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RE-LAYOUT DESIGN OF THE PRODUCTION MACHINE THROUGH BLOCPLAN AND SYSTEMATIC LAYOUT PLANNING (SLP) METHOD

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Abstract

Production machine layout arrangement at PT. Ometraco Arya Samanta requires new planning to increase the efficiency of space use. This research aim to implement systematic layout planning (SLP) and Blocplan-90 can produce proposals for new production machine layouts with research results, including obtaining alternative production machine layouts. Second, reducing material handling distance. Designing the steel material production floor layout using the systematic layout planning (SLP) and Blocplan-90 methods considers the degree of close relationship between the machines used and the production process flow. Several aspects include area requirements, standard track width, and available area. The selection of alternative designs was based on specific criteria such as the total distance moved and the area used. We chose the alternative layout that succeeded in producing increased efficiency in terms of the total reduction in distance moved and the area used compared to the initial layout. Alternative layout analysis shows that alternative layout 2 succeeded in reducing material handling movement distance by 34.68 meters or 22.24% and reducing area requirements by 74 meters or 18.6%, compared to the initial production machine layout.

Keywords: Production Machine Layout, Systematic Layout Planning, Blocplan-90, Alternative Layout.

1. Introduction

In modern manufacturing industries, an efficient production layout is crucial in optimizing workflow, reducing material handling costs, and improving overall productivity. Poorly designed layouts often lead to excessive movement, increased lead times, and inefficient resource use, which can negatively impact a production facility's operational efficiency (Singh & Sharma, 2020). Thus, an optimized layout is essential to enhance the performance of production machines and ensure seamless operations.

Facility layout is a part of facility design that focuses more on the arrangement of physical elements. Physical elements can be machines, tools, tables, and buildings. On PT. Ometraco Arya Samanta, There is a Hall 3 that manufactures steel plate material components; there are several machines, namely, a cutting machine, CNC plasma cutting and gas, CNC face punch, hydra cut bending, manual press and CNC punch. The problem in the production process, especially item 3, is that the layout of the machine is poorly organized. Another problem is the accumulation of material in the production space, which disturbs the movement space for workers, operators, and materials and seems poorly organized.

Designing or redesigning a production layout requires systematic methodologies considering various factors, such as space utilization, process flow, and equipment placement. One commonly used facility layout planning technique is the BlocPlan method, which provides a computerized approach to generate and analyze alternative layout solutions based on adjacency and space requirements (Tompkins et al., 2018). In addition, the Systematic Layout Planning (SLP) method, developed by Richard Muther, is widely recognized as a structured approach to layout design. SLP involves the systematic evaluation of relationships between different workstations and production areas to develop an optimal facility arrangement (Muther, 2015).

This research aims to investigate the application of BlocPlan and SLP methods in the re-layout design of production machines to improve efficiency and productivity. The study will analyze the existing layout, identify inefficiencies, and propose an improved arrangement based on systematic layout planning principles. The findings are expected to contribute to industrial engineering and provide practical recommendations for manufacturing companies seeking to optimize their production facilities.

Numerous studies have demonstrated that integrating these two methods can significantly enhance production efficiency by minimizing material handling distances and improving workflow continuity. For example, research by Nordin et al. (2021) found that the combination of BlocPlan and SLP resulted in a 25% reduction in material handling costs in an automotive manufacturing plant case study. By applying BlocPlan and SLP, manufacturers can develop an optimized machine layout that reduces bottlenecks, enhances flexibility, and improves workplace safety (Chand & Shirazi, 2022).

The analysis in this study used the Systematic Layout Planning (SLP) method and Blocplan-90, which aimed to analyze the layout of production machines and propose a more optimal layout. Research on the layout of production machines is carried out on machines that produce components made of steel plate material; the creation of the proposed layout design using bloc plan-90 software and systematic layout planning does not calculate the time and cost of material handling.

Applying systematic layout planning and blocplan-90 methods can result in more effective layout placement due to reduced distances and more efficient displacement moments. Utilizing the degree of proximity relationship between the machines used and the production process flow can provide a more efficient alternative layout to the layout of PT Ometraco Arya Samanta.

2. Material and methods

2.1. Material

The application of Systematic Layout Planning method and Blocplan-90 software has several stages described namely:

a. INPUT Data to be used are activity relationship chart, activity relationship diagram, area requirements, and distance between machines.
b. Analysis of the layout of production machines will be compared using systematic layout planning method and software blocplan-90.
c. OUTPUT The resulting result will show a reduction in the distance between machines and a reduction in the area used.

