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Factory Layout Redesign With Lean Manufacturing And Simulated Annealing Algorithm At PT. XYZ

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ABSTRACT

PT. XYZ is a manufacturing company in the field of wood processing that produces furniture products and raw materials for rambung. On the production floor of PT. XYZ there is a buildup of materials during the production process. This stacking process does not add value. This results in delays for the next process or can be called waste of delay. Another problem is the backflow of material transfer (backtracking) where the movement of the material flow through several stations affects the completion of the product. In solving these problems, a lean manufacturing approach is used to identify and reduce activities that do not add value during the production process and shorten lead times. The simulated annealing algorithm method is used to fix the backflow problem on the layout of the production floor at PT. XYZ. The results showed that there was a decrease in the displacement moment of 43.44%, an increase in production capacity with an actual process cycle efficiency of 44.98% with an average production of 48 units/day and a proposed process cycle efficiency of 63.91% with an average production - an average of 63 units / day after repairs with lean manufacturing.

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1. INTRODUCTION

Factory layout is the design of the arrangement of factory facilities to optimize the relationship of workers, machines, equipment, information flow, material flow to support the smooth production process. A good factory layout will determine the efficiency and success of a company. Basically, the main objective of designing a factory layout is to minimize the total cost. Based on research, the transfer of materials starting from the form of raw materials to finished products, can take about 40 to 70 times of transfer or about 50% to 70% of all production process activities. It can be concluded, factory layout planning is closely related to the planning of the material transfer process. Factory layout planning cannot ignore the significance of material transfer activities. (Sritomo, 2000).

Currently, the need for wood as a raw material for the furniture industry, which has been using commercial wood such as teak, mahogany, and other types of wood, is increasingly difficult to obtain. Rubber wood obtained from rubber plantations that are no longer productive can be used as a potential source of wood which is used as fuel wood. However, there are obstacles encountered with rubber wood, namely rubber wood that has been cut down in log form or in storage, wet rubber wood contains sap which is a good place for fungus to grow and will cause black or blue stains that can damage the wood texture. . To overcome this problem, rubber wood is preserved against fungal attacks and wood destroying insects. (Suheryanto, 2010)

PT. XYZ is a manufacturing company in the field of wood processing that produces furniture products. The products produced include tables, chairs, clothes hangers, wagons and shelves. PT. XYZ uses a make to order system where product demand varies greatly in terms of quantity and specifications according to consumer demand.

On the production floor of PT. XYZ there is a buildup of materials during the production process. This stacking process does not add value. This results in delays for the next process or can be called waste of delay. Another problem is the backflow of material transfer (backtracking) where the movement of the material flow through several stations affects the completion of the product.

If this problem is ignored, the total distance will be greater and the transfer time will be longer. In solving these problems, a lean manufacturing approach is used to identify and reduce activities that do not add value during the production process and shorten lead times. The simulated annealing algorithm method is used to fix the backflow problem on the layout of the production floor at PT. XYZ.

The lean manufacturing principle introduced by Toyota has proven to improve the performance of the production process. In the book The Toyota Way, after the company adopted lean manufacturing methods, the revenue of the Toyota company increased 8.3 times more than the industry in general. The increase experienced by the company was also followed by high product quality, high productivity and the speed of the production process. (Alexander Prasetya, 2015).

According to Eva Marella's research (2015), the engine layout at PT. DEF is not regular and in the process of moving materials from one machine to another it travels a long distance, causing material handling costs that are much more expensive and the company incurring losses. The goal to be achieved is to reduce losses caused by irregular machine layouts, and minimize material handling costs.

The method used in redesigning the layout of the fabricated floor is the simulated annealing method which can minimize the cost of moving materials. The simulated annealing algorithm was introduced by Metropolis et al. in 1953, and its application to optimization problems. The simulated annealing algorithm is a metaheuristic algorithm, which means an algorithm with an optimization method that is carried out by improving the solution candidate iteratively according to the objective function. This method is able to produce a good solution in a fast (acceptable) time, but does not guarantee that the resulting solution is the best (optimal) solution. Based on probability and statistical mechanics. Problems that require a simulated annealing approach are combinatorial optimization problems, where the search space for existing solutions is too large, so it is almost impossible to find an exact solution to the problem. This is what causes the solution of this algorithm is not trapped in the local optimal. (Eva Marella, 2015)

2. RESEARCH METHOD

2.1 Conceptual Framework

Research can be carried out if a good conceptual framework design is available so that the research steps are more systematic. This framework of thinking is the initial basis for conducting research.

