

Design and Simulation Plant Layout Using Systematic Layout Planning

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Abstract. This research aims to design the factory layout of PT. Gunaprima Budiwijaya in order to increase production capacity. The problem faced by this company is inappropriate layout causes cross traffic on the production floor. The re-layout procedure consist of these three steps: analysing the existing layout, designing plant layout based on SLP and evaluation and selection of alternative layout using Simulation Pro model version 6. Systematic layout planning is used to re-layout not based on the initial layout. This SLP produces four layout alternatives, and each alternative will be evaluated based on two criteria, namely cost of material handling using Material Handling Evaluation Sheet (MHES) and processing time by simulation. The results showed that production capacity is increasing as much as 37.5% with the addition of the machine and the operator, while material handling cost was reduced by improvement of the layout. The use of systematic layout planning method reduces material handling cost of 10,98% from initial layout or amounting to Rp1.229.813,34.

Keywords: Plant Layout, SLP, Cross Traffic, Simulation

1. Introduction

In line with the growth of residential development then there arose a tight competition between the industries of construction materials, so that companies that produce construction materials should continue to improve its performance so that it continues to grow and meet the expectations of consumers. The one thing that supports the improvement of efficiency and effectiveness of the factory is setting the right factory layout that encourages the achievement of the desired production capacity.

Table 1. Status of Demand of PT Gunaprima Budiwijaya 2016

Number	Month	Demand (Kg)	Capacity (Kg)	Deviation (Kg)	Status
1	January	10971.24	8000.00	-2971.24	Not Fulfilled
2	February	5745.00	8000.00	2255.00	Fulfilled
3	March	10495.00	8000.00	-2495.00	Not Fulfilled
4	April	6320.00	8000.00	1680.00	Fulfilled
5	May	9190.00	8000.00	-1190.00	Not Fulfilled
6	June	7928.60	8000.00	71.40	Fulfilled
7	July	4080.00	8000.00	3920.00	Fulfilled
8	August	8794.80	8000.00	-794.80	Not Fulfilled
9	September	3955.00	8000.00	4045.00	Fulfilled
10	October	10115.00	8000.00	-2115.00	Not Fulfilled
11	November	4837.00	8000.00	3163.00	Fulfilled
12	December	3900.00	8000.00	4100.00	Fulfilled



The company could not meet the demand for production in 2016 of 41.67% or 9566.04 Kg (Table 1). The cause of the problem is the layout which is less good on the production floor. The layout isn't good cause cross traffic in production floor. This research aims to design the layout uses a systematic layout planning (SLP). The SLP method applied to optimize the layout of existing machines and reduce the reject [1]; [2] this method provides the layout of the new machines that can improve the flow of materials and helps to improve the utilization of space in the plant [3]. Planning an effective facility layout can significantly reduce the operational costs of the company amounting to 10-30% [4]. Evaluation and design the layout needs to be done to reduce the cross traffic and optimize the use of floor area of production.

2. Methods

Procedure to relayout the production floor consists of three steps, such as analyzing the existing layout, design the plant layout based on the SLP and the evaluation and selection of alternative layouts using simulation program Pro model [5]. Simulation program used as analytical tools to help systematically designed the layout and to support appropriate decision-making to eliminate some of the problems [6] [7] [8].

Steps in the relayout and explanation can be seen here:

- a. Analyzing the existing layout plant to identify the problem on flow of material and operation.
- b. Designing plant layout based on SLP approach to increase production capacity and reduce material handling cost.
- c. Evaluation and selection of alternatives using Simulation Pro model based on two kinds of criteria; cost of material handling and production time.

2.1 Evaluation Existing Layout

The initial plant layout was analyzed using three methods [9]:

1. Plant Layout Checklist
The purpose of the plant layout Checklist is to identify the cause of the movement of the material not needed which can increase production time and cost of materials handling.
2. Material Handling Checklist
The purpose of the material handling checklist is to analyze of material handling equipment utilization and other criteria.
3. Material Handling Evaluation Sheet
The initial layout PT. Gunaprima Budiwijaya analyzed using material handling evaluation sheet. The results obtained from the MHES is total cost of handling materials, and then used as inputs in a systematic layout planning. The data needed in the calculation of the MHES is: transfer of material, the distance between the Department, the frequency of the transfer, material handling equipment used and the cost of the transfer.

