

Redesign Facility Layout using ARD and ARC in the Fiberglass Industry Sector

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ABSTRACT

PT. XYZ is a plastic material and product production company started in Riau in 1997. According to customer need, the company manufactures fiberglass products (FRP) and welcomes design requests. Additionally, PT. XYZ has a stainless steel and polyethylene (HDPE) water tank. In actuality, certain inefficiencies and inefficiencies make it challenging for operators to locate equipment like grinders. The purpose of this study is to identify an effective facility layout for a fiberglass manufacturer. This study redesigns the organization of fiberglass production facilities using ARC (Activity Relationship Chart) and ARD (Activity Relationship Diagram). Results indicated that measurements were moved and cuts were made close to the base material mixture workstation in the operator's room at a 90-degree angle.

Keywords: ARC, ARD, Fiberglass, Layout

Introduction

Competition in the business world is getting tougher; every business is required to conduct business activities effectively and efficiently. The layout of industrial facilities is a business activity that supports the production process by arranging production facilities. An efficient industrial facility or space is not created by itself but results from proper planning. Responsibility for designing an organization with the understanding of using a sustainable, organized organization [1]. This allocation design includes planning and managing the placement of machines, equipment, material flows, and people working at each workstation [2].

Facility layout is part of facility design that focuses more on arranging physical elements in machines, equipment, tables, buildings and so on [3]. Arrangement and Arrangement of Facility Layout in an industry/place/area are essential to increase and improve facilities to support business activities, service feasibility and effective and efficient site utilisation. This arrangement and arrangement is an important decision that determines the efficiency of an operation in the long term [4]. The following requirements for layout design must be met. 1) Greater use of resources—people, tools, and space. 2) Improved information, product, or person flow. 3) A safe working environment and higher staff morale. 4) More effective customer interaction. 5: Flexibility [5].

Facility layout plays a vital role in a company's performance in supporting the smooth production process [6]. Increasing efficiency is one of the biggest challenges many companies face today [7]; one of the ways is by increasing productivity through facility layout and space utilization [8]. The production efficiency depends on how well the machines, equipment and labor facilities are located in the factory [9][10]. The efficiency of company layout and productivity are interrelated with a system's performance, quality and productivity [11]. The main goal of facility layout is to minimize the total distance of material flow, material handling costs and time spent in the manufacturing system [12].

PT. XYZ is a plastic material and product manufacturing company founded in Pekanbaru in 1997. Plastic is an object that is inherent in everyday human life [13]. PT. XYZ produces all fibreglass products and accepts design requests according to consumer demand. The production process starts with taking raw materials or materials at workstation 1, namely cutting and measuring, to the quality control station. In the initial layout of the production floor, there are several workstations whose locations still need to be under the sequence of the production process, such as measuring & cutting stations, raw material mixing stations and multipurpose stations. In addition, it does not have a measured distance from each station, especially to station 3. This causes the risk of product damage and the space to move materials farther. Under these conditions, one thing that the company can do to improve the work environment area is to redesign the layout of the factory facility [14].

Research on redesigning the layout of tofu manufacturing facilities can significantly reduce material handling mileage with Block Layout Overview with Layout Planning (BLOCPLAN) [14][15]. other research compared the BLOCPLAN and CORELAP (Computerized Relationship Layout Planning) algorithms in the electrical industry, where the CORELAP algorithm has a material transfer efficiency of 19.52% while BLOCPLAN is only 0.89% [16]. The findings contrast with research by Danang et al., who found choosing the

BLOCPPLAN method with an efficiency of 52,7% compared to CORELAP with an efficiency of 31.35% [17]. Research using other methods, namely ARC, ARD and AAD, can reduce the number of workers in each department to make the production process more efficient [18]. The new facility layout design has a more efficient handling trajectory of 40% by applying the ARC and ARD methods [19]. research using ARC can reduce shorter distances by 27.6% and save company costs every month by up to 50% [20]. [21]'s research with ARC then carried out simulations on X's department layout in college, resulting in an "L" shaped desk and "U" cabinet layout to reduce displacement.

