Redesigning the layout with algorithm craft on boiler manufacturing

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Abstract. Smooth production flow must be considered in planning the production floor layout. Good design of manufacturing facilities can increase effectiveness and efficiency through reducing material transfer distances, material handling costs and cycle times used. A boiler-making industry has constraints in the preparation of machinery so that back tracking occurs which has an impact on long cycle times and increased material handling costs. So this research was conducted to redesign the layout using the graph method and the CRAFT algorithm. And the results of the layout design of the two methods are done by comparing the moment of displacement. The design of the proposal using the CRAFT algorithm provides an increase in time efficiency of 8.95% or the equivalent of 1598 minutes per product and the cost of material handling fell by Rp 47,403.90 / year.

1. Introduction

Smooth flow of production must be considered in planning the production floor layout because the design of the production floor is one part of the planning of the factory layout. If the smooth production is disrupted, it will be closely related to the production trajectory, total distance, imbalance capacity and floor space (space availability or floor area) will also be constrained. Therefore, it is very important to maximize the smooth flow of production by paying attention to the design of factory layout, especially material handling so that the costs of transferring materials can be minimized [1-4].

Setting the layout of production facilities and work areas is a problem that is often encountered in the industrial world. This problem is unavoidable, even if it is simply regulating equipment or machinery in a room or production floor, as well as in a small and simple scope. In planning the production floor layout, it must also be considered about material handling. In the production process that uses machines that work specifically, the transfer of material between machines must be carried out effectively and efficiently. In the process of making products, it is often found that the product cannot be completed only through a machine or production facility, but must go through a series of processes that use many machines or production facilities. Thus it is unavoidable to carry out material handling.

Research using the CRAFT algorithm has been carried out in many previous studies, in typical companies such as crafting with special machines and getting better material transfer [5-6]. Research has also been conducted on boiler manufacturing companies with simple and graphical methods that calculate the moment of displacement and material handling costs that are more optimal using the
graph method [7]. Research on rubber and rubber compound companies has been carried out using the ALDEP algorithm and getting better results based on the moment of displacement. [8]. Research that has been done in designing the layout in other manufacturing fields uses the BLOCPLAN algorithm in the company that manufactures spare parts for palm oil mill machinery by using a pair of inter-machine matrices and the results obtained minimize production time [9]. Research has also been conducted on passenger wheel producing companies that have constraints on the time and distance of making products so that companies want to increase company productivity using the Systematic Layout Planning method and improve line balancing systems [10]. CRAFT is data processing using a computer that simplifies all data management work. CRAFT is an example of a HEURISTIC technique type program that is based on the interpretation of "Quadratic Assignment" from a layout process program, which has basic criteria used to minimize the cost of material transfer, where this cost is described as a linear function of displacement distance. The CRAFT algorithm calculates the flow times, transfer costs, and distance between activity centers. Then consider location exchanges and test changes in two directions or three directions. An exchange is carried out which causes the greatest reduction in costs, and calculates the new total cost. This process is repeated until there is no significant reduction in costs. This program is cross-oriented, so the possibility of exchanges is not tested all [11-15].

2. Methodology/Experimental

This type of research contains the research methods used in action research [3], because it aims to get a better layout. This research was conducted in the boiler making industry in Medan city. The stages of the research process include the process of collecting, presenting, evaluating and processing data as well as analysis and interpretation. In data collection, it is carried out in two stages, namely primary data and secondary data.

Primary data is direct data obtained from direct research in the field, namely: Sequence of production processes for each component of the product under study, Amount of displacement that occurs in each component, and Distance between machines. Secondary data is data that is not directly observed by researchers. This data is company documentation, the results of previous research and other data, including: current production floor layout, data on production quantities, and machine / equipment specification data.

To make it easy to enter process data that occurs in the Travel Chart, it is necessary to do the coding of each process. Process data and the code used to represent each process that occurs can be seen in Table 1 below:

| No | Process             | Code |
|----|---------------------|------|
| 1  | Raw Material Warehouse | A    |
| 2  | Sand Blasting       | B    |
| 3  | Station of Marking  | C    |
| 4  | Station of Cutting  | D    |
| 5  | Teck Weld           | E    |
| 6  | Welding             | F    |
| 7  | Weld inspection     | G    |
| 8  | Drilling            | H    |
| 9  | Grinding            | I    |
| 10 | Turning             | J    |
| 11 | Assembly            | K    |
| 12 | Hydrotest           | L    |
Each product consists of several components. The bill of material for each product produced can be seen in Table 2.

