Proposed Layout for Optimizing the Fabrication Process

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Abstract

PT. XYZ is a company which is concerned in the manufacture of air conditioning. The problem with the current layout is that each interconnected area has a great distance, and there are backtracking, cross-movement, and does not have one flow process. The problem makes the time of this fabrication process to be long or less effective and due to the distance between the distant areas, causing the distance of material handling moves that are less effective. The long distances can affect the timing of product displacement and the cost of material handling. In this research, the design is created an ergonomic design for the table in the housing area with the aim of increasing the optimality of the fabrication process in PT. XYZ and redesign the layout of each area using the CORELAP Method. The CORELAP Method consists of three stages: the analysis phase, the adjustment stage, and the evaluation stage. The analysis phase includes material flow analysis, Activity Relationship Chart (ARC) analysis, and the space of the available area. The adjustment stage is the stage to arrange the layout of proposed results from the CORELAP Method and adapt to the needs or circumstances of the field. The last stage is the evaluation stage, which is to compare the actual layout and the proposed layout. CORELAP Method is adapted to the needs and conditions in the field to produce the optimal layout that has one flow process of the fabrication process and save the material handling cost of Rp877.622,31 or save material handling cost of 62,53% compared to the actual layout.

Keywords
Activity Relationship Chart, Computerized Relationship Layout Planning (CORELAP), Cost of Material Handling, Ergonomic and Layout of Fabrication Area.

1. Introduction
PT. XYZ is a company engaged in the manufacture of air conditioners. For office buildings or shopping centres, and mining areas, AC (Air Condition) is commonly referred to as AHU (Air Handling Unit) or HVAC (Heating, Ventilation, & Air Condition). This company produces HVAC, which is used to control room temperature, room humidity, and air movement. McDowall (2007). The problem that exists in this company lies in the current layout, which is located in each related area which has a large distance, and the current layout has backtracking, cross-movement, and grooves that do not have one flow process. Therefore, for the current layout, it is necessary to hold a re-layout to improve the fabrication process of products made at a more optimal distance in reducing the cost of material handling.

In supporting a good product-making process, apart from seeing the layout of each area in the production process, it can also be seen how the work process is carried out by the workers themselves. Workers who are working on a production process must also have a comfortable and safe position. The table in the housing area is currently not suitable for Indonesian anthropometry because the table is too low for the housing process on the electrical control panel and too high for the process of assembling the HVAC framework. In improving the ergonomics of the work process carried out by workers, the table must be adjusted to the size/dimensions of the human body and several features are also needed to help workers put the tools needed during the product assembly process, which can also reduce material handling displacement (Deb and Jain 2013, Hasan et al. 2013, Ausaf et al. 2015, Dou et al. 2016, Hees 2015, Koren et al. 2018, Yang et al. 2021).
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After that, the problem formulation that can be taken is how the optimal layout for the HVAC fabrication process at PT. XYZ, how much material handling costs must be spent on the actual layout at PT. XYZ, what is the total material handling cost savings in the fabrication process between the actual layout and layout proposal, and how to design a table in a housing area that is good in improving the ergonomics of an assembly process that is adapted to Indonesian anthropometry.

2. Research Methods

The research method used is to make direct observations in the fabrication area, namely at PT. XYZ, after making observations, found problems in the layout and also less ergonomic housing area table. After the problem is found, it is necessary to determine the objectives and also the benefits of the research carried out. Next is to collect the data needed to be processed in solving existing problems. After the results are found, they will be analyzed based on the existing theoretical basis. Next, formulate conclusions and suggestions that can be used as a reference for the company.

3. Results and Discussions

In optimizing a fabrication process carried out by PT. XYZ in the manufacture of HVAC, base HVAC, ducting, control panel electricity, and ACCU, it can be done by knowing how efficient the layout of the fabrication area is interconnected with one another. A good layout can be a benchmark in knowing the total material handling costs that will be incurred by this company. To find out how efficient the layout is, you can use an Activity Relationship Chart (ARC) to determine the level of relationship between each connected area. Here are the results of processing data using ARC (Figure 1):

