



**RE-LAYOUT OF PRODUCTION FACILITIES AREA
OF CV ROTAN ASIK ASIK JOS TO MINIMIZE
MATERIAL HANDLING**

**By
Purnama Sahid Antasara
ID No. 004201300039**

**A Thesis presented to the
Faculty of Engineering President University in partial
fulfillment of the requirements of Bachelor Degree in
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**THESIS ADVISOR
RECOMMENDATION LETTER**

This thesis entitled “**RE-LAYOUT OF PRODUCTION FACILITIES AREA OF CV ROTAN ASIK ASIK JOS TO MINIMIZE MATERIAL HANDLING**” prepared and submitted by Purnama Sahid Antasara in partial fulfillment of the requirements for the degree of Bachelor Degree in the Faculty of Engineering has been reviewed and found to have satisfied the requirements for a thesis fit to be examined. I therefore recommend this thesis for Oral Defense.

Cikarang, Indonesia, May 1st, 2017

Ir. Andira M.T

DECLARATION OF ORIGINALITY

I declare that this thesis, entitled “**RE-LAYOUT OF PRODUCTION FACILITIES AREA OF CV ROTAN ASIK ASIK JOS TO MINIMIZE MATERIAL HANDLING**” is, to the best of my knowledge and belief, an original piece of work that has not been submitted, either in whole or in part, to another university to obtain a degree.

Cikarang, Indonesia, May 1st, 2017

Purnama Sahid Antasara

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Approved by

Ir. Andira M.T.

Thesis Advisor

Ir. Andira M.T.

Program Head of Industrial Engineering

ABSTRACT

CV. Rattan Asik Asik Jos is a manufacturing company that produces furniture of rattan, but overall these products have the same creation flow, so in this case can be represented by a single type of product items. Products are used as a reference is "Goose Chair" because the demand is the highest. In production activities has some obstacles which are not standard yet in accordance with the criteria of a good layout, then it impacts to the distance of material handling and material flow intersection, causing the cost of material handling increasing. Evaluation and re-layout has purpose to design the layout of the new plant that can use the area as good as well and produce a smooth flow of material so as to reduce material handling costs. Designing the plant layout is conducted on all departments of production facilities with using the the type of product layout and S-shaped line flow. With the implementation of the proposed layout, then a reduction in material handling costs of IDR 4,850,299 (initial layout) to IDR 3,178,996.00 (layout proposal) decrease costs by 34%.

Keywords: *Layout, Cost, Material Handling, Production, R-score, Furniture*

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LIST OF TERMINOLOGIES

- Water hyacinth : One of the floating aquatic plants.
- Material handling : One of the types of transportation that do in an industrial company, which means transferring raw materials, semi-finished goods or finished goods from the place of origin to the determined destination.
- Weaving : Make a work of art craft by wrapping a material alternately by hand.
- Drying : The process of removing a small amount of water contained in a material that can be using sunlight or machine.
- Handycraft : Art activities that focus on hand skills and functions to process the raw materials that can be found in the environment into the objects that are not only has valuable to use, but also has aesthetic value.

CHAPTER I

INTRODUCTION

1.1 Problem Background

Facility Layout is an ordinance setting the production facilities in order to support the production process. The layout is generally evaluated from a production standpoint is the arrangement of the production facilities to get efficiency in a production. The purpose of designing the layout of the facility which is to determine how the coordination of each production facility arranged so that is able to support the efforts to achieve efficiency and effectiveness of the operation of production activities.

The design layout includes the setting layout of operation facilities by utilizing the available area for the placement of the machines, the materials for the operation, and all the equipment used in the operation process. One of the objectives of designing the layout of production facilities is maximizing available area. The use of the room will be effective if the machinery or other plant facilities arranged with considering the minimum distance between machines or production facilities, and the flow of material movements. The good layout of production facilities very involved in the production process as it directly impacts to the running of production processes, can improve product quality, can provide comfort and freedom of movement for workers.

Furniture rattan handicraft company CV. Rattan Asik Asik Jos is a traditional company which is engaged in manufacturing of household goods, exterior and interior products made from rattan. The products produced by this company disparate types and models of each product based on consumer demand. The whole process of making the product has the same creation flow. In the process of making table and rattan chair, the material in the form of bars, small rattan knitted, crocheted banana skins (webbing straps), knitted water hyacinth (webbing straps), dyes, and other adjuvants.

Orders that received by the company use a sequence flow the same production process, the design drawing, cutting, forming the framework, the assembly frame, weaving, finishing, drying and packing process therefore the type of layout that is used is flow shop for setting the placement of machinery and production equipment are placed consecutively production process flow.

Nowadays the location of the factory separated to be 2 factories, the first plant facility area is about 351.5m² and the second plant facilities area of 120 m², both factories 2 kilometers apart. In order to increase the efficiency and effectiveness of the process for the next time they want to have only 1 factory so it will be larger. Remove to new location with the bigger area to accommodate both factories capacity and extended capacity for several next years. The aspect of increasing efficiency and effectiveness is on arrange the material handling then the distance will be shorter also the cost will be decrease in many aspect and purpose the new location.

1.2 Problem Statement

The background of the problem leads to make the statements below:

1. How to design the new layout of the production facility CV. Rotan Asik Asik Jos to minimize material handling cost?

1.3 Objectives

The objectives of this research are:

1. Designing the suitable layout of production facilities handicraft rattan CV. Rotan Asik Asik Jos in a new location so as to minimize material handling cost.

1.4 Scopes

Due to limited time and resources in doing this research, therefore it will be limited to this scope:

1. Design the layout is done only at the production facility.
2. No additional/ changes to the existing facilities of production during research
3. The cost that will be discussed only the operating costs of material handling.

4. Using one type of product, namely the reference products are often produced with the greatest number of requests in each month (product Goose Chair).
5. No limitation for the new location (purposed area).
6. Distance movement calculated rectilinear.
7. The data was obtained from june to august 2016.

1.5 Assumption

The assumption defined used for simplify the problem and help the research are as follows:

1. For each machine / support facilities used allowance 0.75 - 1 meter on each side of the machine and operator allowance is 50% based on the method of industrial facilities.
2. The capacity of requested product that worked (Goose Chair) will be fixed.
3. The product is in good condition without any deffect.
4. The shipping of raw material from supplier once per month.

1.6 Research Outline

Chapter I

Introduction

This chapter contains the problem background of the problem, formulation, objectives and benefits of research and problem definition that serves to determine the specific area of discussion will be made, assuming that serves to simplify the complexity of the problems faced and the systematic writing that contains a sequence of writing a chapter in a thesis.

Chapter II

Literature Study

This chapter describes the general of rattan handicraft factory CV. Rotan Asik Asik Jos consist the history of the company, the location and layout of the plant, the products produced, the source and supply of raw materials, production processes, equipment used and production marketing.

Contain theories that support the data processing are among the factors that affect the design of the layout and the type or types of existing layout.

Chapter III

Research Methodology

This chapter contains steps to resolve the problem in general which is a structured picture step by step problem solving process and is represented in the form of a flowchart.

Chapter IV

Data Collection and Analysis

This chapter consist the data necessary for the completion and processing problems step by step. Also contain description of analysis and interpretation of the data processing has been done.

Chapter V

Conclusion and Recommendation

This chapter will give the conclusion result of this research and also recommendation for future research.

CHAPTER II

LITERATURE STUDY

2.1 Definition Facility Layout Design

Facility Layout Design Definition of facility planning can be expressed as facility design process, analysis, planning, design and arrangement of facilities, physical equipment, and humans that claimed as to increase the efficiency of production and service system.

That setting will be maximizing of the area for the placement of machine or other production support facilities, the smooth movement of material movements, storage of both temporary and permanent, personnel workers and so on. Generally, the plant layout is planned properly participate in determining the efficiency and maintain the viability or success of an industrial workplace (Heragu, 2006).