2.2 Systematic Layout Planning

The systematic layout planning (SLP) is a procedure used to set the layout of workplace in a plant notice to the logical relationship between workplace with high frequency are placed close to each other. SLP technique applied to optimize the existing layout. The application is expected to make the fastest material flow with the lowest cost and least amount of material handling [10]; [11]. Systematic layout planning consists of four stages as follows:

- Stage I: Determine the location where the facility will be built
- Stage II: Make overall facility design
- Stage III: Determine the design of facility layout in detail (to be done in this paper)
- Stage IV: Preparation and installation of design results

The input data required by Systematic Layout Planning are divided into five categories:

- P (Product) : The type of product (goods/service) produced.

- Q (Quantity) : Volume of each type of goods/ components produced.
 R (Route) : The order of operation for each product
 S (Service) : Support service, such as locker rooms, monitoring stations, etc.
 T (Timing) : In what time the type of component of the product was produced, what machine is used to produce it at that time.

It is a step-by-step planning procedure allowing users to identify, visualize, and rate the various activities, relationships, and alternatives involved in a layout project based on input data, the flow of materials, activity of relationships and relationship diagrams. The framework of SLP is shown in Figure 1

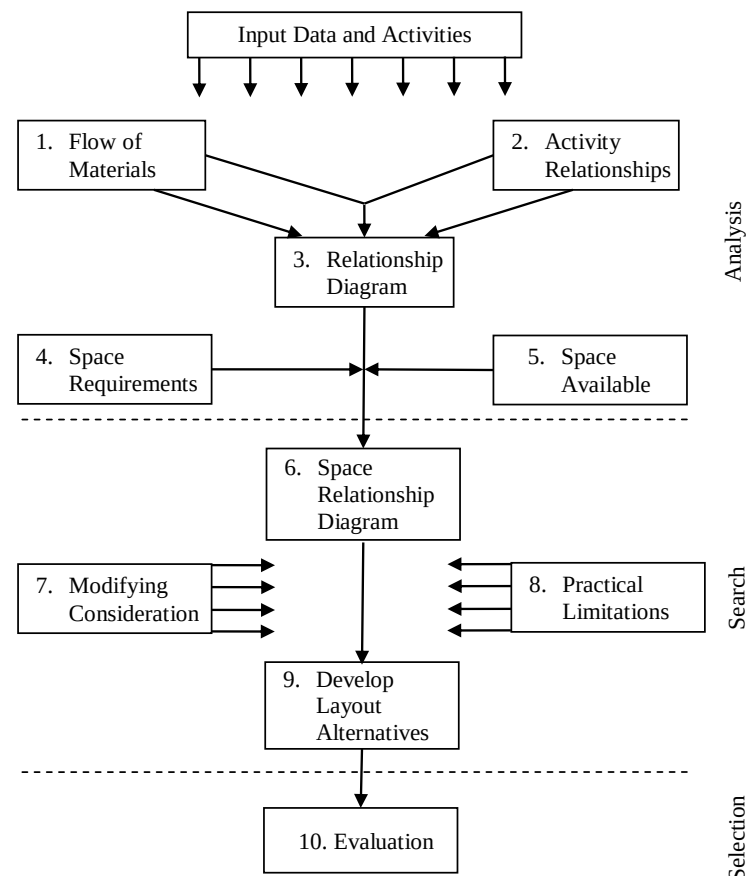


Figure 1. Systematic Layout Planning Procedure [12].

2.3. Evaluation and selection

Evaluation of the layout using two criteria, namely material handling cost and production time. To evaluate the total of material handling costs using Material Handling Evaluation Sheet and production processing time is using simulation using “ProModel version 6”. Production time is the duration that is used to manufacture products including time transferring the material. After evaluating the result of SLP, then selection stage can be done using the best score of each criteria.