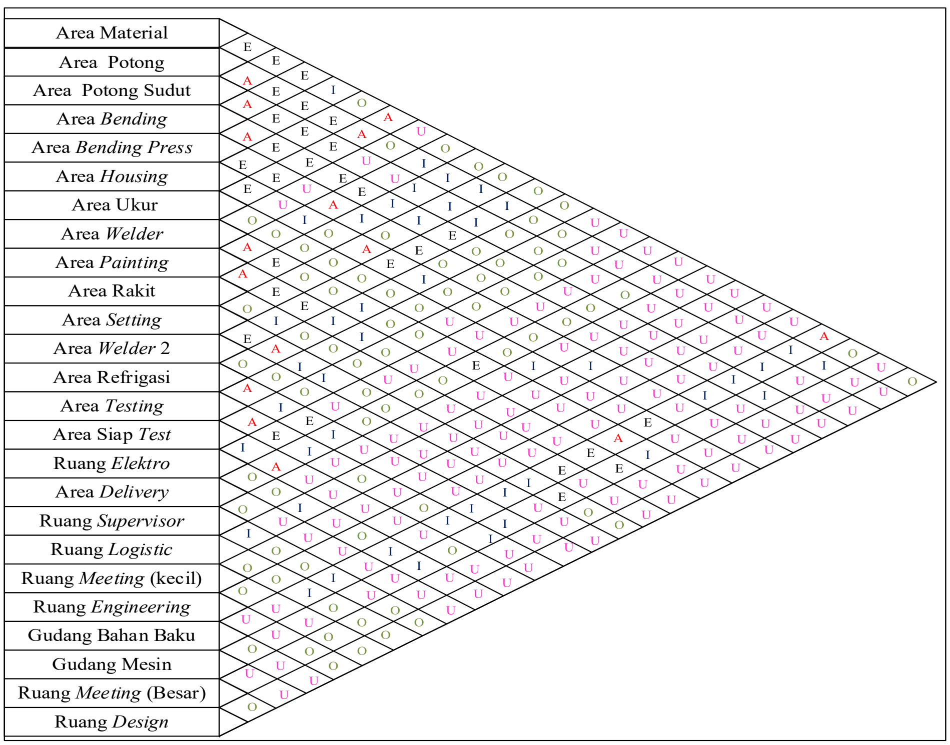


Figure 1. Activity relationship chart (ARC) (source: data processing results)

The picture above is an image of the results of data processing using ARC. The ARC is based on the level of linkage between areas/departments. In this study, there are 25 interconnected areas/departments in the fabrication process. This closeness is indicated by the letters A, E, I, O, U, and X. For A, it is a very strong relationship between areas or must be close (absolutely necessary). For E, this is a strong relationship after A, namely, especially important. For I, it is important to be close, which is important. For O, it is ordinary closeness OK. For U, it is unimportant, and X is undesirable, which means that they cannot be close together. In the ARC that has been created, there is no X because the areas are interconnected or not. Nothing can have a bad impact if there are two areas that are close together. To determine how many levels of closeness will be used, it can be calculated using, as follows:

$$N = \frac{n(n-1)}{2}$$

Where:
n = 25

Then,

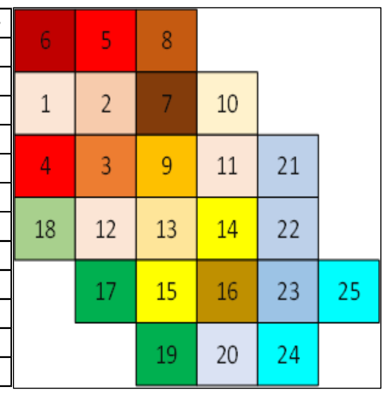
$$N = \frac{25(25-1)}{2}$$
$$N=300$$

A = 5% x 300 = 15
E = 10% x 300 = 30
I = 15% x 300 = 45
O = 25% x 300 = 75
U = 135
X = -

From the ARC that has been created, the ARC results will be implemented using the CORELAP method. Here are the results of using CORELAP (Table 1):

Table 1. Results of data processing using CORELAP

Nama Area	Urutan	*Total Closeness Rate*	Nama Area	Urutan	*Total Closeness Rate*
Area Material	14	75	Area *Testing*	10	80
Area Potong	6	83	Area Siap *Test*	17	71
Area Potong Sudut	11	80	Ruang Elektro	19	66
Area *Bending*	1	89	Area *Delivery*	18	70
Area *Bending Press*	5	84	Ruang Supervisor	21	60
Area *Housing*	9	81	Ruang *Logistic*	20	62
Area Ukur	8	81	Ruang *Meeting* 1	25	53
Area *Welder* 1	13	75	Ruang *Engineering*	23	55
Area *Painting*	3	87	Gudang Bahan Baku	2	87
Area Rakit	15	75	Gudang Mesin	16	72
Area *Setting*	4	86	Ruang *Meeting* 2	24	54
Area *Welder* 2	12	78	Ruang *Design*	22	55
Area Refrigasi	7	81			



Source: Data Processing Results

The following are the differences in the actual layout and proposed layout of the fabrication area at PT. XYZ (Figure 2, Figure 3, Table 2):