Schematically factory facilities planning can be described as follows :

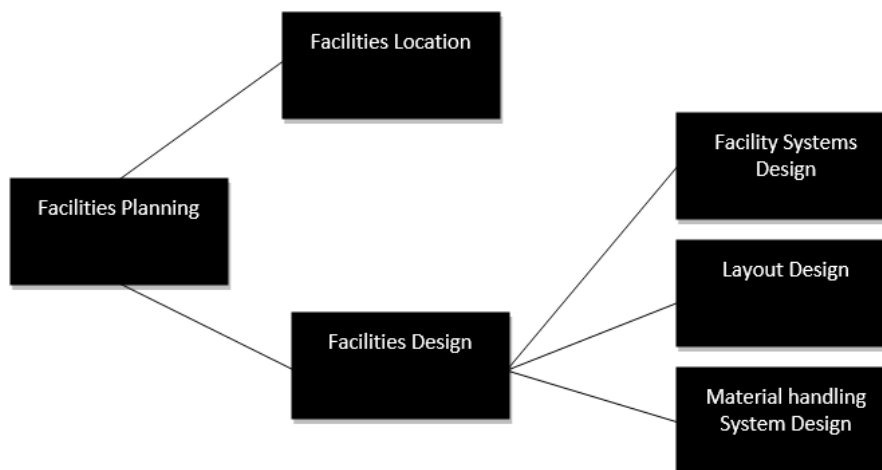


Figure 2. 1 Systemtic of Factory Facilities Planning

2.2 The Objectives of Facility Layout Planning

Facility design objectives are to determine how activities and production facilities can be arranged so as to support the efforts to achieve the ultimate goal of

production effectively and efficiently (Shim, 1999). In addition, there is a factory layout planning purposes, namely to obtain benefits such as:

- a. Facilitate the process of manufacturing
Preparation of machinery, equipment, and a good work space resulted in ease of production processes.
- b. Minimize the transfer of goods
The influence of the material handling distance will affect the cost. Besides the transfer of goods that closer will impact in a reduction in production time.
- c. Maintaining flexibility
There are times when a plant requires layout changes resulting from the change (addition / subtraction facility). This situation requires flexibility in the production process.
- d. Maintaining the work in process
Material handling smoothness activity reduces the accumulation of goods at the work station. Small total circulation time would reduce the number of work in process also resulted in production costs.
- e. Lower cost of capital
A proper use of production facilities would reduce the cost of facilities that are necessary and to avoid duplication of equipment.
- f. Save-space usage
Accuracy in terms of the layout of the equipment used will save (efficiency) rooms were used.
- g. Facilitate supervision
With a good layout will facilitate the supervision of the production activities.
- h. To improve safety for products and employees.
Machinery and equipment that is placed in the right place will reduce the potential of workplace accidents or damage to the goods.

2.3 Principle of Designing The Layout

Based on the basic aspects, objectives and advantages derived from the layout well planned, it can be concluded six basic goal in plant layout, as follows:

- a. Thorough integration of all the factors affecting the production process.

- b. Minimizing movement distance.
- c. The flow of work in progress normally through the factory.
- d. All existing areas utilized effectively and efficiently.
- e. Job satisfaction and sense of security of the workers maintained.
- f. Setting the layout should be fairly flexible.

These objectives can be expressed as the basic principle of the processfactory layout planning.

2.4 The Steps of Planning The Company Layout

The layout of the factory is closely linked with all the planning and layout settings machinery, equipment, materials flow and the people who work at each work station. Good layout of all production facilities in a factory is a basis for the work operations to be more effective and efficient (Karad, 2008). Generally setting production facility as well will provide:

- a. Minimizing transportation of material moving process
- b. Minimizing unnecessary turning movements
- c. Minimize the use of land area
- d. Best production flow patterns
- e. The balance of the use of the land area
- f. The balance in the track
- g. Flexibility in facing of future expansion

2.5 The Types of Layout

One of the important decisions that need to be made is the type of decision determining the appropriate layout will make the efficiency of the manufacturing process for a long time. The types of layout in general is the Layout Product, Layout Process and Layout Technology Group (Shim, 1999).

2.5.1 Layout Based on Production flow (Product Layout)

Product layout can be defined as a method and the placement of all the necessary production fasifitas into a particular department or specialty. In the Product Layout, machines or tools arranged in order of the process of a product.

The considerations in choosing the type of layout are :

- a. There is only one or a few standard products made.
- b. The products are made in large volumes for a relatively long period.
- c. There is a balance between the track operator and production equipments.
- d. Determining the inspection activity were a bit during the production process.
- e. The machine has a special purpose properties and do not require high skills for operators.

The advantage of this type of layout is the work from one process is directly executed in the next process, so that the inventory of semi-finished goods to be small and the production per unit time becomes shorter. Then disadvantages for this type of layout that is the destruction of one machine will affect the entire production process.

2.5.2 Layout Based on Function

This layout is a method of placement machines and production equipment of the same type into one department.

The characteristics of this type of layout are :

- a. A comparison between the number of (Q) and the type of product (P) is small
- b. Production based on job order
- c. The production machinery and the same equipment is placed in one department

The advantage of this type of layout is able to do a variety of types and models of products as well as the specialization of work. While the disadvantages include difficult to balance the path of work in departments that require the area to work in process storage.

2.5.3 Fix Position Layout

For this type of layout, material or component of main product still in its location while production facilities like machines, humans and other supporting components moving to the location of the main components. The advantage of this type of layout is the transfer of material can be reduced, while weakness is requiring the operator with a high skill and a close supervision.

2.5.4 Group Technology Layout

Type this layout, the same components are grouped into one group based on the similarity of shape components, machinery or equipment used. The machines are grouped in a group and placed in a “manufacturing cell”. The advantages of this layout is the presence of grouping products according to the manufacturing process will be obtained maximum machine utilization. Also track the work flow more smoothly and material movement distance will be shorter. While the weakness of this type of layout that is required workers who have high ability and skills to operate all of its production facilities. Smooth working very dependent on the production control activities, especially in balancing the work moving (Heragu, 2006).

2.6 Distance Measurement

There are several systems used to measure the distance of a location to another location. The measure used much depends on the presence of qualified personnel, time to gather data, and the types of material transfer system used.

2.6.1 Euclidean Distance

Euclidean distance is the distance measured straightly between the central facility to the center of the other facilities. To determine the euclidean distance of the facility to other facilities using the following formula :

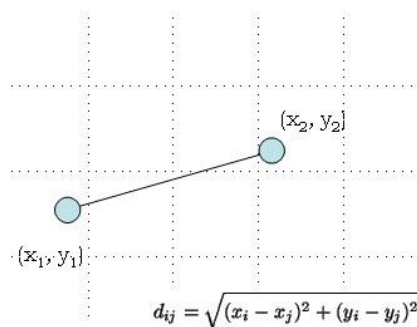


Figure 2. 2 Euclidean Distance

2.6.2 Rectilinear Distance

Distance rectilinear or Manhattan distance is the distance measured perpendicular to follow the path. In the rectilinear distance measurement used the following formula :

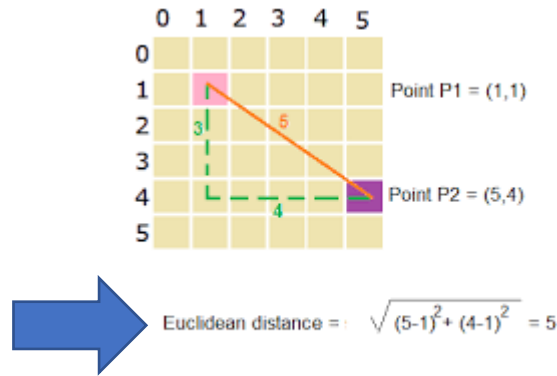


Figure 2. 3 Rectilinear Distance

2.6.3 Square Euclidean

Square Euclidean distance is a measure by squaring the greatest weight a distance between two adjacent facilities. The formula used in euclidean square :

$$d_{ij} = [(x_i - x_j)^2 + (y_i - y_j)^2] \quad (2-1)$$

2.6.4 Aisle

The size range of the aisle is very different from the other distance measurements. Aisle distance will measure the distance along the path traversed by the transfer material conveyance. Aisle distance is first applied to a layout problem of the manufacturing process.

2.7 Technical Analysis Planning and Material Flow Measurement

Settings departments in a factory where the production facilities will be placed in each department in accordance with the groupings based on the flow of material moves between the production facilities or those departments. To evaluate alternative layout planning department or the layout of the production facilities required material flow measurement activities in a technical analysis (Heragu, 2006).

There are two technical analysis that can be used for material flow planning :

a. Conventional Analysis.

This method is generally used for many years, it is relatively easy to use and especially how this will take the form of graphic images are very appropriate for the purposes of analyzing the flow of this kind.

b. Modern Analysis

This method is a new method for analyzing by using a advanced method in the form of formulas and approaches that are deterministic or probabilistic.

Some conventional techniques commonly used and useful in the planning process material flow are as follows:

- a. Operation Process Chart
- b. Process Flow Chart
- c. Multi Product & Process Activity Chart
- d. Flow diagram

In addition to the maps, there are also some more specialized maps to be used to evaluate and analyze the flow of materials in order to design the layout like Assembly Chart, Diagram String, From Travel To Chart or Chart, Triangular Flow Diagram and Activity Relationship Chart.

Flow analysis in this case can be carried out quantitatively and qualitatively. Quantitative analysis can be carried out based on specific criteria such as units of product per hour, the amount of movement movements per day and so on. The production process which has many activities that require movement or movement flow amount of material, information or people from one process to the next process would be more appropriate if the layout of the production facility were analyzed quantitatively.

Analysis of qualitative material is applied to the setting of production facilities or departments where the movement of materials, information or humans relatively little implemented. The qualitative analysis is required if we want to adjust the layout based on the degree of relationship activities such as communication or hierarchical relationships within the organizational structure. Qualitative measures will be a range of degree of relationship that indicates whether the department should be placed close together or far apart with the other departments.