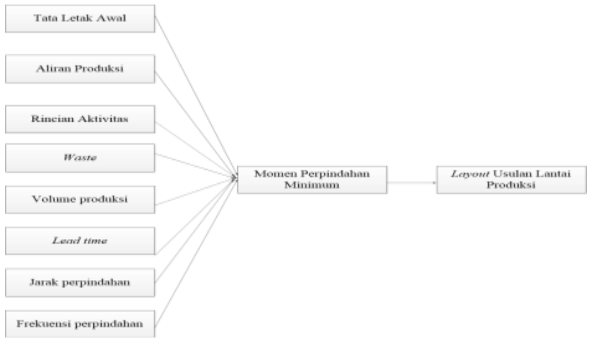

Figure 1. Conceptual Framework

After making improvements through the formation of a future state map, then at this stage an analysis of the design results is carried out. The analysis includes analysis of the current state map and future state map. Between the current state map and the future state map created will be compared and it can be seen the difference in the situation facing the company today with the ideal situation that may be applied in the company through future state design. Further analysis was carried out on the initial layout, the layout designed by the Lean Manufacturing method and the Simulated Annealing Algorithm. The best layout is a layout that has a minimum displacement moment value.

3. RESULTS AND DISCUSSIONS

3.1 Initial Layout Analysis

The current state of the production floor in the factory is still not neatly arranged. The main problem with the layout in the production process can be seen that the criteria for a good layout have not been met, as follows:

a. There is a buildup of materials during the production process. This stacking process does not add value. This results in delays for the next process or can be called waste of delay.
b. There is backflow of material transfer (backtracking) where there is movement of material flow through several stations that affect the completion of the product. Backtracking is from the cutting station to the splicing station and the tenon station to the sanding station.

To compare the selected layout design, the displacement distance and the total moment of displacement are used as a reference. From the calculation results Table 5.21. The total initial displacement distance is 1515.3 meters and the total initial displacement moment is 2,512,610.

3.2 Current State Map Analysis

Current state map is a map that describes the actual condition of the company. Current state map analysis is done by calculating the process cycle efficiency. Calculation of the value of the process cycle efficiency, it can be seen that the amount of time for value added activities is 11000.831 seconds, while the length of time for waste or non-value added activities is 13456.986 seconds and the total time of all activities is 24457,817 seconds. The calculation of the process cycle efficiency is as follows. (Michael, 2005).

Process Cycle Efficiency	= value added time/manufacturing lead time
	= 11000,831 / 24457,817
	= 0.4498 44.98%
Average completion speed	= Total Production (years) / number of working days
	= 13800/289 = 47.75 48 units/day

3.3 Simulated Annealing Algorithm Analysis

The algorithm is run up to 20 iterations with 4 times decreasing temperature. The termination condition was obtained after no more new solutions were obtained in 2 (N=2) decreasing control parameters in a row. There are 7 iterations of the accepted solutions during the algorithm run and can be seen in Table 1.

Table 1. Recapitulation of New Solutions in the Simulated Annealing Algorithm

Iteration	Control Parameters (T)	Workstation Exchange (S')	Displacement Moment (Z')	= S' – S0	Probability of Acceptance (p)	Random Number	Information
1		BD	1486413.5	-	-	-	S' accepted
2		FH	1471021.3	-	-	-	S' accepted
3	100000000	FI	1427645.3	-	-	-	S' accepted
4		HJ	1532785.9	105140.6	0.000027	0.321195	S' rejected
5		AB	1515794.8	-	-	-	S' accepted
6		GI	1486542.5	-	-	-	S' accepted
7		JL	1498582.8	12040.3	0.299983	0.514834	S' rejected
8	9000,0000	HI	1465591.1	-	-	-	S' accepted
9		JM	1476834.2	11243.1	0.324877	0.496312	S' rejected
10		KL	1421023.8*	-	-	-	S' accepted
11		FM	1496583.3	10465.2	0.434821	0.612543	S' rejected
12		BI	1431489	11673.4	0.367126	0.520967	S' rejected
13	8100,0000	AE	1443445,4	11956.4	0.264197	0.462765	S' rejected
14	00	CG	1453770.6	10325.2	0.154298	0.387299	S' rejected
15		DJ	1465025	11254.4	0.317297	0.723981	S' rejected
16		FL	1475548.1	10523.1	0.472319	0.561827	S' rejected
17		EI	1486571.4	11023,3	0.381829	0.827361	S' rejected
18	7290,000	AI	1497494.5	10923.1	0.491723	0.712397	S' rejected
19		BK	1507729.1	10234.6	0.134587	0.671289	S' rejected
20		DH	1519563.5	11834.4	0.301826	0.586691	S' rejected

