Design of Facility Location for new model of Medical Pharmaceutical Refrigerator Production Area on PT. XYZ

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Abstract. PT. XYZ is a manufacturing company that produces medical devices. The company has planned to develop a new product called Medical Pharmaceutical Refrigerator (MPR). Based on research, the company has provided an area for MPR production of 648 m\textsuperscript{2}. After analyzing the process, 5 areas are used in conjunction with other products, but one area called Polyurethane Injection produces a product flow mismatch in the PU area. This problem is solved by designing a layout using the Industrial Facilities method and Systematic layout planning with the Product layout approach. Based on the results of the study, proposed two alternative layouts which then analyzed the weight of material transfer using the From-to Chart method. Layout design 1 has a weight transfer material of 9322.09 per day, while the proposed layout design 1 produces a weight transfer material of 5750.5 per day. So, the MPR production layout is determined using the layout design 2. By determining this layout, a biomedical warehouse area was moved at of 49.42 m\textsuperscript{2}.

Keywords: Facilities layout, Facilities Industry Method, Systematic Layout Planning, Product Layout, From to Chart.

1. Introduction
The design of facility layout is one of the things that need to be considered because it is closely related to the production process. The design is an activity that includes the utilization of the area available for the placement of machinery, the smooth movement of material transfer, material storage, and worker determination. A good layout will provide efficient material flow, shorter transfer distances, minimum material transfer costs, and shorter production processing times. Therefore, to achieve an optimal production process, design and layout of the production floor and facilities are required in a company. PT XYZ is a manufacturing company that manufactures medical devices and plan to add a new product called the Medical Pharmaceutical Refrigerator (MPR). Until now, the company has not planned the facility layout design for MPR products, but the area for production has been provided for 648 m\textsuperscript{2}. After analyzing the process, 5 areas are used in conjunction with other products that are already running, but one area called Polyurethane Injection produces a mismatch in the product flow in the PU area. Based on this description, this research will analyze the determination of the MPR production area requirements with the available area and follow the production flow that has been determined at 5
existing work stations. And how to determine the layout of facilities or work stations to best meet the MPR production capacity.

2. Methods
Below are the steps undertaken for the study:
1. Conduct field studies to understand the actual problems that occur in the field and conduct literature studies to find out how to solve problems that occur in the object of research.
2. Collect data that supports the problem-solving process in research. Primary data is the data of direct observation in the production area and interviews with related parties, and secondary data is data that has been provided by the company including product characteristics, production processes, number of production requests and machine sizes.
3. Designing facility layout to optimize MPR production output using systematic layout planning method. The stages in designing the facility layout can be explained following the sequence of activities developed by Richard Muther, namely through an approach known as Systematic Layout Planning (SLP). The stages in the making the plan are: (a) Activity Relationship Chart, (b) Activity Template Block Diagram, (c) making two proposed alternative layout designs, and (d) evaluating the layout.
4. Propose two alternative layouts then determine the best layout using the from-to-chart method. From-to-chart is a conventional method that is often used for layout planning. The result of From to chart is the weight of material transfer between the amount of material moved and distance traveled. The smallest material transfer weight is the best alternative design because the distance and the amount transferred is better and more efficient. The technique used for distance measurement is the Rectilinear method, which is the distance measured following a perpendicular path. Rectilinear distance measurements used the following notation:

\[ d_{ij} = |x_i - x_j| + |y_i - y_j| \]  

After that, enter the multiplication results of the amount of material moved and the distance of movement at each work station. Then the weight value of the material transfer will be obtained.
5. Inferring the results obtained in this study following the initial purpose of the study, namely to determine the facilities, area requirements and facility layout planning and the best layout obtained based on the overall results of the study. As well as advice to companies or further research development.

3. Result and Discussion

3.1. Product Characteristics
Medical Pharmaceutical Refrigerator (MPR) is one of the medical devices that has a size of 800x500x1820 mm, consisting of 233 parts that are purchased and assembled.

3.2. Production Process
The main production processes carried out for the manufacture of MPR consist of several things there are Transfer of raw material into the production area, Assembly of the inner box, outer box, cooling, evaporator, door and electrical, the inspection process, charging refrigerant, vacuum, aging unit, and packing. Based on the production process, a map of the operation process is then made, and the required machine data and machine facilities are obtained, then analyzed according to the size needed to be entered on the required area sheet.

3.3. Layout Type Analysis
The best layout type that can be applied is a layout based on product flow (Product Layout), this is seen from the products produced in large quantities and processes that take place repeatedly and similar. Also, it can be seen in the application of previous products that machines are arranged in the order of a process.
3.4 Determination of Area Needs

Based on the machine size data, the facilities obtained from the operational process map and the operator’s needs are determined by the area needs that have been given 50% leeway for the crossing road requirements as follows:

Table 1. Results of Determining the Need for Area

| Work Station               | Machine Name | Space Requirements (m²) |
|----------------------------|--------------|-------------------------|
| Inner Box Assembly         | BM/Rack/Work Table | 15,76785               |
| Outer Box Assembly         | Rack/Jig Outer Box   | 8,499                   |
| Combine Cabinet Assy       | CM/Rack/Work Table  | 21,7575                 |
| Cooling Assembly           | BRM/Rack/Work Table | 5,5605                  |
| Evaporator Assembly        | BRM/Rack/Work Table | 7,566                   |
| Door Assembly              | Work Table      | 7,00275                 |
| Unit Process               | BRM/Rack/Lifter unit | 7,44375               |
| Vacuum Unit                | VM            | 7,425                   |
| Refrigerant Charging       | RCM           | 3,21                    |
| Welding Unit               | UWM, HLD/Lifter Unit | 3,225               |
| Electrical Assembly        | Work Table     | 4,3275                  |
| Safety Inspection          | DPM, ECT, WIM  | 3,25575                 |

3.5 Facility Layout Design

The stages of designing the facility layout using systematic layout planning methods.