3. Result and Discussion

3.1 Evaluation Existing Layout

The result of the use of plant layout criteria checklist for initial layout of 38% answered "Yes". That means, 62% of the criteria is not met and material handling criteria checklist produces 49% answer "Yes" and the cost needed of handling materials on initial layout Rp 11,346, 590.68

3.2. Designing plant layout based on Systematic Layout Planning

3.2.1. Calculate the amount of machines used Routing Sheet

Capacity used to re-layout is the highest of the year 2016 i.e. request in January. the number of machines need to be calculated to produce the product capacity using the routing sheet. After obtained the number of machines needed, compared with the number of machines that already exist in the production floor. The result is shown in Table 2.

Table 2. The Comparison Of The Machine Quantity

No	Machine	Quantity of machine needed	Quantity of machine already exist	Machine shortage
1	Mixer 20 Kg	1	2	+1
2	Mixer 200 Kg	1	1	0
3	Mixer 500 Kg	1	1	0
4	Dempul	1	1	0
5	Sandmill	1	2	+1
6	Atritor Cie	2	1	-1
7	Timbangan	2	1	-1
8	Packing	10	1	-9
9	Manual	13	5	-8
10	Saringan	8	5	-3

The results of routing sheet calculation are used as the number of machines on an alternative layout.

3.2.2 Analyze The Material Movement Used From To Chart (FTC)

From To Chart (FTC) is the map that is used to analyze the movement of material that occurs in the production floor. In this study, the type FTC used are the FTC distance and FTC cost. The FTC distance is the chart showing distance between machines or departments in the production floor. Range data retrieved from a distance using the formula calculation of rectilinear. FTC cost are the result of the frequency multiplied by the costs/meter with the distance between the departments. Frequencies obtained from the MHES. Transfer cost for handling manual is Rp 156.25/meters and cost for handling with trolley is Rp1736,11/meter.

3.2.3 Activity Relationship Diagram

The data obtained in the FTC processed further by calculating the Inflow and outflow's coefficient (quantitative) is then converted into a form of qualitative called activity relationship chart (ARC). The ARC was changed to List the relationship closeness to see a priority in drafting the layout using Relationship Diagramming algorithm [12]; [13]. The Activity Relationship Diagram of production floor layout has seen in Figure 2.

3.2.4 Space Requirement

The space requirement for each workspace is a result from the required space compared with the space that is available. If there is a discrepancy, then it will use the larger area of the workspace for calculating the area of AAD, because of the inclusive allowance. The space requirement for each department show in Table 3.

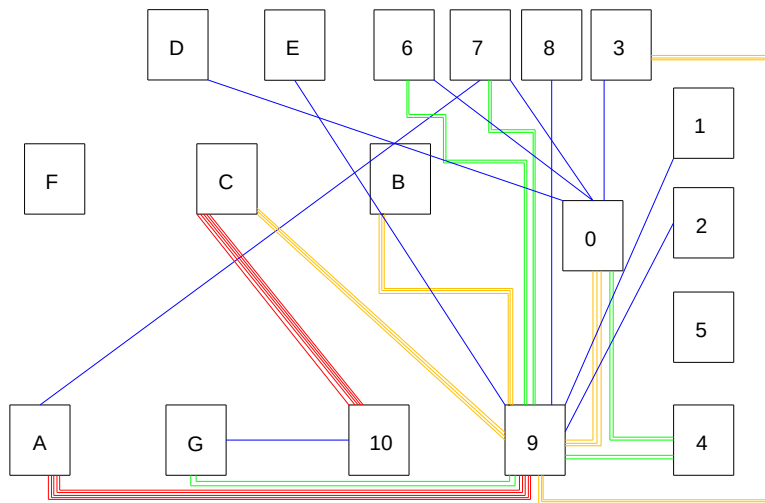


Figure 2. Activity Relationship Diagram of PT. Gunaprima Budiwijaya

Table 3. Space Requirement Each Department

Dept.	Production Area	Space Area (m ²)	Require Space
1	Mixer Machine 20 Kg	0.55	5.38
2	Mixer Machine 20 Kg	0.5	5.38
3	Mixer Machine 200 Kg	1.25	6.5
4	Mixer Machine 500 Kg	1.68	6.92
5	Putty Machine	1.1	5.62
6	Sand mill Machine	1.38	6.12
7	Sand mill Machine	1.38	6.12
8	“Atritor Cie” Machine	0.39	12.32
9	Weighing Area	ei	15
10	Packing Area	20	20
A	Raw Material Warehouse	30	55.52
B	Resin Warehouse	40	23.55
C	Storage	40	0
D	Pail Warehouse	10	8.608
E	Cans Warehouse	10	5.7875
F	Used Drum Warehouse	45	58.5
G	Temporary Storage	10	10
0	Empty Area	5	5
TOTAL AREA		233.23	256.3255

3.2.5. Space Relationship Diagram

Space relationship diagram is similar to Activity Relationship Diagram (ARD) the difference is just on the vast of the space. Activity relationship diagram only describing the relationship of each department. The space relationship diagram using the real space for each department in the layout.