2.8 Analyzing of Quantitative Analysis for Material Flow

In conducting the quantitative analysis of the material flow can use several methods as follows:

a. From – To chart

Quantitative analysis of the flow of material to be measured by the quantity of material moved as weight, volume, number of units and units of other quantitative. Map commonly used to perform quantitative analysis are from to chart. This technique is very useful for conditions in which many of the items that flow through an area. The numbers are in a from to chart will show the total weight of the load to be transferred, the material movement distance, volume or combinations of these factors.

Here is an application from to chart for the three components that are processed by machine order in Table 2.1, while the flow component as shown in Figure 2.4.

Table 2. 1 Quantity and Production Tracking

Component	Quantity Production/day	Flow process
1	25	A-B-D-E
2	15	A-C-D-B-E
3	10	A-D-E

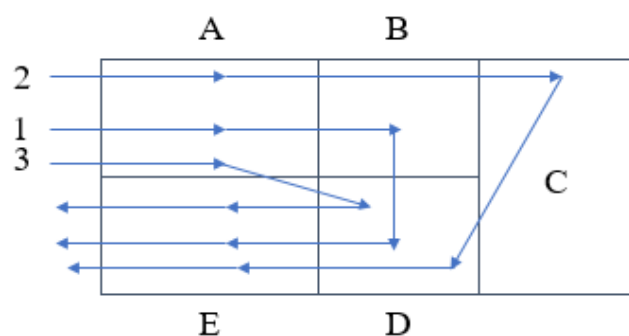


Figure 2. 4 Flow of Component

In the figure 2.4 to which indicate the amount of material transferred from A to B is a component 1 with a capacity of 25. Material that is moved from D to E are parts 1 and 3 with a quantity of 25 and 10, bringing the total displaced 35.

dari \ ke	A	B	C	D	E
A		25	15	10	-
B	-			25	15
C	-	-		15	-
D	-	15	-		35
E	-	-	-	-	

Figure 2. 5 From to Chart

b. Inflow and Outflow

Inflow is used to locate and determine the coefficient of material handling costs that goes into the work station from another work station while the outflow is used to find out the costs coefficients from one work station to another work station. Calculations based on the inflow and outflow of material handling costs and From To Chart so that it can be described as follow :

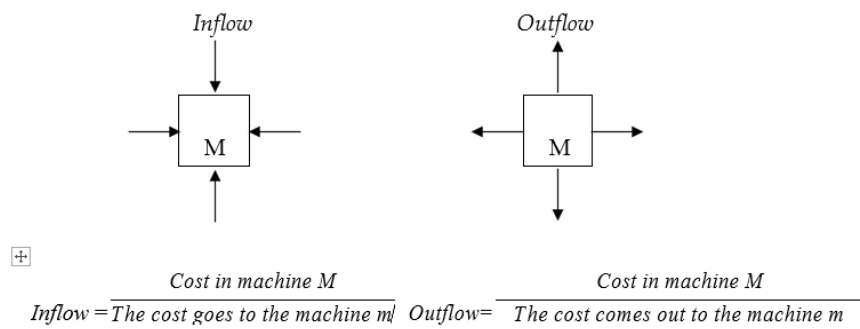


Figure 2. 6 Inflow and Outflow of Flow Material

c. Priority Scale Table

Priority Scale Table illustrates the order of priorities among the work stations in a production layout, so expect a material handling costs to a minimum. Calculation of inflow and outflow into considerations in making the priority scale table, where the priorities sorted by price coefficient fare ranging from the largest to the smallest. The purpose of making priority scale table among others, is to shorten the distance of material handling, minimizing material handling costs, and improve the layout of production become more optimal.

2.9 The Steps of Planning Facility Layout

Stages of layout design process is described following the sequence of activities with the approach of Systematic Layout Planning (SLP). Schematically SLP implementation procedures can be described as follows:

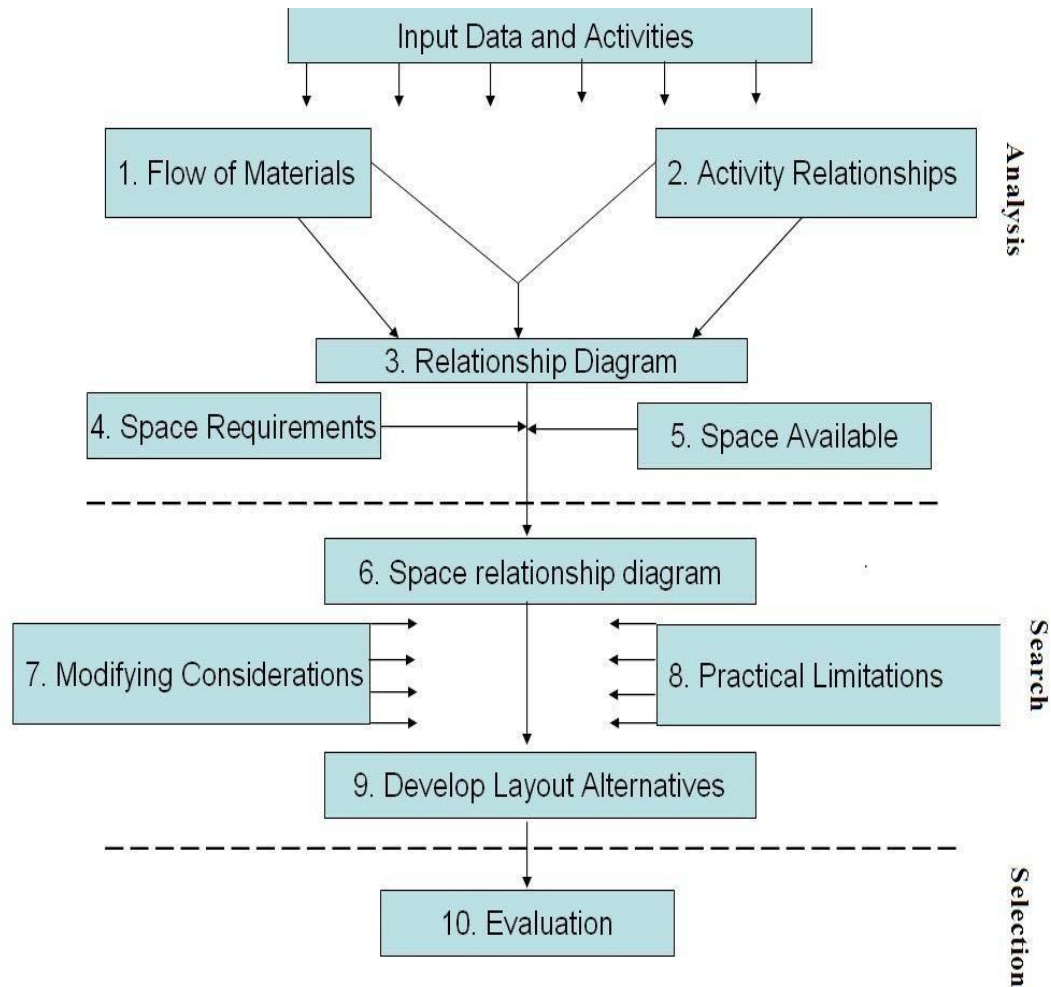


Figure 2. 7 The Basic Steps of SLP

Basically the above steps can be grouped into three stages: stage of analysis, the research stage and phase of the selection process. The analysis phase includes the analysis of material flow, activity relationship analysis, relationship diagrams activity, analysis of space needs and the space available. While the research stage involves planning room connection diagrams to the creation of alternative layout. (Shim, 1999). For the selection phase was done by evaluating alternatives designed layout:

a. Data Input

The initial step in the design of the layout is to collect preliminary data. There are three sources of data in the planning layout which are :

➤ Product design data

Data relating to the design of the product is very influential on the layout that will be created. Basically, the design of the product is so closely linked with the workmanship and the assembly sequence so that it does not directly affect the design of the layout. This data can be described in terms of working drawings, maps of assembly and bills of material.

➤ Process design data

These data illustrate the stages of manufacture of components, equipment and machinery needed for the production process. This data can be represented in the form of a map of the operation.

➤ Data draft production schedule

This data is a description of where and how much and when a product will be made based on the demand forecast. This data will be influential in determining the number of machines, employees, material handling equipment, and so on.

b. Analysis of material flow

Material flow analysis is a quantitative measurement analysis for each movement material transfer between departments or operational activities. This illustrates the flow pattern of incoming material to the finished product. There are a variety of alternative material flow that can be used include the following:

➤ The flow pattern of straight lines used for the production process is short and simple.



Figure 2. 8 Straight Line

➤ L-shaped flow pattern, this pattern is used to accommodate if the pattern of flow lines can not be used and the cost of the building is too expensive when using a straight line.

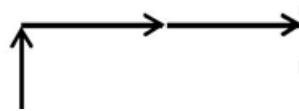


Figure 2. 9 L-Shapped Line

- U-shaped flow pattern, this pattern is used if the inflows and outflows of material products at the same relative locations.