Calculation of distances using the rectilinear system, that is, the distance measured between the center of one work station and the center of the other work station. Each work station is searched for its central point, which is 0 of X and Y. The reason for using this method is the flow-carrying trajectory/path traveled by materials and semi-finished products (Rengganis and Mauidzoh, 2021).

2.2. Methods

Layout design using Systematic Layout Planning (SLP) is widely used in research. This approach is widely used for a wide variety of problems, and according to Wignjosoebroto, the method of solving includes several stages, among others, issues of production, transportation, warehousing, supporting services, and activities encountered in the office or office layout (Karisma & Fatimah, 2022). Drawing up a layout using the SLP method, according to Wignjosoebroto, can be divided into three phases, the first of which is the analysis phase. In this phase, input data, including product and process information, is collected. Once the input data has been collected, a material flow and activity analysis are performed. The results of this analysis are then used as a basis for creating the Activity Relationship Diagram (ARC). From ARC, an activity relationship diagram or Activity Relationship Diagram (ARD) is created. Next, considering the area size's needs and the available area, a Space Relationship Diagram (SRD) is created. Second is the Synthesis Phase or design process. This phase is the stage of creating or designing alternative layouts. Adjustments to layout creation goals can be specified in this method by adjusting layout creation goals. Third, the alternative selection phase of the layout. In this phase, research was carried out on alternative layouts. The choice of alternative layout is based on several objectives to be achieved (Siahaan & Oktiarso, 2019).

BLOCPLAN is a facility layout design system developed by Donaghey and Pire at the Department of Industrial Engineering, University of Houston. The program creates and evaluates layout types to respond to input data. BLOCPLAN bears a resemblance to CRAFT in the preparation of departments. The difference is that BLOCPLAN can use linkage maps as data input, whereas CRAFT uses from-to charts. The layout cost can be measured by the size of the distance and by proximity. The program determines the number of lines in BLOCPLAN, which is usually two or three lines. BLOCPLAN also has a disadvantage: it will not accurately capture the initial layout. Layout development can only be sought by making changes or exchanging the layout of departments with one another. In addition to the linkage map, BLOCPLAN sometimes uses another data input, namely a from-to chart; only the two inputs are used, and only one is used when performing layout evaluation. The layout cannot be evaluated by combining linkage maps and flow data. (Pratiwi and Muslimah, 2012).

3. Data Processing & Analysis

3.1. Initial Area of Production Layout

The requirements of the area of the production floor for the layout of the steel plate material production machine are adjusted to the actual conditions, for each dimension of the production machine, an allowance will be given that serves to determine the area of the production floor and the needs of the track (aisle) will be added according to the design of the production floor.

Table 1. Large Area Needs

Code	Machine / facilities	Total	Long (m)	Width (m)	Allowance (20%)(m^2)	Area (m^2)	Area Total (m^2)
A	*Cutting Machine*	3	3,2	2,2	1,40	8,44	25,32
B	*Blander Machine*	2	4,3	2,7	2,32	13,93	27,86
C	*CNC Plasma Cut and Gas*	1	14,5	4,8	13,92	83,52	83,52
D	*CNC Ficep Punch*	1	3,5	3,1	2,17	13,02	13,02
E	*CNC Punch*	1	4	3,5	2,8	16,8	16,8
F	*Press Manual*	2	2	1,5	0,6	3,6	7,2
G	*Hydracut* Bending	2	6	2,3	2,76	16,56	33,12
-	Track Requirement	1	95,5	2	-	191	191
			Total				397,84

In the table above it is known the total requirement of the production floor area of 397.84 m^2. The extensive needs of this production floor will later be needed as an alternative creation of the layout of the production machine.

3.2. Distance Between Machine

The distance between production machines is the distance that connects machines to machines in order to transfer material from one machine to another. Calculation of the distance between production machines by reference of the center point of each production machine to find out the distance between production machines.