In addition, one of the most widely used methods to increase productivity efficiency through facility layout design is SLP (Systematic Layout Planning). In the steel industry [10], compressors [22], iron [23], the offshore and onshore services industry [24], the generator industry [25], Japanese restaurants [26], jute industry [6], switch gear [27] and Cross Traffic [28]. SLP is a technique used to improve layouts and improve material flow. From previous studies, many have increased productivity by reducing material flow distances and transfer times.

This study uses the Activity Relationship Chart (ARC) method, Activity Relationship Diagram (ARD). The redesign of the facility layout must pay attention to the degree level of each workstation by using the arrival degree method using the activity relationship chart (ARC), Activity Relationship Diagram (ARD) and Activity Allocation Diagram (AAD), which pay attention to the qualitative and quantitative values of a proximity factor so that it is more effective and efficient. This method is easy to understand because it does not use complicated mathematical formulations [29]. Based on the explanation above, this study aims to identify an effective facility layout for a fiberglass manufacturer. The easiest way to write your paper to fit the writing format of the Journal of Science, Technology and Industry is to *copy-paste* your paper into this *template*. This *template* will be given to you by the editors of the Journal of Science, Technology and Industry, if your paper is declared to be published in the Journal of Science, Technology and Industry, whether revised or not. The writing of foreign terms should be written in *italics*. *Page setup* for the Journal of Industrial Engineering is Top, Bottom and Left = 3 cm, Right = 2.5 cm, Gutter = 0". The orientation is Portrait with Mirror margins. The paper *size* is custom with Width = 7.42 cm and Space = 1.25 cm The layout is Different odds and even with Header = 1.27 cm and Footer = 1.27 cm. The vertical alignment is Top. (Note: The above decimal writing rules are adjusted to the writing rules on *Microsoft Word* uses "." as a decimal sign instead of ",", ". The rules of decimal writing in the Journal of Science, Technology and Industry follow the rules of writing Mathematics).

Research Methods

This approach was chosen due to its benefits, one of which is the systematic partitioning of activity areas and ability to reduce empty space. Microsoft Visio uses the Activity Relationship Chart (ARC) and Activity Relationship Diagram (ARD) methodologies to aid with data processing. While ARD determines the priority degree of proximity to facilities or departments, ARC can be used to determine the link between facilities and departments. The following are the stages of research using this methodology.

1. Observation of the study subject, specifically the fiberglass manufacturing facility
2. Recognizing by calculating the size of the manufacturing buildings
3. Drawing manufacturing layouts while being observed.
4. ARC planning
5. Use worksheets to review the ARC assessment results.
6. Build ARD
7. Creating a new location template or layout

Results and Discussion

Initial lay-out of Fiberglass Production Station

Based on observations of the manufacture of fibreglass production, the building area is 25 m x 12 m, as shown in Figure 1—assessment of the initial layout of PT. XYZ has not been optimally organized, and there is no factory layout of production workstations. The placement of facility layout has not been optimally positioned because there are workstations that are not closely related between facilities, such as one workstation and another. Workstation 2 is too far away, so workers go back and forth from one workstation to another.

Research object, field, and processed data are novel in this study. The target of the research is obviously distinct from other studies because it is produced by companies that are substantially different from those cited in earlier studies. so that linked businesses will find the study's findings beneficial.

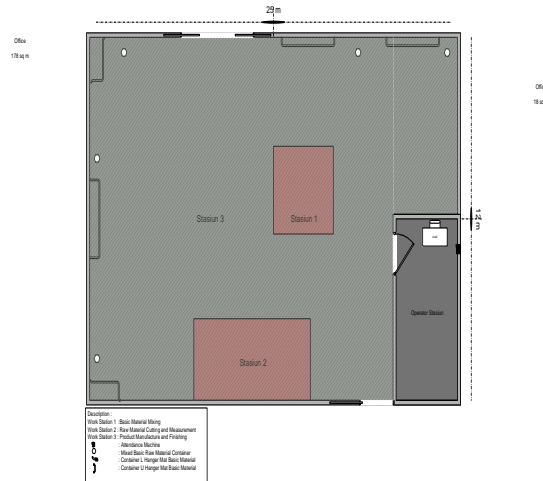


Figure 1. Initial lay-out of Fiberglass Production Station

Activity Relationship Chart (ARC)

An activity Relationship Chart (ARC) is a simple method or technique in planning the layout of a facility or department based on the degree of activity relationship, which is often expressed in a "qualitative" assessment and tends to be based on subjective considerations of each facility/ department [30] [31].