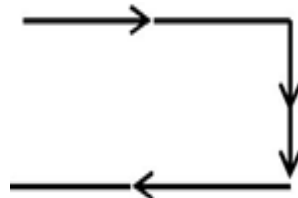


Figure 2. 10 U-Shapped Line

- The flow patterns form O, this pattern is used if the exit and entry of materials and products in one place / one door. These conditions make it easier to control entry and exit of goods.

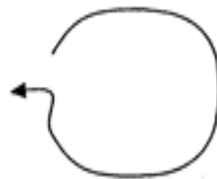


Figure 2. 11 O-Shapped Line

- The flow patterns form of S, is used if the flow of production is longer than the rooms were occupied.

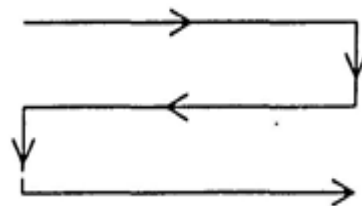


Figure 2. 12 S-Shapped Line

c. Analysis Activity Relationship

In designing the layout activity relationship analysis is required to determine the degree of closeness of the relationship between departments is viewed from two aspects: qualitative and quantitative. For the qualitative aspects will be more dominant in analyzing the degree of relationship is usually indicated by

activity and activity relationship (ARC), while for the quantitative aspect is more dominant in the analysis of material flows.

To help determine which activities should be put in a department, have been assigned a grouping degree of relationship, which is followed by a sign for each of these degrees. According to Richard Muther various relationships include:

A = Absolute need these activities brought near (close to one another).

E = Very important these activities together.

I = It is important that the activities are adjacent.

O = Normally (proximity), where there were no problems.

U = No need for any geographic overlap.

X = Not desirable are adjacent activities.

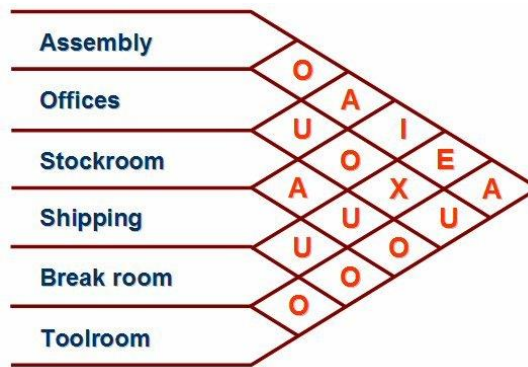


Figure 2. 13 Activity Relationship Chart

Map of activities that have been created are then used as the basis for activity relationship diagram (ARD) which is to determine the location of each activity / depatement. In it easier to make the activity relationship diagram (ARD) need to be created spreadsheets that are shown in the table.

Table 2. 2 Spread Sheet Activity Relationship Chart

SPREAD SHEET ACTIVITY RELATIONSHIP CHART							
No	Activity	Degree Closeness					
		A	E	I	O	U	X
1	Assembly	2	-	4	6	3,5	-
2	Office	1,5	-	-	3,6	5	-
3	Stock Room	-	4	-	2,6	1,5	-
4	Shipping	2	3	1,5	-	-	6
5	Break Room	-	-	4	-	1,2,3	6
6	Tool Room	-	-	-	1,2,3	-	4,5

d. Activity Relationship Diagram

Diagram activity relationship between the degree of relationship to combine activities and material flow. In this ARD degree of closeness between the facilities is expressed by a letter code and the line where the meaning of these symbols can be explained in the following figure :

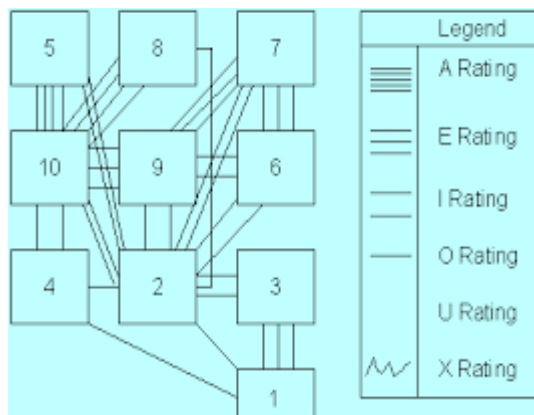


Figure 2. 14 Activity Relationship Diagram

Each letter code is then supplied a reason code is the basis for determining the author determines the degree of closeness, such as:

- The noise, dust, vibration., Odor and others.
- The use of machinery or equipment, data information, material handling equipment together.
- Ease of supervision activities.
- Cooperation which is closely related and each carrier departments. Various reasons above can be adapted to the conditions existing problems in the field where the research took place.
- Relationship Diagram room.

At this stage of the evaluation process area is needed for all activities of the company and the area available. The design layout work facility, ideally made in advance, while the factory building was set according to the design layout of the facility that has been dibuat.namun in some cases, as a process of plant layout is done after the factory buildings stand. This can occur in the layout design of the project, due to limited funding for the establishment of a new plant, knock a matter of time. Connection diagrams room can be made after analyzing the extent needed and combined with ARD.

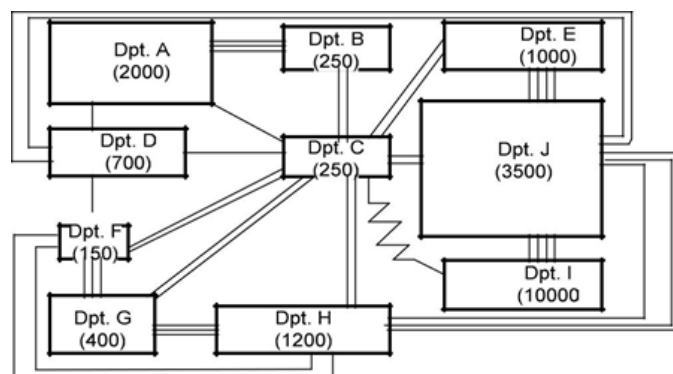


Figure 2.15 Room Relationship Diagram

e. Total Area Required

There are several methods in determining the area of the room needs including:

➤ Method of Industrial Facilities

This method determines the space requirements based on production facilities and support facilities production process used. Area room is calculated from the size of each type of machine used multiplied by the number of each type of machine used plus allowances for operators and aisle.

➤ Template method

This method provides a real picture of the shape and the entire space requirements in a model or template with a certain scale.

➤ Industry Standard Method

The industry standard is made on the studies carried out on the assessed industry has been established in the design layout of the facility as a whole.

f. Draft Alternative Layout

Connection diagrams rooms are basic in the manufacture of alternative design layout. To make the design layout can be made of a Block Layout with certain scale represents the building with the constraints of space owned. There are three methods that are used to represent a well-designed layout, the Picture or sketch, two-dimensional model (template), three-dimensional model.

g. Evaluation And Follow Up

Alternatives layout has been created, selected alternative design that would best suit the organization's objectives. Here are techniques for evaluating the design layout :

➤ Comparison of Profit and Loss

In this technique, compiled a list of the advantages and disadvantages of each alternative on offer. The selected alternative is that which has the advantage that relatively large.

➤ Ranked

Technique is done by selecting factors considered important, then made a list of rankings of each alternative for each factor. Alternative design with the highest total score will be selected as the design layout will be created.

➤ Factor Analysis

This is almost the same as the ranking method is to determine the factors that are considered in the design of the layout, then do weight given to each factor. The most critical factor given the greatest weight. Weights are also given for each alternative ranking factors. Alternative design of the first rank gets the greatest weight. Results of times the weight factor and a weighted ranking score of the alternative design. Alternative design the best layout is the highest score.

➤ Comparison of costs

This method is done by comparing the costs for each alternative design. The costs identified is the cost of investment, operation, and maintenance. Alternative design with the smallest cost will be selected as the best design alternative.

2.10 Definition of Material handling

One of the important problems in terms of production activity / production process is the movement of material from one level to the next production process. To enable the production process required to run their activities with the removal of material called Material Handling. There are many definitions of, or understanding given to material handling (Arora, 2007). Here are two definitions in general, namely:

a. Material Handling is the art and science of the movement, storage, protection, and control of the material.

➤ Art

Material handling can be expressed as art, because of the problems of material handling can not be explicitly resolved solely by formula or mathematical models. Material handling requires a 'vote' right or wrong, where the company that expert in material handling aspect will judge.

➤ Science

Material handling can be expressed as a science because it involves engineering methods. Define problems, collect and analyze data, create alternative solutions, evaluation of alternatives, select and implement the best alternative is an integral part of the solution and the material handling system design process. Analysis of mathematical models and qualitative techniques are very meaningful as part of this process.

➤ Movement

Movement of material takes time and requires the use of place (ie handling of materials used at the right time and the right place). Material movements requires a match between the size, shape, weight, and condition of the material with the movement trajectory and frequency analysis.

➤ Storage

Material storage as a buffer between operations, facilitates the work of man and machine. To consider in the storage material include the size, weight, condition and capacity of a pile of material, the need to take and put the material, the constraints of the building such as floor loading, condition of the floor, the distance between the columns, and tall buildings.