3.5.1 Material Transfer Planning. The characteristics of the raw material used for MPR assembly have varying sizes with a total number of parts of 233 items, as well as a low material flow rate and displacement distance with a relatively short product design layout type. Then applied material transfer is done manually, with a minimalist special Trolley Picking.

3.5.2 Making Activity Relationship Chart. The activity relationship chart is an analysis phase that is made in the form of a chart and is used to show the level of activity relationships between work stations. Each determination of the level of relationship is made by considering several reasons intended for the smooth production process.

![Figure 1. Activities-Relationship Chart](image-url)
Table 2. Table of reasons for work station connection

| Code | The Reason                  |
|------|----------------------------|
| 1    | Work flow sequence         |
| 2    | Use the same operator      |
| 3    | Transfer of material       |
| 4    | Facilitates repair         |
| 5    | Facilitate supervision     |
| 6    | Job interdependence        |
| 7    | Noise, dust                |

3.5.3 Creation of a Block Diagram Activity Template. The activity relationship diagram between work stations is made to show the combination of the level of visual relationship between work station area and the product flow that occurs in each process. Activity template block diagrams are made based on activity related worksheets. Two alternative ATBD designs were made as follows.

![Figure 2. Proposal ATBD 2](image)

![Figure 3. Proposal ATBD 1](image)

3.5.4 Designing Alternative Layouts. The alternative of layout design is based on a block diagram activity template in the form of a block scale with a certain scale and adjusted to the available area.
3.5.5 Evaluation of Alternative Layouts. Two alternative layouts have been made and evaluated, then the best alternative design is chosen. In the layout evaluation used the analysis of the movement of material activity between workstations on both layouts using the From-to-Chart method, used to determine the smallest material transfer weight. The flow of material is drawn based on the activity flow in the Activity template block diagram. Calculation of the distance between activities using the rectilinear distance measurement method.

- **Proposed Layout Analysis 1**

  Based on the block layout, the first suggestion is to get coordinate points at each workstation that can be seen in Figure 6.

**Figure 4. Proposal Block Layout 1**

**Figure 5. Proposal Block Layout 2**

**Figure 6. FTC Distance Between Centers Analysis 1**
After that, make a mapping with from-to-chart with the amount of material transferred between workstations that can be seen in Figure 7.

![Figure 7. FTC Amount of Material Analysis 1](image1.png)

Based on the amount of material and the distance that has been obtained, make a weight transfer matrix which shows the multiplication between the amount of material and the distance as follows.

![Figure 8. FTC Transfer Weight Analysis 1](image2.png)

- Proposed Layout Analysis 2

Based on the block layout, the first suggestion is to get coordinate points at each workstation that can be seen in Figure 9.
After that, make a mapping with from-to-chart with the amount of material transferred between workstations.

**Figure 9. FTC Distance Between Centers Analysis 2**

| Dari | Ke | 0   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  |
|------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0    | 1  | 10,3| 28,04| 21,64| 53,83|
| 1    | 2  | 4,06| 6,08 | 23,81|
| 2    | 3  | 2,38| 3,08 | 3,01 |
| 3    | 4  | 3,86| 5,74 | 4,65 |
| 4    | 5  | 6,08| 3,08 |
| 5    | 6  | 11,44|
| 6    | 7  | 3,03 |
| 7    | 8  | 2,14 |
| 8    | 9  | 11,03|
| 9    | 10 | 7,07 |
| 10   | 11 | 33,02|
| 11   | 12 | 5,21 |

**Figure 10. FTC Amount of Material Analysis 2**

Based on the amount of material and the distance that has been obtained, make a weight transfer matrix which shows the multiplication between the amount of material and the distance as follows:
From the results of the calculations in Figure 11, the determination of the proposed layout 2 produces a displacement weight of 5750.5, which causes a backflow of semi-finished material.

Based on the above calculation, the determination of the proposed layout 2 has a displacement weight of 5750.5 per day, which is smaller than the proposal layout 1, which has a displacement weight of 9322.09 per day. Thus, the MPR production layout was set using the proposed layout 2, although there was a backflow for semi-finished materials because the delivery time for raw materials and semi-finished materials did not occur at the same time, so it would not interfere with the smooth flow of materials.

4. Conclusion
Based on the result and the discussion above, the conclusion for this research are:
1. To increase the production area for the new model MPR with a production capacity of 4153 units, an area of 98.2966 m² is required. By determining the number of work stations as many as 17 areas of which 5 of them are existing work stations, then the addition of operators is needed as well as the addition of several new machines as follows: 1 piece of Bending, Crane, Refrigerant charging, Ultrasonic welding, and Safety inspection machine, 3 piece of Brazing and Vacuum machine.
2. By determining the production layout based on product layout, an analysis of the weight of material transfer in the two alternative layout proposals obtained layout proposal 1 has a displacement weight of 9322.09 per day and proposal layout 2 has a displacement weight of 5750.5 per day. The best MPR production layout to use is the proposed layout 2. By setting the layout, a biomedical warehouse area of 49.42 m² is required.

5. References
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Figure 11. FTC Transfer Weight Analysis 1