

# **Efficiency of Working Layout and Handling Materials Using the Activity Relationship Chart Method**

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## **Abstract**

PT. XYZ is a manufacturing company engaged in the manufacture of plastic roof. The products produced are Alderon, RS, Flat, and Wuwungan. In production requires a lot of raw materials, but the company does not have an area where raw materials. The production process of PT. XYZ uses forklift transport equipment. Obtained material handling transfer cost at the initial layout of Rp28,403,362.45. Therefore, it is necessary to design a new layout and design a warehouse proposal. Obtained material handling transfer cost in the ARC proposal layout of Rp19,360,439.60 with efficiency of 32%. It also created a comparative layout using corelap software. Obtained the cost of material handling movement on the layout of the proposed software corelap of Rp23,957,207.44 with an efficiency of 16%. So in this case the proposed layout ARC layout is better because it can save 32% cost of material movement from the initial layout

## **Keywords**

Layout, ARC, CORELAP, Material Handling, Class Based Storage and 5S.

## **1. Introduction**

PT. XYZ is a company engaged in manufacturing, which produces plastic roofing. The placement of raw materials for roofing at PT. XYZ does not have a dedicated area, so a lot of raw materials are placed around the production machine. This makes the performance of the workers less effective, because workers have to look for raw materials to be produced which are spread over several production areas first, then take them to a weighing room to determine the ratio of the product mixture to be used in making the roof. It is not uncommon for workers to ask other workers the location of the raw materials they are looking for, which makes the raw material extraction process less efficient. When the raw materials sent by suppliers arrive at the company, workers will immediately unload each raw material using a forklift and are placed in various places irregularly near the production machine area or in areas adjacent to the building entrance. The use of transportation of raw materials can only be done by using a forklift due to the large amount of raw materials in the tens of kilograms to tons required for production needs in each shift. This also makes companies have to pay extra in the use of heavy equipment such as forklifts, which are mostly used to transport raw materials from the pro-duction area to the weighing area.

Therefore, in order to support the performance of workers in the material transfer process, it is necessary to improve the layout design in order to streamline the movement of raw materials that are placed less effectively to be more effective so as to make worker productivity more effective and efficient, and can minimize the amount costs used to transport raw materials using a forklift.

## **2. Research Methodology**

This work begins with research methods such as conducting direct field observations at PT. XYZ. After conducting observations, several problems were found in determining the layout that was less efficient which could make employee performance less effective, as well as irregular placement of raw materials which led to high costs of moving raw materials. The purpose of making this re-search is based on existing problems, namely, to make layout proposals that are more efficient and provide layout proposals that minimize the cost of moving materials. Then retrieval of the data required for data processing such as distance, time, speed, number of departments, number of raw material arrivals

and so on. The data is then processed and analyzed in accordance with the predetermined theories in order to obtain the best proposed results. The final step is to draw conclusions and make suggestions for the company.

### 3. Results and Discussion

In providing a design efficient layout. An efficiency calculation is needed from the initial layout in order to know the efficiency value. The following is the calculation of the efficiency of the initial layout of PT. XYZ:

$$\begin{aligned}
 \text{Efficiency} &= \frac{\text{task time}}{(\text{number of work stations} \times \text{time cycle})} \\
 &= \frac{1440}{(10 \times 2442,96)} \\
 &= \frac{1440}{24429,96} \\
 &= 5,8 \%
 \end{aligned}$$

From these results, the efficiency value of the company's initial layout has an efficiency value of 5,8%. This value will be compared with the efficiency value of a proposed layout. Before calculating the efficiency value of the proposed layout, an activity relationship chart method is needed to design the proposed layout. Following are the steps in designing the proposed layout.

To make the layout proposal more efficient, some data is needed, such as the name of each department and the area of each area. The first step is to determine the value of closeness between departments to complete the activity relationship chart as shown below:

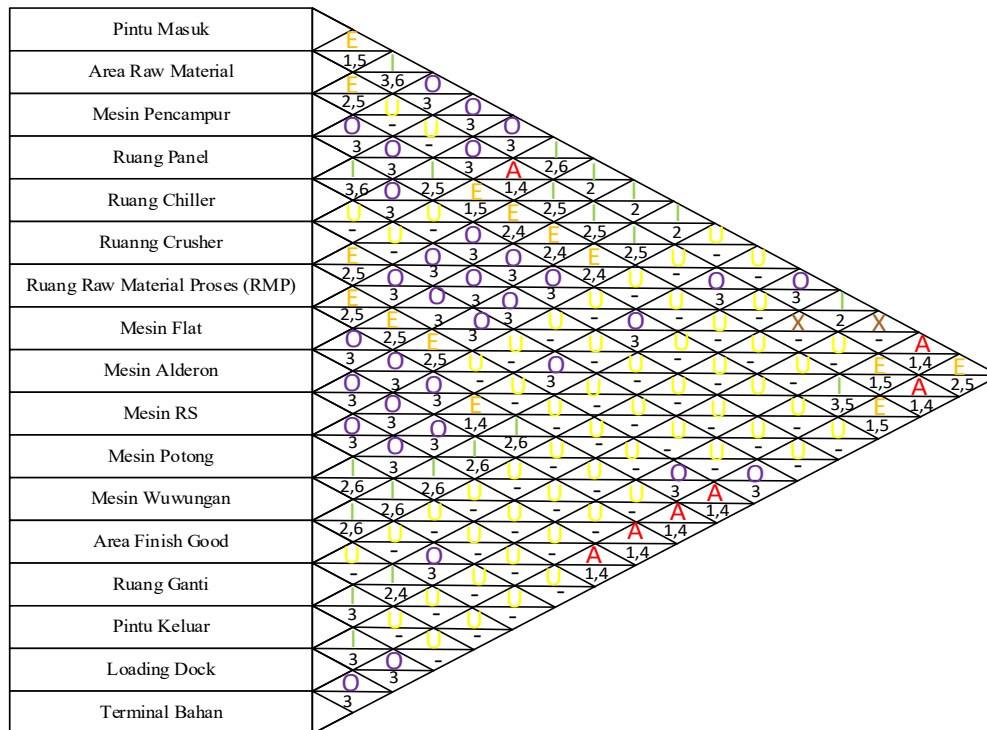


Figure 1. Relationship chart

Based on the activity relationship chart (Figure 1), a worksheet can be made to compile the proposed block diagram to determine the layout arrangement at PT. XYZ. Here are the proposed dimension-less for layout preparation:

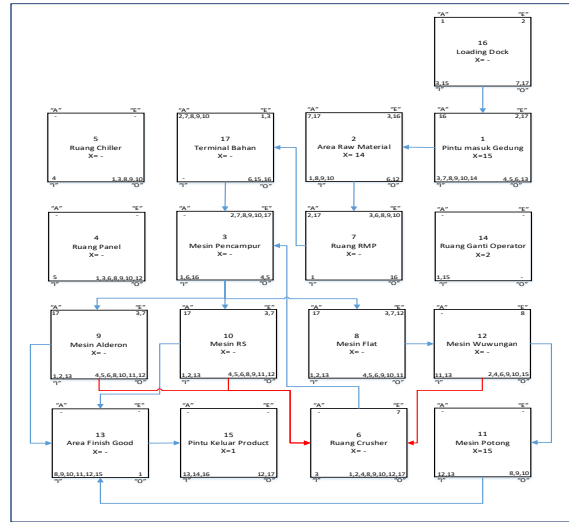


Figure 2. Block diagram

Below is a block diagram of the proposed layout to make the layout more efficient (Figure 2). The block diagram is marked with two different color lines, the blue line marks the movement of the raw material arriving at the loading dock until the raw material is processed and becomes a roofing product. The red line indicates products that are rejected and reprocessed into powder raw material. The following is a picture of the proposed layout that is suggested to be implemented by the company:

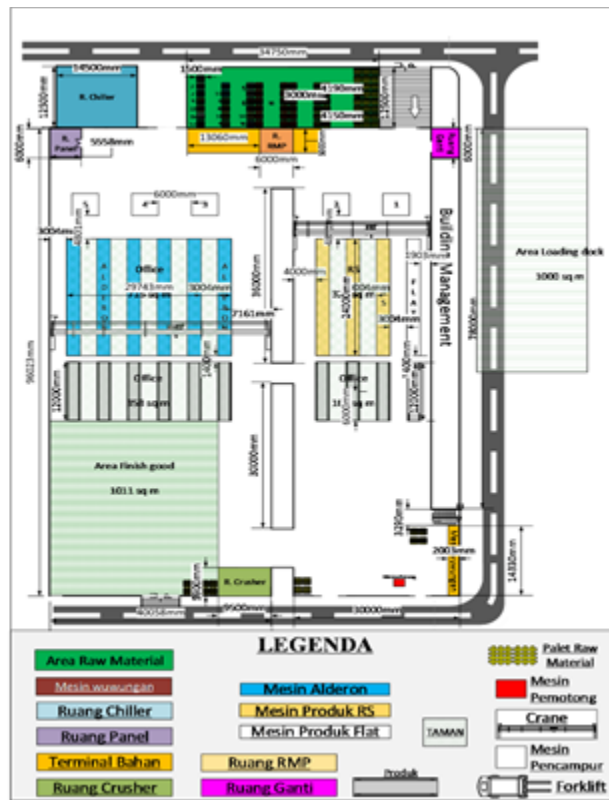


Figure 3. Storage area

In making the layout, improvements were made to create a storage area for raw materials so that the placement of each raw material becomes more regular (Figure 3). Making this warehouse can also have an effect on reducing the cost of moving raw materials. Therefore, for the grouping of raw materials, class-based storage is used which uses the total frequency of the use and receipt of raw materials in the production process for one year. The following is a grouping of raw materials that have been grouped (Table 1):

Table 1. Grouping of raw materials

Kode Bahan Baku	total frekuensi	persentase	total persentase	Kelas
X1	534	53,29%	79,94%	A
X10	267	26,65%		
X5	45	4,49%	16,47%	B
X11	43	4,29%		
X2	42	4,19%		
X6	35	3,49%		
X7	4	0,40%		
X9	4	0,40%	3,59%	C
X3	6	0,60%		
X8	4	0,40%		
X12	2	0,20%		
X14	4	0,40%		
X13	4	0,40%		
X15	2	0,20%		
X16	2	0,20%		
X4	2	0,20%		
X17	2	0,20%		

Based on the class grouping of each raw material, raw materials that are in class A must be placed close to the entrance and exit of the warehouse. Therefore, it can be arranged the location of each raw material as follows:

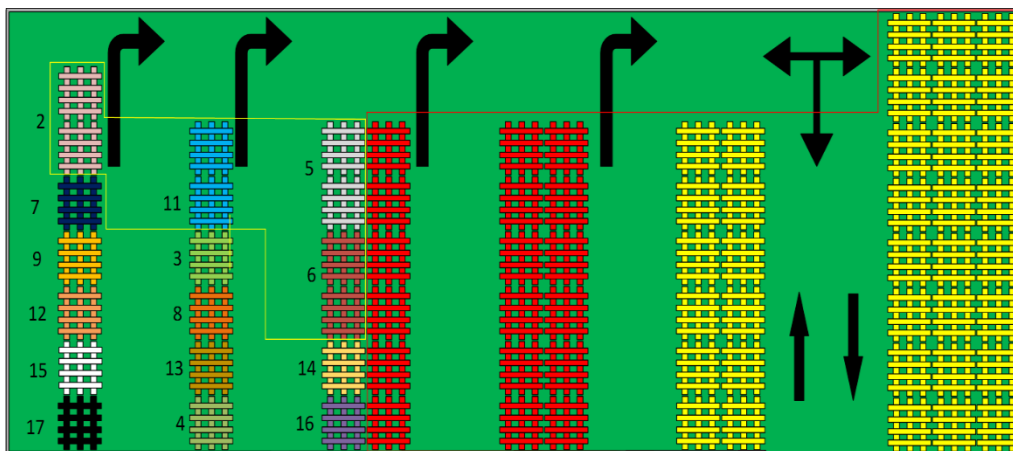


Figure 4. Raw material placement of warehouse

Yellow pallets are raw materials from X1 based on the results of the number of pallets that come each week, 70 units of pallets needed for X1 raw materials have a total of 108 pallets, the capacity for each raw material in the warehouse proposal is obtained from the most height in a year, namely between June 2016 - May 2017 (Figure 4). Placement of raw materials with a capacity of 3 piles of pallets which adjusts to the highest reach capacity of the forklift, which is 3 meters high. The alley distance between raw materials is 3 meters because it adjusts the needs of forklift movement. The capacity of the warehouse to accommodate excess material can be anticipated as much as 24 pallets by reducing the width of the lane that the forklift passes at the entrance area, so that the size of the forklift lane is 2,5 meters. This distance is still included in the optimal distance for a forklift with an allowance of 0,25 meters.