The iteration stops at the 20th iteration on the condition that no solution is accepted again in 2 consecutive decrease in control parameters. The solution accepted in the simulated annealing algorithm is in the 10th iteration because it has the minimum total moment of displacement among all iterations carried out with a total number of displacement moments of 1421023.8 meters/month. The graph of the recapitulation of the search for a new solution for the simulated annealing algorithm can be seen in Figure 2.

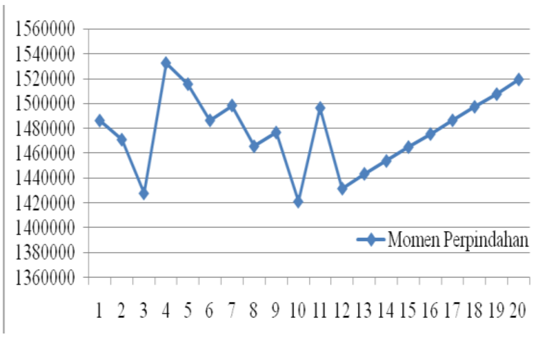

Figure 2. New Solution Search Recapitulation Simulated Annealing Algorithm

The redesign of the layout with the simulated annealing algorithm design has a total displacement moment value that is smaller than the previous total actual displacement moment, which is 1421023.8 meters/month. The final layout of the proposed design of the simulated annealing algorithm can be seen in Figure 3.

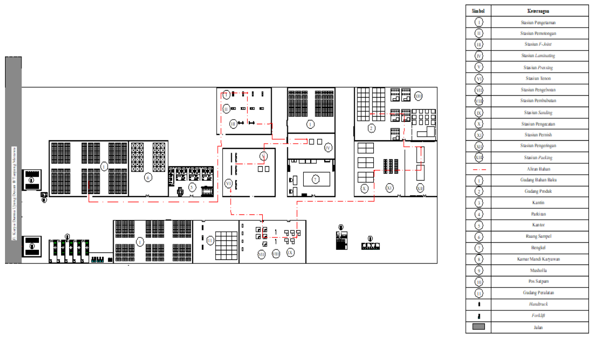

Figure 3. Final Layout of the Proposed Annealing Algorithm Design Results

3.4 Future State Map Analysis

Future state map is a map that describes the condition of the company's proposal by reducing waste. In the future state map, the time for value added activities is 11000.831 seconds, while the length of time for waste or non-value added activities is 6212.236 seconds and manufacturing lead time is 17213. .067 seconds. The calculation of the process cycle efficiency is as follows.

Process Cycle Efficiency = value added time/manufacturing lead time
= 11000,831 / 17213,067 = 0.6391 63.91 %

Production Increase $= \frac{\text{Manufacturing Lead Time Aktual} - \text{Lead TIme Usulat}}{\text{Manufacturing Lead Time Aktual}} = \frac{24457,817 - 17213,067}{2445,8171}$
= 0.2962 x Average completion speed
= 0.2962 x 48 units/day
= 14.2 15 units

After improvements have been made using lean manufacturing methods and simulated annealing algorithms, the actual manufacturing lead time can be compared at 24457.817 seconds with an average production of 48 units/day and the proposed manufacturing lead time of 17213,067 seconds with an average production of 63 units/day, obtained an increase in production of 15 units/day. Comparison of actual and proposed data based on lean manufacturing can be seen in Table 2.

Table 2. Comparison of Actual and Lean Manufacturing

No	Information	current	Suggestion
1	Process Cycle Efficiency	44.98%	63.91%
2	Average completion product	48 units/day	63 units/day

4. CONCLUSION

In the production process, there are non-value added activities, namely the delay caused by the accumulation of materials in the production process and the long distance of material transfer between departments that have a relationship. Non value added activities have a total time of 13456,986 seconds. The redesign of the new layout using the simulated annealing algorithm has a total displacement moment value of 1421023.8 meters/month which is smaller than the actual total moment displacement value of 2512610 meters/month.

Simplification of the production process in the actual process cycle efficiency of 44.98%, after the improvement measures with lean manufacturing and the simulated annealing algorithm, the proposed process cycle efficiency is 63.91% with an average increase of 15 units/day of product completion.

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