➤ Protection

Which includes among other material protection performance pemngawasan, packing and grouping material; to protect damage and loss of material. Material protection should use a safety device which is connected to the information system. Including protection against material mishandled, misplaced, wrong decision, and order the wrong process. Material handling systems should be designed to minimize the purposes of supervision, and to lower costs.

➤ Supervision

Oversight material consists of physical surveillance and monitoring material status. Physical surveillance is surveillance-oriented structure and the distance between the placement of material. Supervision is monitoring the status of the location, quantity, destination, ownership, authenticity, and schedule material. Caution should be taken to ensure that should not be too much oversight conducted on material handling systems. Conduct proper oversight is a challenge, because the proper supervision is highly dependent on the organizational culture and the people who organize and carry out material handling functions.

➤ Material

Broadly speaking, the material can be powdered, solid, liquid, and gas. Material handling systems among forms have different treatment between the shape of the material.

- b. Material Handling has meaning material handling just the right amount of material to comply in good time at a suitable place, at the right time in the correct position, in the appropriate sequence and a low cost by using the correct method.

2.11 Aspects of Transfer of Material Costs

In general the material handling cost will be divided into three classifications:

- a. Costs associated with the transport of raw material from the original source to the plant and finished goods product delivery to consumers who need them. The cost of transportation here is a function that is directly related to the plant site

selection of the location where the source material is located as well as the location of the destination.

- b. In - Plant Receiving and Storage, ie costs diperlukan for transfer of material from one process to the next to final product delivery.
- c. Handling materials carried by the operator on the machine works and assembly process takes place on the table assembly (Arora, 2007).

In an effort to analyze material handling costs, the following factors should be very concerned, which are :

- a. Material
 - The purchase price of the machinery / equipment.
 - The cost of the entire material used.
 - Maintenance and repair costs - part inventory.
 - Direct power cost (kilo watt hour, fuel and others).
 - Costs for oil.
 - Costs for equipment benches (complementary).
 - The cost of the installation, including here the whole material and material handling operator cost and rearrangement.
- b. Material handling operator costs
 - Direct Labor Cost (all personnel involved in the operation of material handling equipment).
 - Training Cost to run the material handling equipment.
 - Indirect Labor Cost (staff and service departemens) and others.
- c. Financial Charge
 - Interest on investment material handling equipment
 - The cost of insurance, depreciation and others (Arora, 2007)

2.12 The Purpose of Material handling

The main purpose of the planning material handling is to reduce production costs. Furthermore, material handling is very influential on the operation and design facilities were implemented. Some of the objectives of material handling systems, among others (Arora, 2007)):

- a. Maintain or improve the quality of products, reduce damage, and provide protection against material.
- b. Improved security and develop working conditions.
- c. Increase productivity:
 - Material will flow in a straight line.
 - Material will move a distance as close as possible.
 - Transfer of a number of materials on one particular.
 - Mechanization material handling.
 - Automation material handling.
- d. Increasing the level of use of facilities.
 - Increase the use of building.
 - Procurement of multipurpose equipment.
 - Standardization material handling equipment.
 - Maintain and put all the equipment according to the needs and develop a preventive maintenance program.
 - Integration of the entire material handling equipment in a system.
- e. Reduce deadweight.
- f. As inventory control.

2.13 The Consideration of Material Handling System

a. Characteristics Material

In designing the absolute material handling systems known in advance the characteristics of the material being handled, so that in the use of material handling equipment avoid mistakes that lead to increased costs. Material characteristics can be categorized merdasarkan things like the following.

- Physical properties: The form of a solid, liquid, or gas.
- Size: Large volume, length, width, and height of the material.
- Weight: Per piece, per box, or per unit volume.
- Forms: Form a long plate, square, round, and so on.
- Conditions: Heat, cold, dry, wet, and so forth.
- The security risks: Easy explosive, toxic, easily broken, easily broken, and so on.

b. Material Flow Level

Two main points in the flow of the material is about the quantity of material being removed and the material movement distance.

c. Types of Company Layout

Type the characters fixed position layout with very large-sized products and production levels are low, the activity of material handling using cranes, hoists, and truck-truck industry. Process-type character layout with varied products and production levels low and medium, material handling activities using hand truck, forkliftruck, and AGV's. Type of product layout, to handle the flow of products with high production rates are being used mainly conveyor for removal of components with a truck (Arora, 2007).

2.14 Material Handling Cost

In designing the plant layout, the material movement activity is one thing that is quite important to notice. The purpose of the removal of material is as follows:

- Increase capacity.
- Improving working conditions.
- Improve customer service.
- Increase the use of space and equipment.
- Reduce costs (Arora, 2007)

Some of the material handling activities that need to be considered is the transfer of materials to the storage of raw materials and finished out of the barn, and the transfer or transport of which occurred in the factory alone. Factors - factors that affect the calculation of material handling costs include the distance from one work station to another work station and transport costs per meter movement. Measurement of the mileage adapted to existing conditions in the field. Thus, if the distance has been determined and the frequency is already taken into account the material handling material handling costs can be known, where:

Total Material Handling Cost = cost per meter movement x distance haulage x fequency (2-5)

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Framework

Research methodology will explain the activity of the research. It is started from the initial observation until the conclusion of the problem. Every step will explain about the process as a whole and give general information related to that process. The steps can be seen in the figure 3.1.

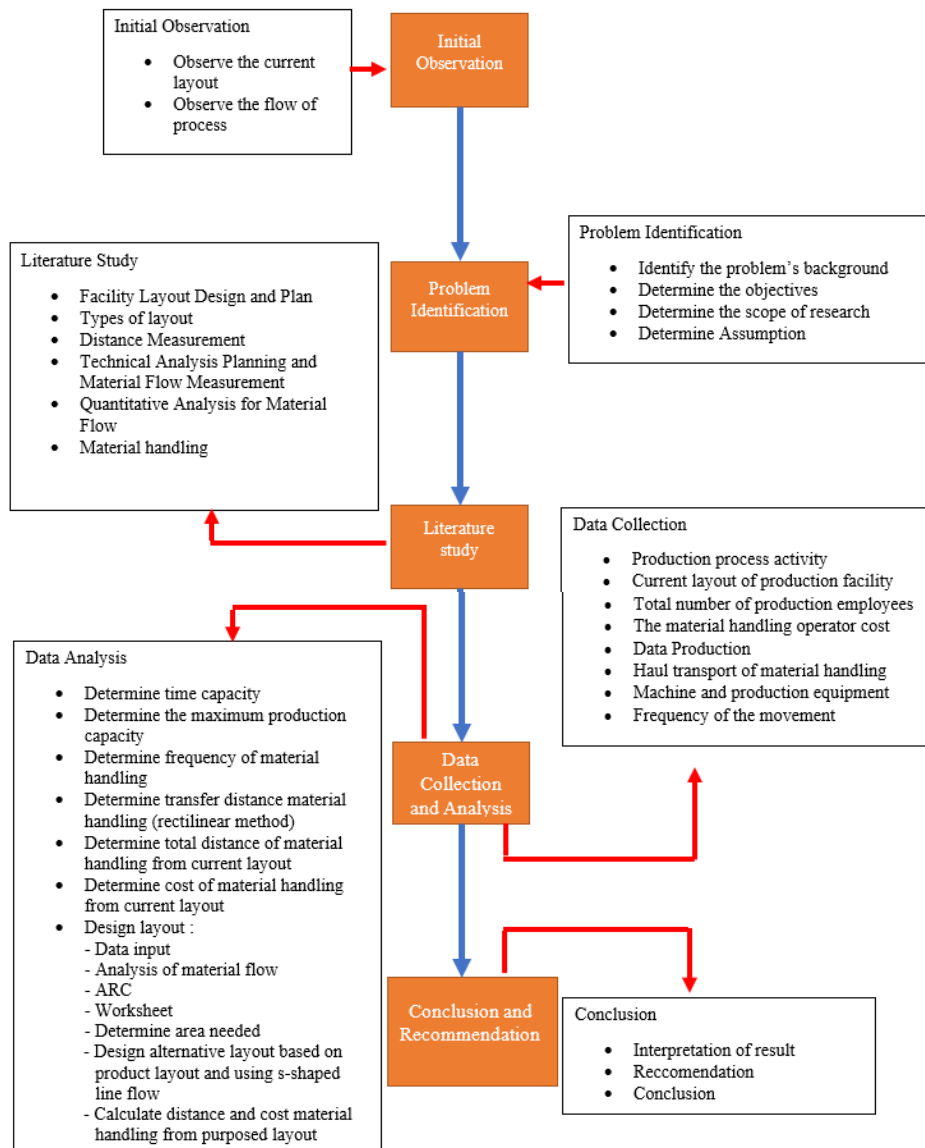


Figure 3. 1 Research framework

3.1.1 Initial Observation

The first step taken is to conduct field studies conducted during the study at CV. Rotan Asik Asik Jos. In this phase, the recognition and understanding of the corporate environment and then Observe the both of current location also compare to the candidate location or prospective location.