Table 2. Distance Between Machine

From	To	Distance (m)
Cutting Machine 1 (A)	Press Manual 1 (F)	13,04
Cutting Machine 2 (A)	Press Manual 1 (F)	20,6
Cutting Machine 3 (A)	Press Manual 2 (F)	29,12
CNC Plasma Cut and Gas (C)	CNC Ficep Punch (D)	6,69
Blander Machine 1 (B)	CNC Punch (E)	27,49
Blander Machine 2 (B)	CNC Punch (E)	21,01
Press Manual 1 (F)	Hydracut Bending 1 (G)	12,89
Press Manual 2 (F)	Hydracut Bending 2 (G)	12,14
CNC Ficep Punch (D)	Hydracut Bending 1 (G)	4,45
CNC Punch (E)	Hydracut Bending 2 (G)	8,47

3.3. Activity Relationship Chart

An activity relationship chart (ARC) or activity relationship map can be measured by a measure of the degree of closeness of relationships between machines. The values used indicate the degree of relationship according to the underlying reason in an activity relationship map.

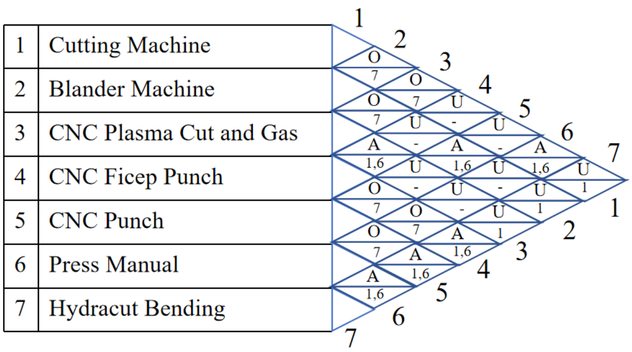

Figure 1. Activity Relationship Chart

3.4. Space Relationship Diagram

Further, the creation of an activity relationship diagram (ARD) that describes the relationship between the flow patterns of production activity and the location of each production machine. The creation of ARD was carried out after ARC data providing an explanation of the relationship of material flow to the location of each machine was obtained.

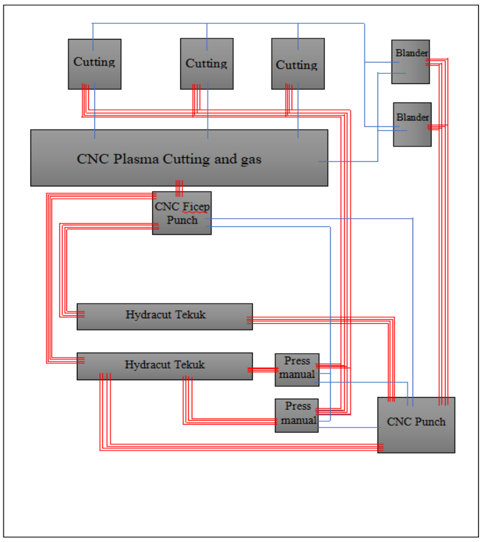

Figure 2. Activity Relationship Diagram

3.5. Blocplan-90 Software Analysis

Subsequent design alternatives are carried out by the blocplan method. Calculation using Blocplan-90 software. The data used as input in this method comes from the Activity Relationship Chart (ARC) and the area of each production department.

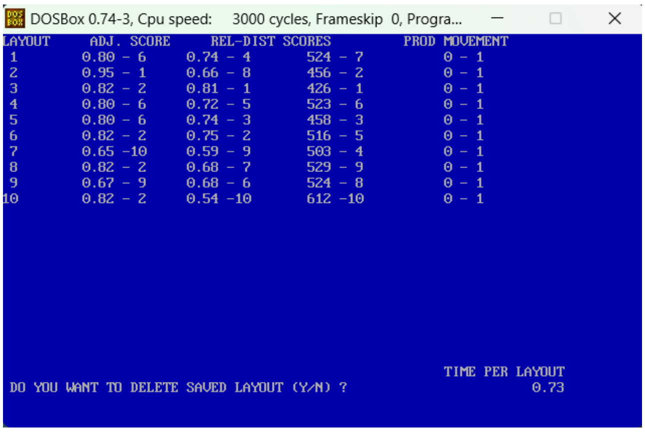

Figure 3. Blocplan-90 Software Analysis

Of the 10 analysis results obtained using BlocPlan-90 software, the best layout is the one that has R-Score/ADJ Scores sorted. The highest R-score was the 3rd analyzer with a value of 0.82, and the Rail Dist with a value of 426. Therefore, the 3rd and 6th layouts were chosen as alternatives to the layout proposal.