After planning the proposed layout and a proposed warehouse, then calculating the efficiency of the layout to be made and obtained from the method described above, the efficiency value of the initial layout is 5.8%, this value will be compared with the calculation of the proposed layout efficiency value. The following is the calculation of the efficiency of the proposed layout:

$$\begin{aligned}
 \text{Efficiency} &= \frac{\text{Distance before} - \text{Proposed layout distance}}{\text{Initial distance}} \times 100 \\
 &= \frac{3164,1 - 2200,325}{3164,1} \times 100 \\
 &= \frac{963,775}{3164,1} \\
 &= 30,45 \%
 \end{aligned}$$

From the calculation of the efficiency, the value of efficiency is 30,45%. This value will be compared with the distance between an initial layout and the proposed layout. The following is a comparison result of each of the layout distances that have been made in graphic form (Figure 5):

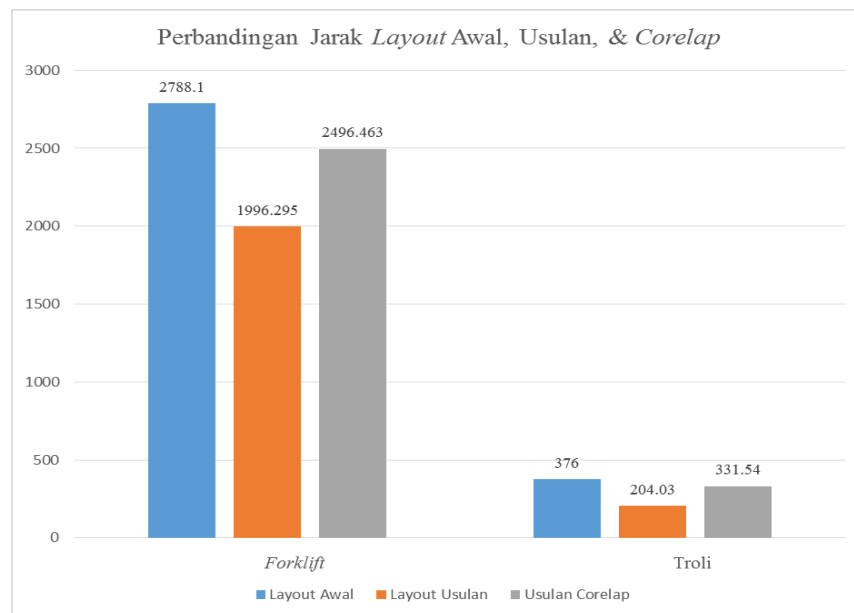


Figure 5. Layout Distance

From the graph, it can be seen that the distance from the proposed layout has decreased significantly. So that the value of the proposed layout efficiency is 30.45%.

Furthermore, to compare the cost of material transfer from the cost of moving material in the initial layout and the proposed layout, it is necessary to calculate the cost of material handling in the company. To determine material handling costs, other calculations are required, such as calculating the distance of material movement, maintenance costs, depreciation costs, operator costs, and fuel costs (for forklifts). The following is the calculation result of the costs obtained:

### 3.1 Material Transfer Fee (Forklift)

Information along with description:

- Number of working days : 25 days
- Number of working hours :

- Purchase price : Rp200.000.000.00,- (capacity of 3 ton)
- Residual value : Rp80.000.000.00,-
- Forklift speed : 1,316 meter/second
- Economic life : 15 years
- Number of operators : 1
- Operator wages : Rp3.600.000.00,-/ month  
: Rp144.000.00,-/day
- Type of fuel : Solar
- Price of fuel : Rp9.000.00,- (Non-Subsidy)
- Utilization of fuel : 3000 meter/liter
- Maintenance cost : Rp3.600.000.00,-

Source: PT. XYZ

### 3.1.1 Total Usage Distance Forklift

$$\begin{aligned} \text{Total usage distance forklift} &= \text{Number of working hours per year} \times \text{forklift speed per second} \\ &= 7.560.000 \text{ second} \times 1,316 \text{ meter} \\ &= 9.948.960 \text{ meter/year} \end{aligned}$$

### 3.1.2 Maintenance Cost

$$\begin{aligned} \text{Maintenance cost} &= \frac{\text{maintenance fee per year}}{\text{total distance used for forklift per year}} \\ &= \frac{\text{Rp200.000.000.00-80.000.000.00}}{9.948.960 \text{ meter}} \\ &= \frac{\text{Rp3.600.000.00}}{9.948.960 \text{ meter}} \\ &= \text{Rp 0,361 per meter} \end{aligned}$$