3.1.2 Problem Identification

The next step is to find out the current problems and the problems after replacement. The background of this study is the condition of the production facility layout CV. Rattan Asik Asik Jos is not referring to the material flow is appropriate. It also resulted in the intersection of the flow of material that may affect the level of safety and performance of workers.

3.1.3 Study Literature

The study of literature is done by collecting references from the company and other sources related to:

- Understanding Planning and designing the layout manufacturing facility for many objectives.
- Understanding methods that used for re-layout.
- Understanding material handling definition and aspects.

3.1.4 Data Collection

The releveant data wil be collected are primary data and secondary data, The primary data from interviews with manager or owners of the company and the secondary data from the research and report such as:

- Current Layout
- Production facilities area
- Flow diagram
- OPC
- The size of the machine / tool.
- Production data
- Demand data

3.1.5 Data Analysis

Based on my data in several type so the methods that used for analysis are designing the layout by using type of product layout and s-shaped line flow. In analyzing the data first we determine the maximum production capacity. In fulfillment of production orders received by the company must be known whether it can be filled in accordance with the ability of production capacity installed in the company. when there is excess production order can be done by way of overtime or subcontracting to be transferred to other companies. In determining the production capacity to use the data products are often ordered and produced in large quantities (reference product) within 3 months of the research. From data production, the products are often manufactured / ordered in the largest number of products Goose Chair.

After determine the production capacity, determine the distance between each production facilities in current layout. The distance between the work stations can be found by determining the center between work stations, next is the distance calculation using the system within the elbow (rectilinear), which is the distance measured between the center of one work station to another work station centers. Each - each work station sought its center point is 0 of X and Y. The reason for using this method is the path / lane transportation of the material flow in the CV. Rattan Asik Asik Jos passing side aisle layout block work station so the method is more appropriate, where the formula as follows :

$$d_{ij} = (x_i - x_j) + (y_i - y_j) \quad (3-1)$$

Where : X_i = coordinate x_i in center facility of i

Y_i = coordinate y in center facility of i

d_{ij} = distance center facility between i and j

The next step is determining the performance of the initial layout and material handling cost. From the calculation of distance between each work stations above, it can be seen that the performance of the initial layout is the total distance material handling (D).

$$D = \sum_{j=1}^n d_j \quad (3.2)$$

Where : D = Total distance of material handling
 d_j = Distance of material handling for each work stations
 n = The number of work stations

After that then calculate the cost material handling of initial layout. Factors that affect the calculation of material handling costs are: the distance from one work station to another work station, the frequency of transfer between work stations and transport costs per meter movement. Measurement of the mileage adapted to existing conditions. Thus, if the distance (path length) is already known and the frequency is already calculated so the cost of material handling can be known where :

$$\text{Total MHC} = (\text{MHC per meter}) \times \text{distance of movement} \times \text{frequency} \quad (3-3)$$

The next step is design the layout. The design is done to correct the initial state are considered less appropriate. These improvements are based on the layout of the proposed acquisition performance (path length and cost of material handling) are better than initial performance. The steps taken in designing the layout purposed is as follows: the first step in designing the layout using data obtained in the initial data gathering phase step - step workmanship of the products manufactured and other data is associated with the production process then analyzing material flow by using flow process chart, flow diagram, from to chart, activity relationship. When done designing the layout, the layout purposed made need to consider Activity Relationship Chart (ARC) and the worksheet. ARC is based on certain reasons and the level of interest symbolized by the letters A, I, E, O, U and X. The letters show how the activity of each work station will have a relationship directly or closely related to one another. To make easier in analyzing, Activity Relationship Chart (ARC) is converted into a worksheet. Then determine the area required, Determining the needs of the area required industrial facilities method is a method of determining the needs of the room based production facilities and support facilities production process used. In this method the space requirements based on the number of machines and equipment used in the production process. Room area

is calculated from the size of each type of machine or equipment used machine further added measure of tolerance multiplied by the number of machines the equipment plus allowances for operators and aisle, then calculate the distance travel material handling and cost of material handling layout purposed.

The next step is determination of selected alternative proposed layout or accepted. In determining the alternative chosen to design the layout come from information before including: determining the needs of the room, making of Activity Relationship Chart. In the determination of selected alternative is obtained from the calculation of the minimum distance.

$$\begin{aligned} D_{jk} &= D_{ja} - D_{ju} \\ \text{Min DJK} &= \sum D_{jk} \end{aligned} \quad (3-4)$$

Where : D_{jk} = Difference in distance to each work station.

D_{ja} = Distance of material handling initial layout.

D_{ju} = Distance material handling layout purposed.

D_{jk} = Distance material handling choosen.

After the alternative layout was choosen then added other supporting facilities like office facilities, locker room workers and WC or bathroom workers.

3.1.6 Conclusion and Recommendation

From the analysis that has been done, the next step is to define conclusions to answer the purpose of research and provide suggestions and recomendation for the development of this research further.

CHAPTER IV

DATA COLLECTION AND ANALYSIS

4.1 Data Collection

Disadvantages of the plant layout that now is the layout of each work station is not appropriate, for not taking into account the degree of closeness between work stations, looks at cutting stations and assembly frame work stations placed far apart where the formation process step of the operation sequence. The work area is not standard so that disturb the freedom of movement and comfort of workers. And there are intersections of material flow that can gives increasing of material handling cost. Irregularities conditions existing layout can affect the material flow is not perfect. it is necessary to design a new layout to rearrange the path of material / goods to maximize in functioning foe each works stations.

The solution is to combine 2 layout that seperate become 1 layout by relocating build new factory which is minimizing the material handling and support the development in the future. Where the company holds seek new land for relocate the factory because limitation of area which are owned for the merger of 2 layout of the company.

For completion method is used type of product layout. Redesign the layout of the proposed expected to generate new layouts so as to minimize the cost of material handling. The data required are explained as follows:

4.1.1 Activity of Production Process CV Rotan Asik Asik Jos

The production area of the company seperated into 2 companies which are the area of first company is 351 m² and the area of second company is 120 m². In CV. Rotan Asik Asik Jos there are some of activities of production process. These are the production procces in first company as follows :

1. Cutting Station

Rattan rod straightened, then measured in accordance with the specified size, as measured checked first before being cut in order to avoid mistakes, then the rattan is cut, after cutting is completed then sanding so that segments of rattan becomes smooth, after the cut and sanded, rattan sticks ready to do the gluing and assembled

2. Framework Station

First the rattan rod that had been cut drilled and bent according to the model that has been planned, in order the cut and perforation became more smoother so sanded again, then combine parts to one another, after that is boat caulking and sanding,

3. Weaving Station

After the framework is completed, the next process framework wrapped with rope knitted and woven rattan water hyacinth.

These are the production process in second company after production process in first company as follows :

1. Finishing

In here the process is eliminating the fuzz of rattan from the chair product that has been weaving in first company. Then painting process based on customer demand.

2. Drying

This process is drying under the sunlight until the paint is dry.

3. Packing

The product already dry and passed from quality control will be packed with paper and coated by cork then tied with rope then inserted into the box and ready to be send.

4.1.2 Operation Process Chart

First the flow of operation be must be known, so the flow operation of produce rattan can be seen below.