3.2.6. Practical Limitation

Designing the layout based on Area Allocation Diagram and there will be limitations in placing departments on the production floor:

1. Sand mill machine requires 50 cm thick step.
2. Placement of machines should be close to the wall to facilitate electrical installation.
3. Placement of warehouse cultivated with rolling door.

3.2.7 Layout of Systematic Layout Planning

Systematic Layout Planning produced 4 alternatives layout that shown in figure 3, figure 4, figure 5, and figure 6 as follow

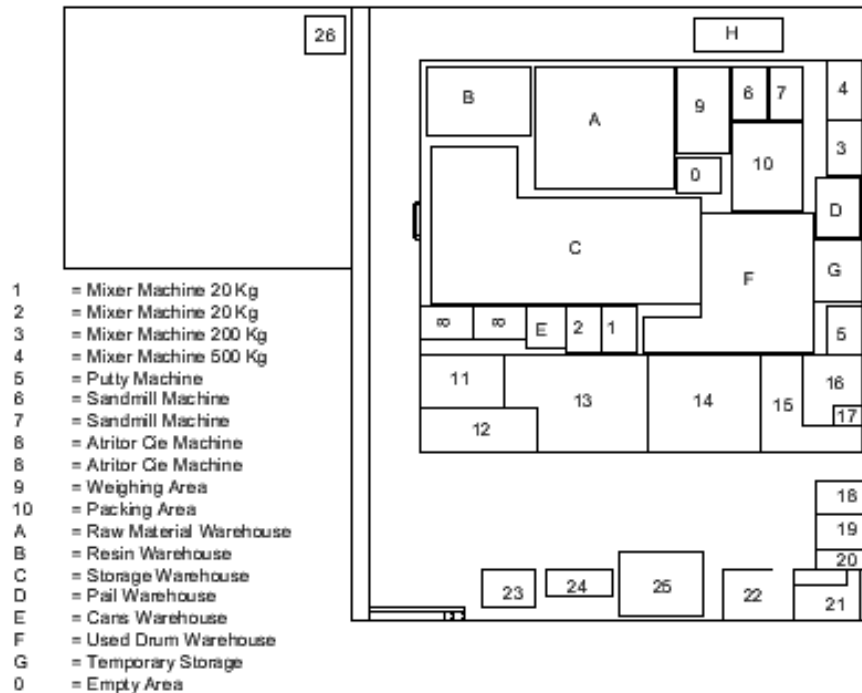


Figure 3. Layout of Systematic Layout Planning Alternatives 1

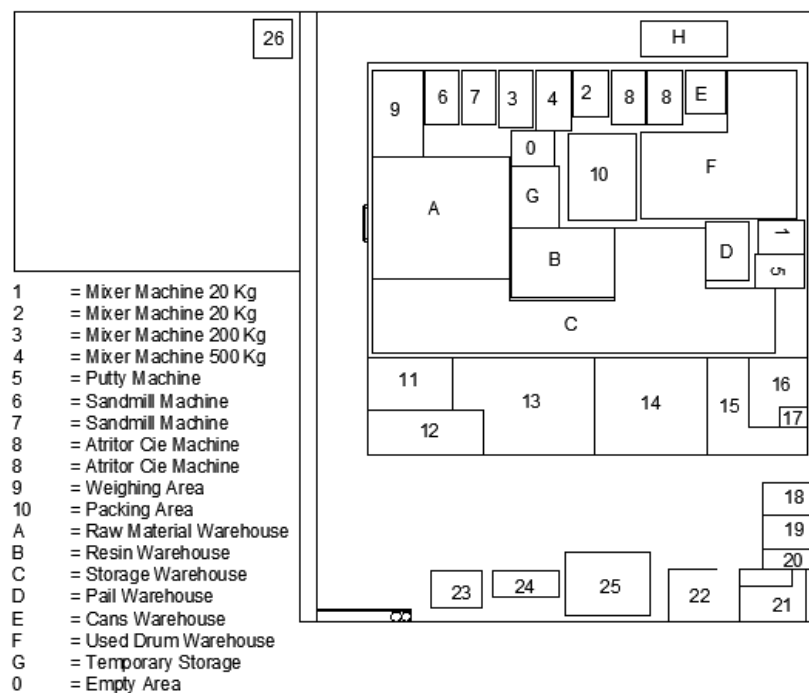


Figure 4. Layout of Systematic Layout Planning Alternatives 2

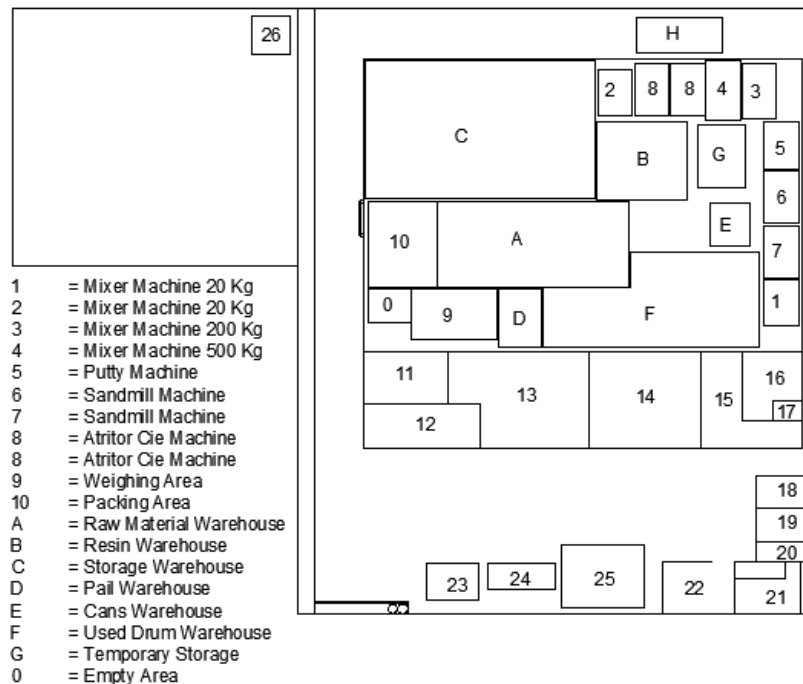


Figure 5. Layout of Systematic Layout Planning Alternatives 3

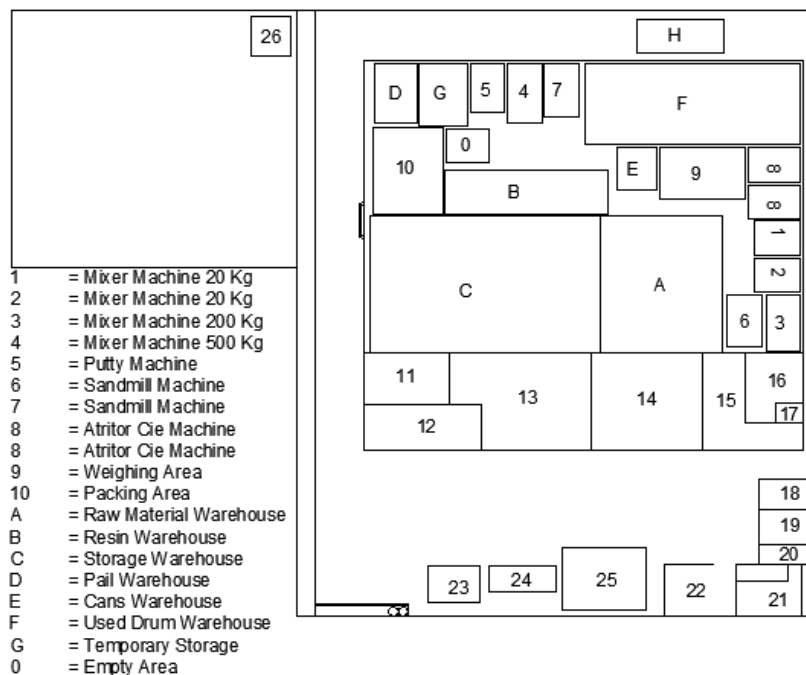


Figure 6. Layout of Systematic Layout Planning Alternatives 4

3.3. Evaluation and Selection

The result of reckoning material handling costs and production process time can be seen in Table 4. Each layout alternative results in different material handling costs. Alternatives 1, 2, and 4 results in lower material handling costs compared to the initial layout material handling material cost, but for alternative 3 material handling costs generated over the cost of the initial layout material handling.

Table 4. Result of Material Handling Costs and Production Process Time

Alternative	MHES Cost	The percentage decline or and increase in cost	Production Process Time (Hour)