### 3.1.3 Depreciation Cost

$$\begin{aligned} \text{Depreciation cost} &= \frac{\text{forklift purchase price-salvage value}}{\text{economic age}} \\ &= \frac{\text{Rp200.000.000.00-80.000.000.00}}{10 \text{ years}} \\ &= \frac{\text{Rp12.000.000.00,- per year}}{9.948.960 \text{ meter}} \\ &= \frac{\text{Rp12000000}}{9.948.960 \text{ meter}} \\ &= \text{Rp1,20 per meter} \end{aligned}$$

### 3.1.4 Operator Cost

$$\begin{aligned} \text{Operator wages} &= \frac{\text{worker's salary per day} \times \text{number of workers}}{\text{number of hours worked per day}} \\ &= \frac{\text{Rp144.000.00} \times 1}{7 \text{ hours}} \\ &= \text{Rp20.571.42 per hour} \\ &= \text{Rp5,71 per second} \end{aligned}$$

$$\begin{aligned} \text{Operator cost} &= \frac{\text{operator salary per second}}{\text{forklift walking speed per second}} \\ &= \frac{\text{Rp5,71}}{1,316 \text{ meter}} \\ &= \text{Rp4,3 per meter} \end{aligned}$$

### 3.1.5 Fuel Cost

$$\begin{aligned} \text{Fuel cost} &= \frac{\text{price of fuel per liter}}{\text{fuel consumption per liter}} \\ &= \frac{\text{Rp9.000.00}}{3000 \text{ meter}} \\ &= \text{Rp 3 per meter} \end{aligned}$$

### 3.1.6 Material Handling Cost

$$\begin{aligned} \text{Material handling cost} &= \text{Maintenance Cost} + \text{Depreciation Cost} + \text{Fuel Cost} + \text{Operator Cost} \\ &= \text{Rp0,361 per meter} + \text{Rp1,20 per meter} + \text{Rp3 per meter} + \text{Rp4,3 per meter} \\ &= \text{Rp8,861 per meter} \end{aligned}$$

### 3.2 Material Handling Cost (Hand Clift)

Information along with description:

- Number of working days : 25 days
- Number of working hours : 7 hours
- Number of working hours :  $\frac{7 \text{ hours/day}}{7.560.000 \text{ second/year}}$
- Purchase price : Rp5.000.000.00,- (Bishamon Brand)
- Residual value : Rp4.000.000.00,-
- Speed running by trolley : 1.321 meter/second
- Maintenance cost : Rp200.000.00,-
- Economic life : 5 years
- Number of operators : 1
- Operator wages : Rp3.600.000.00,-

Source: PT. Unipack Plasindo

#### 3.2.1 Total Trolley Usage Distance

$$\begin{aligned} \text{Total trolley usage distance} &= \text{number of working hours per year} \times \text{trolley speed per second} \\ &= 7.560.000 \text{ seconds} \times 1,321 \text{ meter} \\ &= 9.986.760 \end{aligned}$$

#### 3.2.2 Maintenance Cost

$$\begin{aligned} \text{Maintenance cost} &= \frac{\text{maintenance fee per year}}{\text{total distance of trolley use per year}} \\ &= \frac{\text{Rp200.000}}{9.986.760 \text{ meter}} \\ &= \text{Rp0,02} \end{aligned}$$

#### 3.2.3 Depreciation Cost

$$\begin{aligned} \text{Depreciation cost} &= \frac{\text{trolley purchase price-salvage value}}{\text{economic age}} \\ &= \frac{\text{Rp5.000.000-Rp4.000.000}}{5} \\ &= \text{Rp200.000} \\ &= \frac{\text{Rp200.000}}{9.986.760} \end{aligned}$$

$$= \text{Rp}0,02$$

### 3.2.4 Operator Cost

$$\begin{aligned} \text{Operator wages} &= \frac{\text{salary per day} \times \text{number of workers}}{\text{number of hours worked per day}} \\ &= \frac{\text{Rp}144.000.00 \times 1}{7 \text{ hours}} \\ &= \text{Rp}20.571.42 \text{ per hour} \\ &= \text{Rp}5,71 \text{ per second} \end{aligned}$$

$$\begin{aligned} \text{Operator cost} &= \frac{\text{operator salary per second}}{\text{trolley walking speed per second}} \\ &= \frac{\text{Rp}5,71}{1,321 \text{ meter}} \\ &= \text{Rp}4,3 \text{ per meter} \end{aligned}$$

