Layout

This layout will produce the reduction on movement moment of 55% and will reduce the material handling cost for Rp 7,881,662.82 per month, compared to the choice of not making layout change.

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