Initial	Rp 11,292,201.80	-	-
1	Rp 10,119,807.57	10.38	148.5
2	Rp 10,062,388.46	10.89	142.53
3	Rp 15,241,479.21	-34.97	177.5
4	Rp 11,270,681.90	0.19	152.6

4. Conclusion

The initial layout analysis yielded that, the company's initial layout can only fulfill 38% on the checklist of layout criteria and 49% on material handling checklist. The cost of material handling in the initial layout is Rp 11.292.201.80. The search results using systematic layout planning can increase production capacity from 8,000 kg to 11,000 kg or 37.5% and can reduce material handling costs by 10.98% compared to the initial layout or approximately Rp1,229,813.34. Production time of simulation result is 142,53 hours. Production time can be fulfilled by the company within one month because available time is 192 hours. This propose layout must be improve using another improvement method like pairwise exchange method.

5. References

- [1] Sutari O and Rao S 2014 Development of Plant Layout using Systematic Layout Planning (SLP) to Maximize Production – A Case Study. *International Journal of Mechanical And Production Engineering* **2**(8), 63-6.
- [2] Wiyaratn W, Watanapa A and Kajondecha P 2013 Improvement Plant Layout Based on Systematic Layout Planning. *IACSIT International Journal of Engineering and Technology* **5**(1), 76-9.
- [3] Shewale PP, Shete MS, and Sane SM 2012 Improvement in Plant Layout using Systematic Layout Planning (SLP) for Increased Productivity. *International Journal of Advanced Engineering Research and Studies* **1**(3), 259-61.