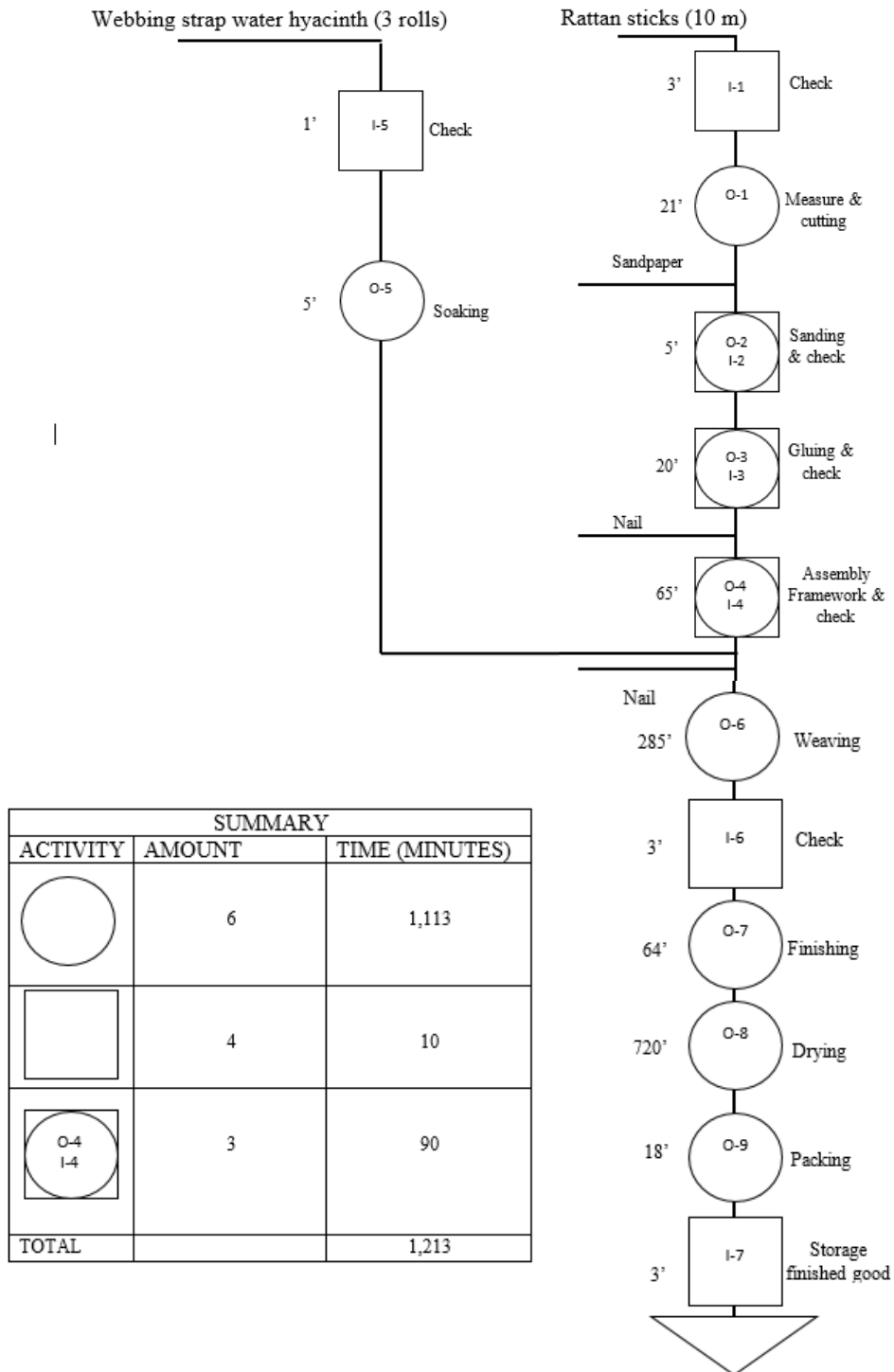


Figure 4. 1 Operation Process Chart

4.1.3 Flow Diagram

Is a diagram that uses notations to describe the flow of data in a system, whose use is helpful to understand the system logically, structured and clear. This diagram is used tools in describing or explaining the work process of a system, so the flow diagram in factory 1 can be seen in figure 4.2 and factory 2 can be seen in figure 4.3. The red circle representative as the intersection flow.

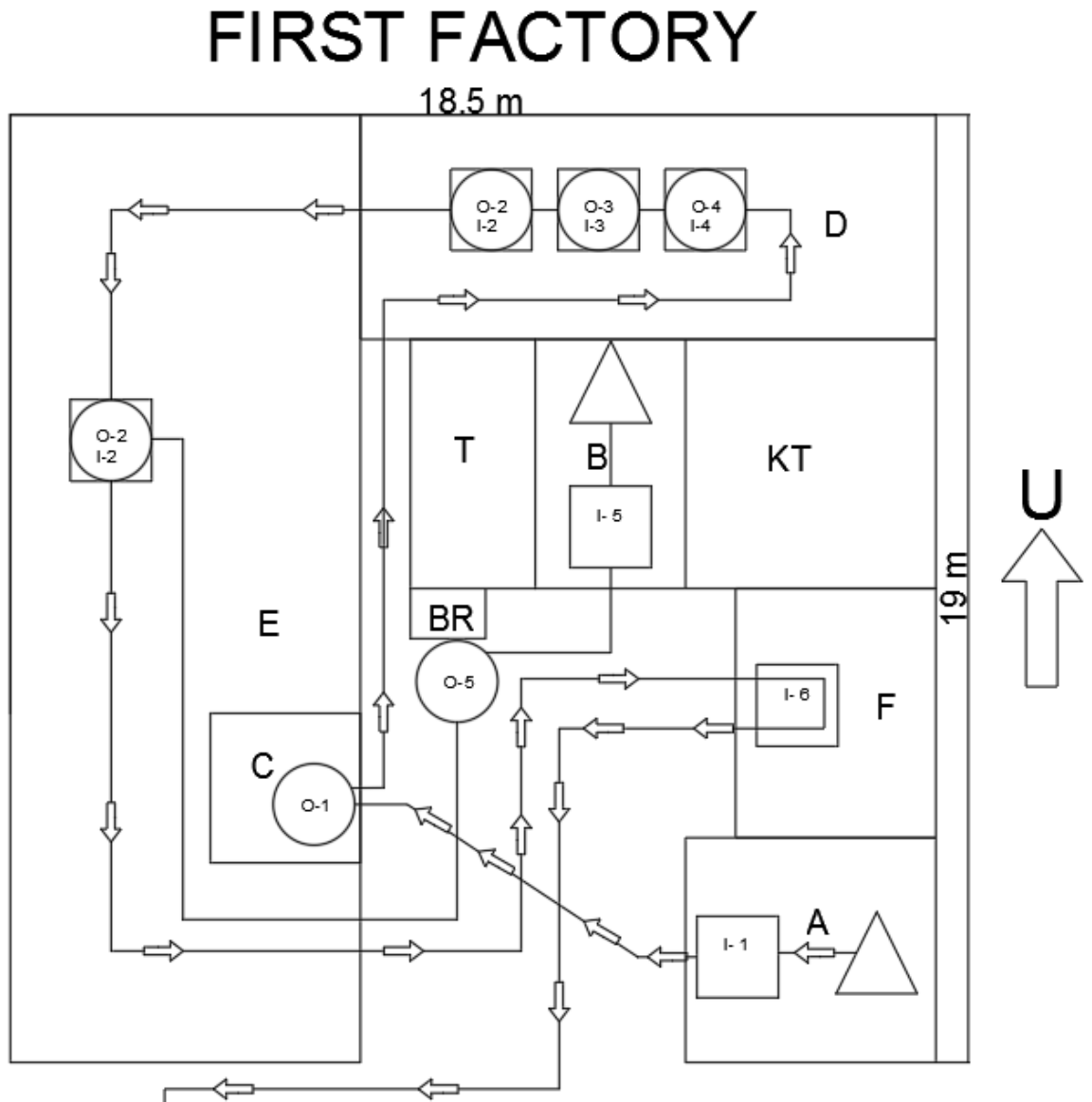


Figure 4. 2 Flow diagram in First Factory

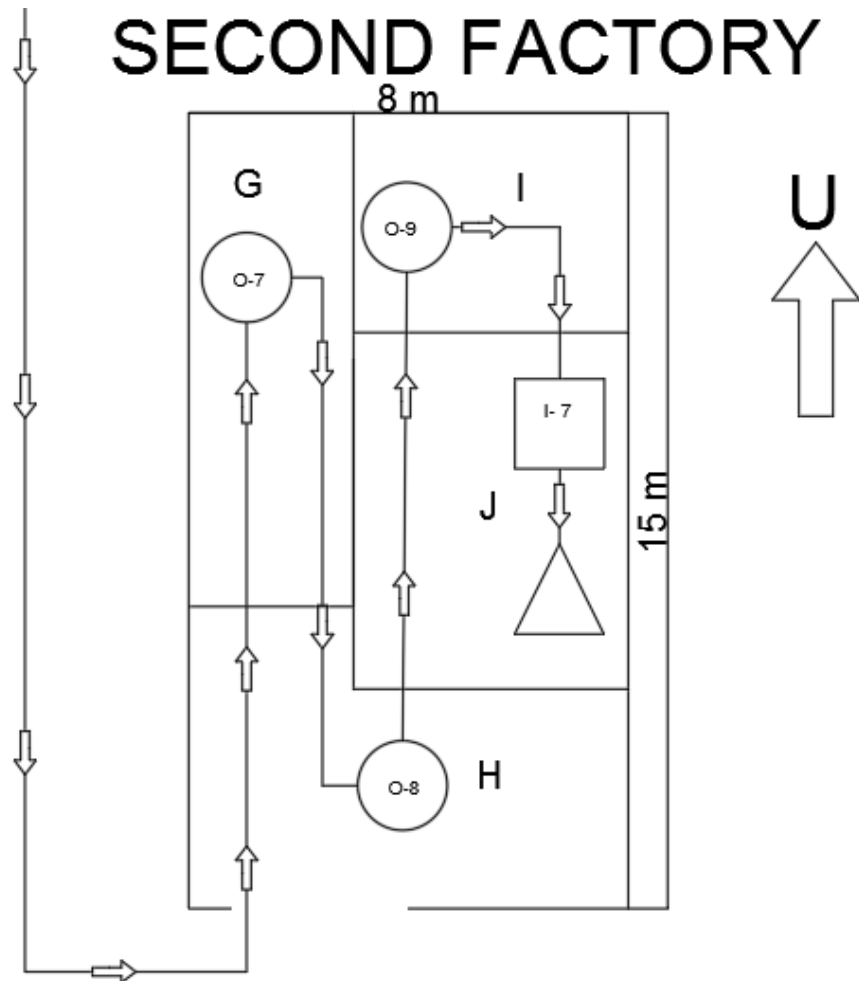


Figure 4. 3 Flow Diagram in Second Company

4.1.4 Employees Data

The shift of labor hours on a CV. Rotan Asik Asik Jos is for employees of the production is to start work from Monday to Saturday 08.00 - 16.00. Rest time is set for one hour, which is between the hours of 12:00 to 13:00 pm. Thus, an effective working hours Monday - Saturday is 7 hours (420 minutes). The number of production workers in the CV. Rotan Asik Asik Jos at this time, totaling 42 production workers and one worker transportation of the vehicle. Salary for one worker Rp750.000 per month. Labor can be grouped into several sections, as listed in Table 4.1.