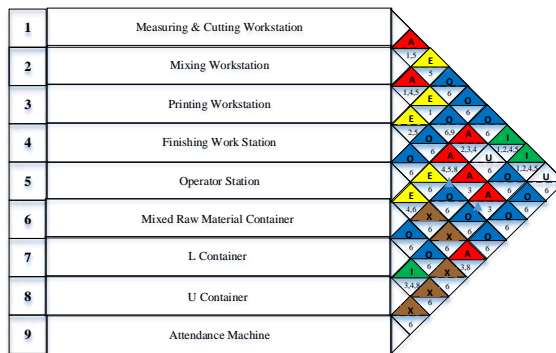


Figure 2. Activity Relationship Chart (ARC)

ARC uses codes in the form of letters that will map the level of closeness of the relationship between one facility to another. The following letter codes are used in ARC.

Table 1. Closeness Rating of ARC

Code	Degree of Relationship
A	Absolutely Necessary
E	Especially Important
I	Important
O	Ordinary
U	Unimportant
X	Undisireable

ARC also uses a number that represents why a facility is brought closer. An explanation of these reasons can be seen in table 2. numbers 1 to 5 are reasons for facilities needing to be closer together, number 6 is optional whether a facility needs to be brought closer together, and numbers 7 to 9 are reasons for facilities not needing to be closer together. In ARC, there can be more than one reason for determining a facility's proximity.

Table 2. Reason for the Proximity of the Facility to ARC

Number	Decription
1	Has functional work
2	Using the same workforce
3	Using the same space area
4	The degree of frequent personal contact

Number	Decription
5	Workflow sequence
6	Has no relationship
7	Carry out the same work activities
8	Using the same equipment
9	Dirty and tires

The close relationship between facilities is represented by letter and color codes. Each letter and color code has a priority level of proximity that varies from absolute to unimportant. For example, a measuring and cutting station needs to be brought closer to a mixing station (Absolutely necessary) so that it is coded A (red color) for reasons 1 (has available work) and 5 (workflow sequence). The provision of letter and color codes for each relationship of the facilities above has its reasons which will be recapitulated into the worksheet.

Worksheet

The next stage in this research is recapitulating the assessment results into a worksheet. The following is a worksheet of the results of the recapitulation as follows.

Table 2. Worksheet

No	Department	Degree of Proximity					
		A	E	I	O	U	X
1	Measuring & Cutting Workstation	2	3	7,8	4,5,6	9	-
2	Mixing Workstation	3,6	4	-	6,8,9	7	-
3	Printing Workstation	6,7,8	4	-	5,9	-	-
4	Finishing Work Station	-	6	-	5,7,8,9	-	-
5	Operator Station	9	6	-	-	-	7,8
6	Mixed Raw Material Container	-	-	-	7,8	-	9
7	L Container	-	-	8	-	-	9
8	U Container	-	-	-	-	-	9
9	Attendance Machine	5	-	-	2,3,4	1	6,7,8

After making the assessment results, it can be seen the close relationship between facilities, for example, such as:

1. On Measuring & Cutting Workstation with Mixing Workstation. The distance between these facilities is to be close to each other. This is because both facilities have work functions and workflow sequences.
2. On measuring & cutting work station with printing station. The relationship between these two facilities became commonplace. Because these two facilities are workflows, it is not recommended to be too far and not too close.
3. Measuring & cutting workstation with Base Mat L hanger holder and Base Material U hanger holder. The relationship between these facilities needs to be closed because they have a work function, the same workforce, the degree of personnel contact often used and the workflow sequence.
4. Then, the relationship between the printing workstation, the operator room and the attendance machine are included in the unnecessary category. Because they do not have a strong reason to be close, an example of a U-hanger container, a basic material mat and an attendance machine means no relationship between facilities.
5. Facilities belonging to the unwanted category are measuring & cutting workstations for attendance machines, mixing workstations for U and L containers, and hangers for basic materials. Then the facilities are unnecessary, one of which is the attendance machine for the mixed material container. This means that the distance between these facilities is very flexible, not tied to each other and can be placed far apart or close together

Activity Relationship Diagram (ARD)

ARC can further describe the relationship between facilities by using ARD [32] [33]. Analysis of layout design by considering the degree of association between facilities is one of the important things to be considered further [34]. The symbols and colors used to create and present Activity Relationship Diagrams shown in the table 3.