Table 3. Calculation of Proposed Layout Distance One By SLP Method.

From	To	Distance (m)
Cutting Machine 1 (A)	Press Manual 1 (F)	16,04
Cutting Machine 2 (A)	Press Manual 1 (F)	8,87
Cutting Machine 3 (A)	Press Manual 2 (F)	9,01
CNC Plasma Cut and Gas (C)	CNC Ficep Punch (D)	10,68
Blander Machine 1 (B)	CNC Punch (E)	11,44
Blander Machine 2 (B)	CNC Punch (E)	6,04
Press Manual 1 (F)	Hydracut Bending 1 (G)	19,50
Press Manual 2 (F)	Hydracut Bending 2 (G)	19,96
CNC Ficep Punch (D)	Hydracut Bending 1 (G)	3,87
CNC Punch (E)	Hydracut Bending 2 (G)	22,24

3.6. Calculation of Material Handling Distance

From the results of observations that have been carried out at PT. Ometraco Arya Samanta, obtained alternative layout coordinate points using Systematic Layout Planning and Blocplan methods. Calculation of material displacement distance is carried out by the method of rectilinear calculation.

Table 4. Calculation of Proposed Layout Distance of Two By Blocplan Method.

From	To	Distance (m)
Cutting Machine 1 (A)	Press Manual 1 (F)	12,14
Cutting Machine 2 (A)	Press Manual 1 (F)	8,91
Cutting Machine 3 (A)	Press Manual 2 (F)	8,56
CNC Plasma Cut and Gas (C)	CNC Ficep Punch (D)	10,65
Blander Machine 1 (B)	CNC Punch (E)	5,25
Blander Machine 2 (B)	CNC Punch (E)	5,58
Press Manual 1 (F)	Hydracut Bending 1 (G)	15,84
Press Manual 2 (F)	Hydracut Bending 2 (G)	20,9
CNC Ficep Punch (D)	Hydracut Bending 1 (G)	19,48
CNC Punch (E)	Hydracut Bending 2 (G)	13,91

Table 5. Calculation of Proposed Layout Distance of Three With Blocplan Method.

From	To	Distance (m)
Cutting Machine 1 (A)	Press Manual 1 (F)	24,59
Cutting Machine 2 (A)	Press Manual 1 (F)	20,2
Cutting Machine 3 (A)	Press Manual 2 (F)	19,45
CNC Plasma Cut and Gas (C)	CNC Ficep Punch (D)	24,87
Blander Machine 1 (B)	CNC Punch (E)	12,72
Blander Machine 2 (B)	CNC Punch (E)	6.32
Press Manual 1 (F)	Hydracut Bending 1 (G)	9.98
Press Manual 2 (F)	Hydracut Bending 2 (G)	9.95
CNC Ficep Punch (D)	Hydracut Bending 1 (G)	18.67
CNC Punch (E)	Hydracut Bending 2 (G)	10.54

3.7. Area Calculation

Machine area requirements do not change because the machine is only moved in position instead of changing its dimensions, while for trajectory needs are adjusted to the machine location according to systematic layout planning (SLP) and blocplan-90 analysis.

Table 6 Calculation of Area used.

Large Area Requirement	First Layout	Alternative 1	Alternative 2	Alternative 3
Machine Area (m^2)	206,84	206,84	206,84	206,84
Track Area (m^2)	191	160	117	117
Total (m^2)	397,84	366,84	323,84	323,84

4. Results and discussion

Based on the results of the calculation of the proposed layout that has been carried out using the Systematic Layout Planning and Blocplan methods, the following are the results obtained from this study.

4.1 Total Proposed Layout Distance Changes

The total displacement distance on the proposed layout is based on the results of data processing, resulting in several layout alternatives. To see the comparison between the material handling distance in the initial layout and the proposed layout, it can be seen in Table 7.

Table 7. Total Change in Displacement Distance.

Layout	Total Displacement Distance (m)	Total Distance Reduction (m)	Percentage (%)
First Layout	155,9	-	-
Alternative 1	127,65	28,25	18,12
Alternative 2	121,22	34,68	22,24
Alternative 3	157,29	-1,39	-0,89

4.2 Total Changes in Proposed Layout Area

Total decrease in widespread need on proposed layouts based on data processing results, resulting in few layout alternatives. To see the comparison between the broad needs on the initial layout and the proposed layout, it can be seen in Table 8.