**Table 2. Bill Of Material Boiler**

| Level | Code Part | Name Part          | Number |
|-------|-----------|--------------------|--------|
| 0     | UD        | Upper Drum         | 1      |
| 0     | LD        | Lower Drum         | 1      |
| 0     | DE        | Dish End           | 2      |
| 1     | RS        | Round Shell        | 3      |
| 1     | RMH       | Ring Man Hole      | 1      |
| 1     | NO        | Nozzle             | 12     |
| 1     | PM        | Pipe Membrane Wall | 6      |
| 1     | PR        | Boiling Door       | 1      |

And the sequence of production processes from product components can be seen in Table 3.

**Table 3. Sequence of Product Component Processes**

| Produk Komponen | Urutan Proses          |
|-----------------|------------------------|
| RS              | A-C-D-E-D-E-F-E-G-K    |
| RMH             | A-C-D-E-D-F-I-K        |
| NO              | A-C-D-I-J-K            |
| PM              | A-B-M-F-K              |
| PR              | C-D-M-F-J-F-I-K        |

From the data on the number of products above, it can be estimated the amount of raw material needs, namely the iron plate needed. Based on existing Bill Of Material, it can be known the number of component requirements of each product. The following will be given data about the number of component requirements of each product which can be seen in Table 4.

**Table 4. Boiler Production Volume**

| Name of Part          | Code Part | Number | Volume of Production (Unit) |
|-----------------------|-----------|--------|-----------------------------|
| Upper Drum            | UD        | 1      | 12                          |
| Lower Drum            | LD        | 1      | 12                          |
| Dish End              | DE        | 2      | 24                          |
| Round Shell           | RS        | 3      | 36                          |
| Ring Man Hole         | RMH       | 1      | 12                          |
| Nozzle                | NO        | 12     | 144                         |
| Pipe of Membran Wall  | PM        | 6      | 72                          |
3. Results and Discussion

3.1. Processing Data using the Systematic Layout Plant (SLP) Method

Systematic Layout Plant (SLP) is a layout design using qualitative methods that require a close relationship in completing the process. The first step to design with SLP is to create an Activity Relationship Chart (ARC), which is a map that explains the closeness of a department / machine to other departments.

The level of relations in the ARC is symbolized by 5 letters, namely A, E, I, O, U and X. The reasons for conducting close relations between departments are: Workflow sequence, Work Process Equation, Transfer Frequency, Noise Level, Heat. An example of a close relationship between a warehouse of raw materials and sand blasting, both departments have reasons to be brought closer because of the order of work flow as well as the warehouse of raw materials towards measurement. The frequency of displacement is also high so the level of relations between the two departments is absolutely necessary to be close (A). While the welding relationship with the assembly has a smaller displacement frequency so that the proximity of the two departments has a lower importance to be brought closer (I). ARC formed can be seen in Figure 1.

![Activity Relationship Chart on Steam Boiler](image)

**Figure 1.** Activity Relationship Chart on Steam Boiler

3.2. Processing data using the CRAFT Method

CRAFT is data processing using a computer that makes it easy for all data management work. CRAFT is an example of a HEURISTIC technique type program that is based on the interpretation of "Quadratic Assignment" from a layout process program, which has basic criteria used to minimize the cost of material transfer, where this cost is described as a linear function of displacement distance. In
the software select the Facility Location and Layout menu and then select the Functional Layout menu with objective criterion Minimization like Figure 2.

![Figure 2](image1.png)

Figure 2. The first step in selecting CRAFT work

Enter the material flow and the contribution per unit between the entire unit into the spreadsheet. Enter the flow loads and units to all departments into the spreadsheet can be seen in Figure 3.

![Figure 3](image2.png)

Figure 3. Input material flow data and material handling moments

After entering material flow data and material handling moments, the Function Layout Solution menu will appear as shown in Figure 4.

![Figure 4](image3.png)

Figure 4. Solve Problem CRAFT
4. Conclusion.
In the initial conditions, the distance between stations is 887.7 meters, the material handling moment is 15,760.80 meters per year. The selected proposal using the CRAFT method of designing the proposal provides an increase in time efficiency of 8.95% or equivalent to 1,598 minutes per product and the cost of material handling fell by Rp. 47,403.90/year.

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