Table 3. Symbols and Colors in Activity Relationship Diagrams.

Degree of Proximity	Description	Colour
A	Absolutely	Red
E	Very Important	Yellow
I	Important	Green
O	Ordinary	Blue
U	Not Important	No colour
X	Unwanted	Brown

ARD is created after the creation of ARC by considering the level of proximity between facilities. The results of ARD in this study can be seen in the following figure.

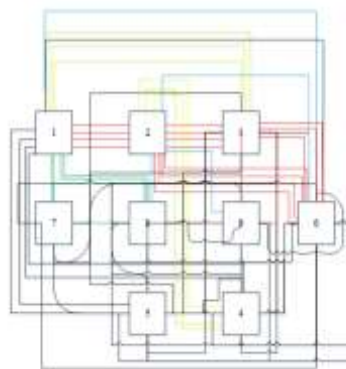


Figure 3. Activity Relationship Diagram (ARD)

In Figure 3, it can be seen that facility 1 (Measuring & Cutting Workstation) has an absolute relationship or must be brought closer to facility 2 (Mixing Workstation). The line code given between the two facility connections is 4 red lines which represent the closeness of the facility, which is absolute.

Template

After creating ARC, worksheet and ARD, the last is making a template according to the degree of proximity.

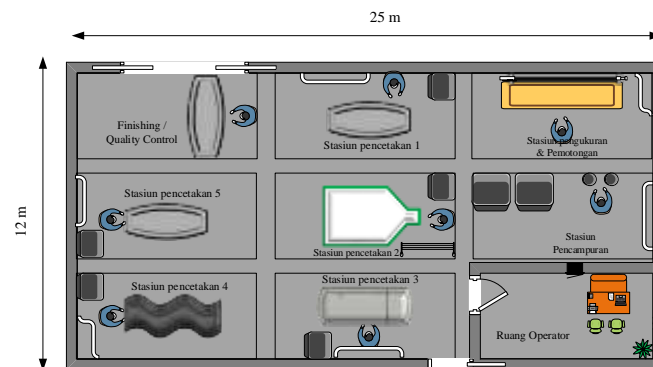


Figure 4. Activity Relationship Diagram (ARD)

This change can be compared by looking at Figure 1, the initial layout, and Figure 4, which is the template (image after repair). From the two pictures, there are changes to the workspace or facilities, such as:

1. The measuring and cutting workstation is moved adjacent to the primary raw material mixing workstation. Because the level of importance and the proximity between stations is absolute and must be brought closer. It aims to make it easier for workers and the distance is just a short distance from the printing station. It is also a workflow.

2. There was a rotation and change in the operator's room because it was by the size of other workstations based on the calculations made so that the Fiberglass production division room looked more spacious and efficient, and the workers experienced comfort in crossing while working.

Some of the added production facilities are the addition of 4 printing workstations because there is still empty floor space. The more printing workstations, the more effective and efficient the Fiberglass production process is. Therefore, additional printing workstations were carried out.

Conclusion

Based on the analysis that has been done, several changes must be made, namely. As a result of calculations to make the Fiberglass production division room appear more spacious and practical, rotations and adjustments were made in the operator's room. This allowed the workers to feel comfortable crossing while working.

In the corner of the Fiberglass manufacturing division, the measuring and cutting station was relocated next to the base material mixing workstation. So that there is no back-and-forth process during manufacturing and the production flow method is structured.

The operator's room rotates 90 degrees to the right of its prior orientation. Use the remaining left floor space after setting up the two parallel stations for measuring, cutting, and mixing base material due to changing the primary material mixing workstation and the cutting and measuring workstation's remaining floor space size.

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