Table 8. Total Change of Area Needs.

Layout	Total Area Needs (m)	Total Area Decrease (m)	Percentage (%)
First Layout	397,84	-	-
Alternative 1	366,84	31	7,79
Alternative 2	323,84	74	18,6
Alternative 3	323,84	74	18,6

Alternative production machine layout 2 can be used as a proposal for the layout of production machines due to the analysis results of a decrease in material handling distance by 34.68 meters or 22.24% and a decrease in area area requirements by 74 meters or 18.6%, obtaining the most efficient result compared to other production machine layouts. The layout changes can be seen in figures 4 and 5.

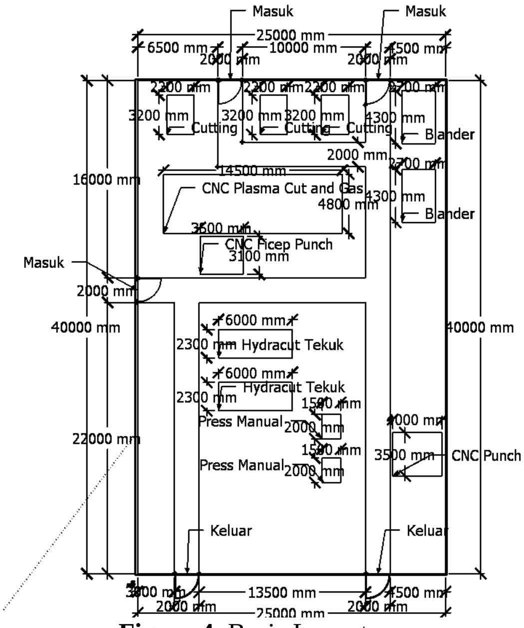

Figure 4. Basic Layout

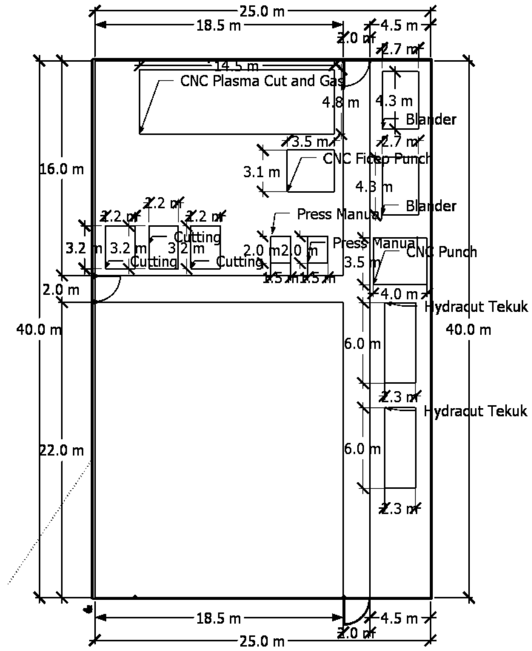

Figure 5. Proposed Layout

5. Conclusion

The use of systematic layout planning (SLP) and 5S on the production floor of the steel material project has concluded that:

a. The design of the production floor layout with the systematic layout planning (SLP) method considers the degree of proximity relationship between the facilities used and the flow of the production process. Some aspects include area requirements, standard path width, and available area. The selection of alternative designs is based on criteria such as total displacement distance and area used, where the alternative layout selected successfully results in increased efficiency in terms of a total decrease in displacement distance and area used compared to the initial layout.

b. The analysis of alternative layouts demonstrates the successful results of the second layout. It effectively reduced material handling displacement distance by 34.68 metres, or 22.24%, and decreased area requirements by 74 metres, or 18.6%, compared with the initial production machine layout. This success instills confidence in the decision-making process.

c. The evaluation results using the respondent response sheet on the selected alternative layout show an increase in all indicators of the 5S method (seiri, seiton, seiso, seiketsu, and shitsuke), with an overall average score reaching 4.34 from 3.54 in the initial layout. Thus, based on the Likert scale, applying the 5S method on the material steel production floor can be categorised as very good.

Credit authorship contribution statement
Zandy Sholahudin Zaeni: Conceptualization, Writing – review & editing.
Anda Iviana Juniani: Supervision, writing, review & editing.
Khafifulloh Al Faqih Zam Zammi : peer-review & editing

Declaration of Competing Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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