- [4] Barnwal S and Dharmadhikari P 2016 Optimization of Plant Layout Using SLP Method. *International Journal of Innovative Research in Science, Engineering and Technology* **5**(3), 3008-15.
- [5] Law AK 2000 *Simulation Modeling and Analysis*.(Singapore: McGraw Hill Higher Education).
- [6] Guimarães AMC and Diallo M 2012 Using Simulation in an Industry of Gasket Products: A Case St. *Engineering Management Research* **1**(2), 153-62.
- [7] Tearwattanarattikal P, Namphacharoen S and Chamrasporn C 2008 Using ProModel as a simulation tools to assist plant layout design and planning: Case study plastic packaging factory. *Songklanakarin J Sci Technol* **30**(1), 117-23.
- [8] Akpınar ME, Yıldız SA, Karabulut Y and Doğan E 2017 Simulation Optimization for Transportation System: A Real Case Application. *TEM Journal* **6**(1), 97-102.
- [9] Apple JM 1990 *Plant Layout and Material Handling*.(USA: John Wiley & Sons, Inc).
- [10] Muther R 1973 *Systematic Layout Planning*.(Boston: CBI Publishing Company).
- [11] Jain S and Yadav TK 2017 Systematic Layout Planning: A Review of Improvement in Approach to Pulse Processing Mills. *International Research Journal of Engineering and Technology (IRJET)* **4**(5), 503-7.
- [12] Tompkins JA 2010 *Facilities Planning*. fourth edition ed.(California: John Willey & Sons).
- [13] Sugandhi SD and Bharule A 2016 Fine Blanking Plant Layout Improvement Using Systematic Layout Planning. *International Journal of Scientific Engineering and Research (IJSER)* **4**(4), 1-4.