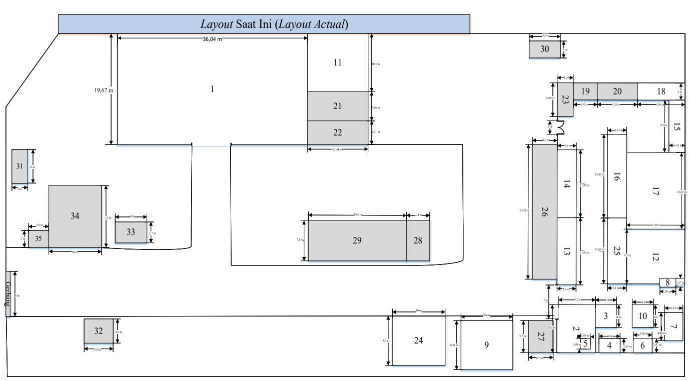


Figure 2. Actual layout of the fabrication area (source: data processing results)

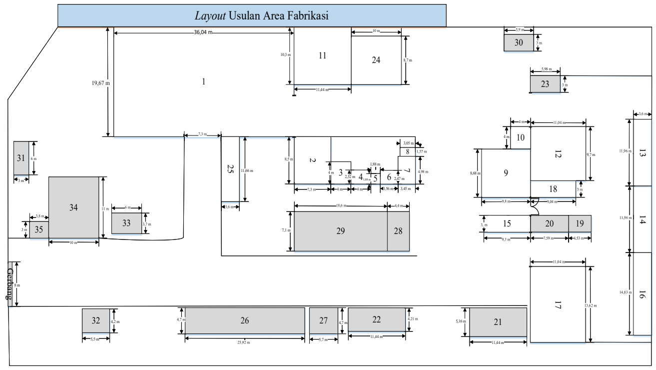


Figure 3. Proposed layout of fabrication area (source: data processing results)

Table 2. Description of the fabrication area

KETERANGAN		6	Area *Bending*	12	Area *Setting*	18	Ruang *Logistic*	24	Area *Welder* 1	30	Toilet 1
1	Gudang Bahan Baku	7	Area *Bending Press*	13	Area Refrigasi	19	Ruang *Engineering*	25	Area Rakit	31	Toilet 2
2	Area Material	8	Area *Welder* 2	14	Area *Testing*	20	Ruang Supervisor	26	Produk Rental 1	32	Parkiran
3	Area Ukur	9	Area *Painting*	15	Ruang Elektro	21	Ruang Desain	27	Produk Rental 2	33	Kandang Buaya
4	Area Potong	10	Area *Housing*	16	Area Siap *Test*	22	Ruang *Meeting*1	28	Genset	34	Parkir Motor
5	Area Potong Sudut	11	Area Mesin	17	Area*Delivery*	23	Ruang *Meeting*2	29	*Maintenance* Produk	35	Pos Satpam

After obtaining a proposed layout that has significant differences in the distance in each interconnected area, there is a material handling cost difference between the actual layout and the proposed layout. Then, before looking for savings from material handling costs, the material handling costs per meter must be determined for each type of transfer (Table 3):

Table 3. Material handling costs for each type of displacement

Jenis Pemindahan	Biaya *Material Handling*
Forklift	Rp17,50
Hand Pallet	Rp10,078
Pekerja/Orang	Rp7,79

Source: data processing results

After looking for the cost per meter of each type of displacement, the costs to be incurred from each type of displacement can be calculated as follows in Table 4:

Table 4. Comparison of material handling costs per year

Type of transporter	*Material Handling* Cost Per Meter	Price / Salary	Economic age	Total Initial Fee	Amount of Proposed Fee	Difference amount	Savings (%)
Hand pallet	10,07	Rp 3.900.000	10 years	344.310,39	288.076,27	56.234,11	16,33
Forklift	17,50	Rp 200.000.000	20 years	790.293,70	83.849,25	706.444,44	89,39
People / Workers	7,79	Rp 4.500.000	0	268.922,17	153.978,42	114.943,75	42,74
Total				1.403.526,27	525.903,96	877.622,31	62,53

Source: data processing results

In addition, to improve the ergonomics of the work process carried out by workers, the table must be adjusted to the size/dimensions of the human body and several features are needed to assist workers in placing the tools needed during the product assembly process. With a table that is already classified as ergonomics, it can improve the health level of workers and can also help reduce material handling displacement. To complete the table, chairs were made that were adapted to the current conditions. The following are the designs of tables and chairs that are added to support the table (Figure 4-6):