### 3.2.5 Material Handling Cost

$$\begin{aligned} \text{Material handling cost} &= \text{Maintenance Cost} + \text{Depreciation Cost} + \text{Operator Cost} \\ &= \text{Rp}0,02 \text{ per meter} + \text{Rp}0,02 \text{ per meter} + \text{Rp}4,3 \text{ per meter} \\ &= \text{Rp}4,34 \text{ per meter} \end{aligned}$$

From the results of the calculations that have been obtained, it is known that the costs for each transportation means used in the company are as follows in Table 2:

Table 2. Transportation means

Jenis Pemindahan Material	Biaya Perpindahan Material Per Meter
<i>Forklift</i>	Rp8.861
Troli	Rp4.340

After knowing each of the transportation equipment costs, these costs are then included in the process sequence in the production process. Then in each department multiplied by the distance, frequency, and cost of material movement per meter on each conveyance. Then the costs in the process sequence from the loading dock department to the finish good area are added up and the results are as shown in the following graph:



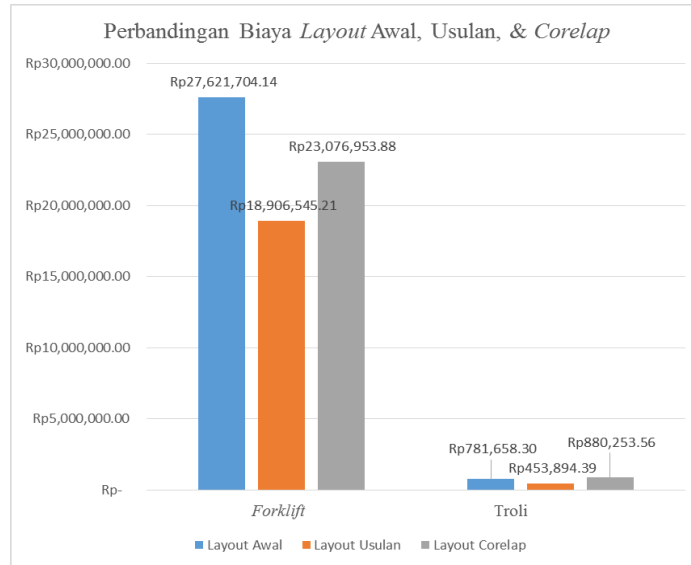


Figure 6. Cost of proposed layout

From this graph, it is found that the most significant costs are in the proposed layout (Figure 6). So that we get a calculation to calculate the efficiency value of the proposed layout design, namely:

$$\begin{aligned}
 \text{Efficiency} &= \frac{\text{Initial cost} - \text{Proposed layout fee}}{\text{Initial cost}} \times 100 \\
 &= \frac{\text{Rp}28,403,362.45 - \text{Rp}19,360,439.60}{\text{Rp}28,403,362.45} \times 100 \\
 &= \frac{9,042,922.8}{28,403,362.45} \\
 &= 31,8 \%
 \end{aligned}$$

So that the efficiency obtained from the proposed layout and material transfer costs in the proposed layout has the lowest efficiency value. So that the proposed layout is the optimal layout in designing a new layout.

## 4. Conclusions and Suggestions

### 4.1 Conclusion

The following are the conclusions and suggestions from the research that has been done:

- To support a more effective and efficient work process, the layout arrangement can be started by changing the department layout by sequencing the work process in order to determine the sequence of the production process. The proposed layout is done by using the ARC method, sequencing the production process to determine whether or not the relationship between these departments is important, after which the data is processed into a worksheet so that it is easy to read the results of the ARC. Then the results from the worksheet are made into a dimensionless diagram to apply the proposed layout design to ARC which has been made manually, the most effective and efficient layout is in manual ARC layouts, because the manufacturing process takes into account other details such as worksheets and dimensionless. diagram.
- Efforts to minimize the cost of moving the initial raw material can be done by minimizing the distance from the raw material itself. From the results of data processing, to obtain an effective raw material transfer distance required a new layout proposal that has been made manually. This is because the proposed displacement distance in the proposed ARC layout is Rp19.360.439,60 with an efficiency of 32%. This is already effective compared to

the transfer of raw material in the initial layout of Rp28.403.362,45 and the proposed layout of the corelap of Rp23.957.207,44.

#### **4.2 Suggestion**

There are suggestions that can be given to solve the problems that exist in PT. XYZ namely:

- In providing an effective layout and small raw material transfer distance, a warehouse that has been designed in sub-chapter 4.3.8 is created. The warehouse is made to provide an effective layout so that the production line in the initial layout is not disturbed by raw materials on each side of the production area.

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