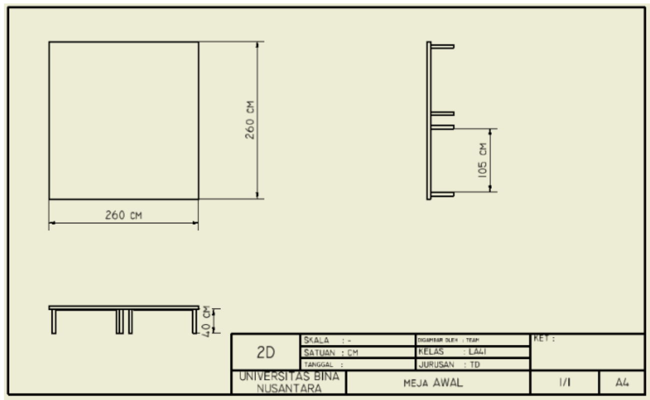


Figure 4. Home desk in the housing area (source: data processing results)

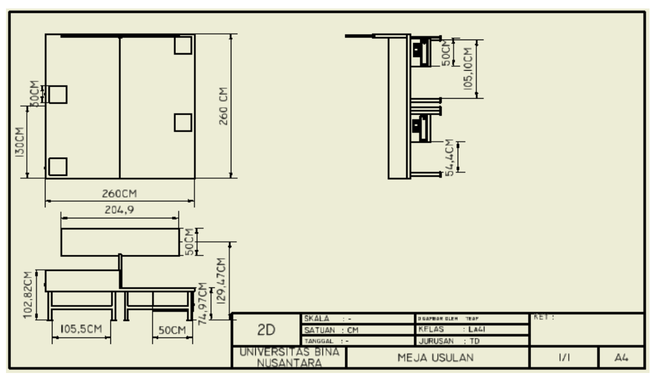


Figure 5. Proposed desks in housing areas (source: data processing results)

In making the table in the housing area, the table making is based on the dimensions of the Indonesian body. The parts of the dimensions of the Indonesian body are used as benchmarks for making the table height. For the table in assembling the electricity control panel, use D4, which is an elbow height of 102.82cm in a standing position. For a table in assembling an HVAC frame, use the dimensions of an Indonesian with a sitting position like D16, namely popliteal height with a size of 43.09cm, D12, which is a thick thigh with a size of 18.79cm, and with the allowance given between the hips and the ends of the table is 13.09cm which comes from using D11, namely the elbow height in a sitting position with a size of 31.84cm which is reduced by the thickness of the thighs, namely 18.79cm.

Figure 6. Chairs in the housing area (source: author, 2017)

4. Conclusions and Suggestions

Based on the results of the processing and analysis that has been made, several conclusions are obtained, namely as follows:

1. The optimal layout for the HVAC fabrication process at PT. XYZ is that there are no more layouts with backtracking, cross-movement, and one flow process. In the proposed layout, the design room and meeting room 1 (large), which were previously adjacent to the warehouse, were removed, and doors were made in the design room and meeting room so that the trajectory to be taken would be fewer and more effective in reducing material handling costs. It will be issued by the company. In addition, parts of the material area, measuring area, cutting area, corner-cutting area, bending area, and bending press area are also placed close to the warehouse, and these areas have been adjusted to the fabrication process due to back tracking and cross-movement in the previous layout. Other areas are also placed close together according to the fabrication process of each product made.
2. The total material handling costs for PT. XYZ that must be spent on the actual layout is IDR 1,403,526.27, with the total distance for each related area of 1442.4m.
3. Total material handling cost savings for the proposed layout is IDR877,622.31. With a percentage of material handling cost savings of 62.53%.
4. The proposed table design for the housing area is made based on the needs of the fabrication process and the workers at work. The proposed table has been made using Indonesian dimensions. In addition, the proposed table is made using the 50th Percentile (P50) based on the average Indonesian person and worker. The table is made to have different heights to suit what product will be made. The dimensions used in making the first table, namely to assemble the HVAC body frame, are dimensions in sitting positions such as D16, D12, and D11, namely popliteal height (43.09cm), thigh thickness (18.79cm), and elbow height in a sitting position (31.84cm) with the allowance from the groin to the end of the table which is 13.09cm from the result of subtracting D11 and D12. For the table to assemble the electricity control panel, use the dimensions in the standing position, namely D4 with elbow height in the standing position with a size of 102.82cm. With the height of the board, namely using the dimensions of an Indonesian in a standing position, namely D2 with an eye height of 154.47cm.

Here are suggestions that companies can use:

1. The company re-layout based on the results of research using the CORELAP method because, with this layout, the company can optimize the fabrication process, which has an impact on reducing material handling costs.
2. Applying ergonomic principles to make the proposed table in the housing area so that companies can improve work efficiency in the housing area.
3. There is a need for a safety colour for each area to increase the awareness of workers to be more careful and thorough when working.

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