Table 4. 1 Total of Workers

No	Department	Number of Workers
1	Cutting	2
2	Framework	6 (2 gluing and 4 assembly framework)
3	Weaving	24
4	Finishing	6
5	Packing	4 (separate into 2 group)
Total		42

Table 4.1 shows that the total workers in cutting department are 2, in framework department there are 6 worker divided into 2 workers for gluing and 4 workers for assembly, in weaving department there are 24 workers, in finishing department there are 6 workers and in packing department there are 4 workers divided into 2 workers for drying and 2 workers for packing.

4.1.5 Initial Layout

Based on operation process chart in CV. Rotan Asik Asik Jos there are some of work area which are :

1. Storage of rod rattan material
2. Storage of knitted rattan raw materials
3. Cutting
4. Framework
5. Waeving
6. Storage of WIP
7. Finishing
8. Drying
9. Packing
10. Storage of finished goods

4.1.6 Production Floor Area

The total area of production process in CV. Rotan Asik Asik Jos can be seen on Table 4.2.

Table 4. 2 Production Floor Area

Activity Area	Code	Length (m)	Width (m)		Area (m ²)
Storage of rattan rod raw material	A	5	4,5		22,5
Storage of knitted rattan, hyacinth rope, banana leaves rope	B	5	3		15
Cutting	C	3	3		9
Framework	D	45	11.5		51.75
Weaving *	E	19	7	133-9	124
Storage of WIP	F	5	4		20
Office Room	KT	5	5		25
Toilet	T	5	2.5		12.5
Bath tub	BR	1	1.5		1.5
Finishing	G	9	3		27
Drying	H	4	8		32
Packing	I	4	5		20
Storage of Finished Good	J	7	5		35
Total Area					395.25
Description * Total area weaving = area weaving - cutting area (Figure 4.2)					

Table 4.2 shows that the area for each work station. Cutting station has 9 m² then framework station has 51.75 m² and soon. The orange box means that because cutting area inside weaving station so to calculate total area of weaving is weaving area minus by cutting area and the yellow box means out of production floor. In From the size of the unit contained in Table 4.2 can be explained on the layout area production company CV. Rotan Asik Asik Jos in Figure 4.4 for the first plant and Figure 4.4 for the second plant.

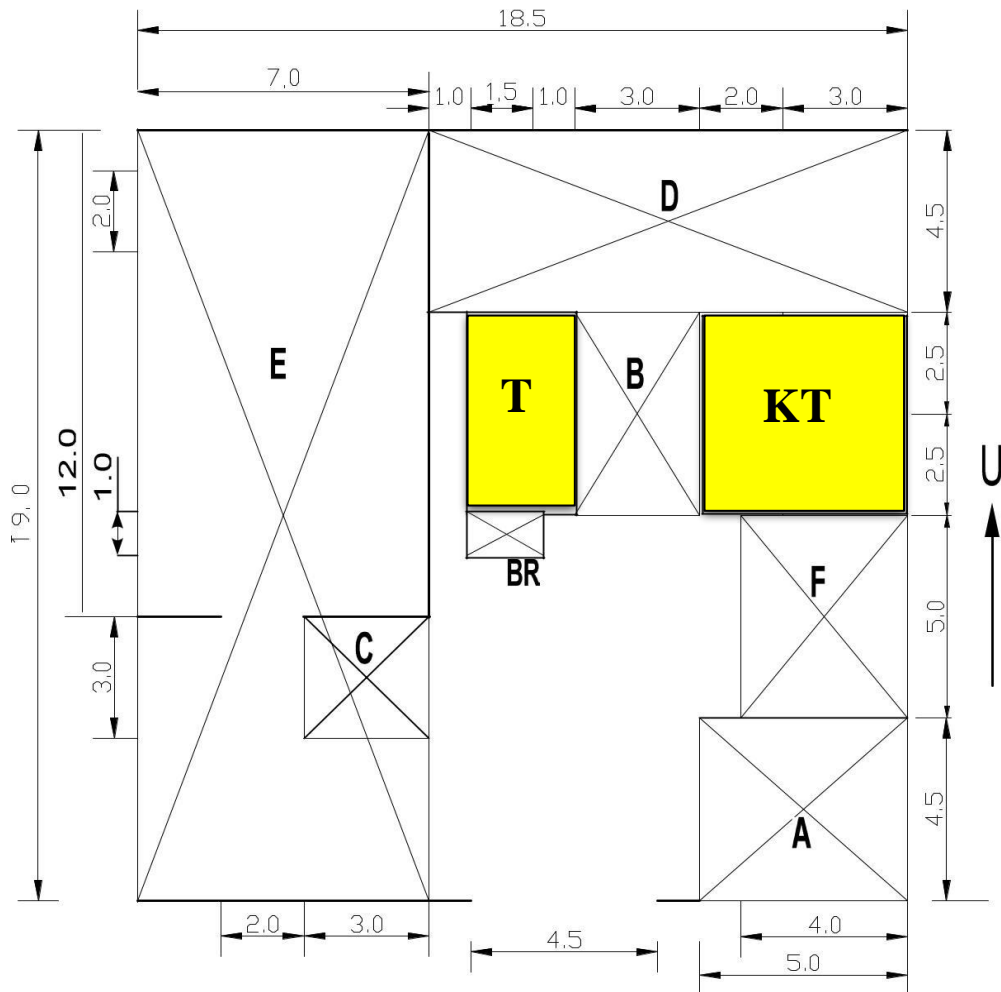


Figure 4. 4 Current Layout in First Company

Figure 4.4 shows that the current layout in first company also the area of each work station that can calculate from length and width that shown. Total length of first company is 19 m and the total width of first company is 18.5 m. The yellow one means out of production area because KT is office and T is toilet and both not affect to the production procces.

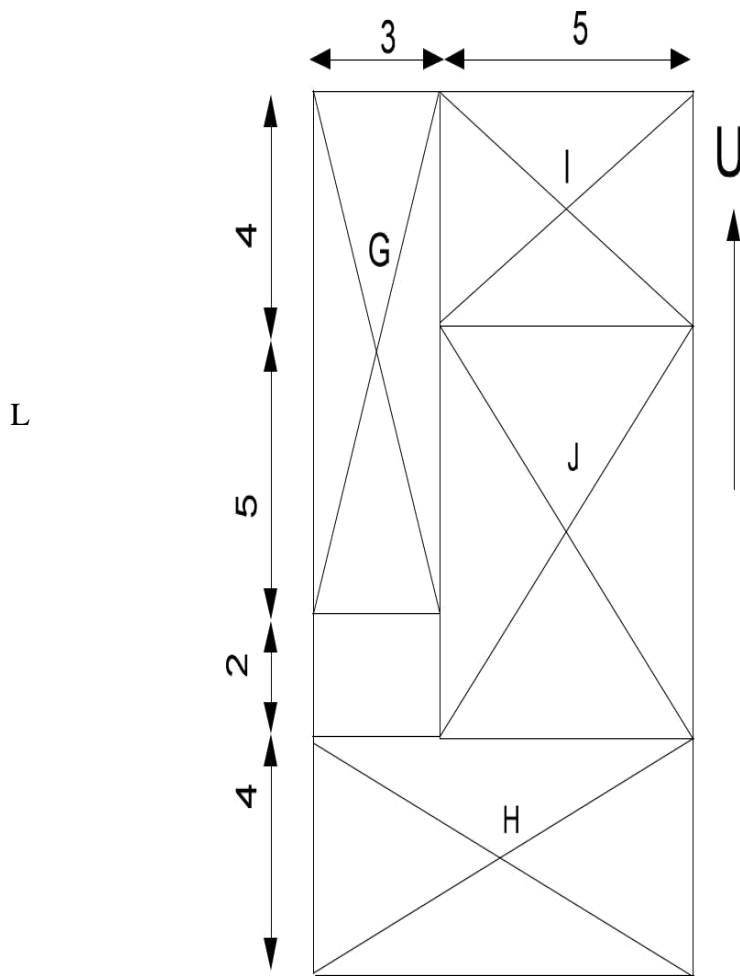


Figure 4. 5 Current Layout in Second Company

Figure 4.5 shows that the current layout in second company also the area of each work station that can calculate from length and width that shown. Total length of second company is 15 m and the total width of second company is 8 m. All of work station in second company are nclude to production floor.

4.1.7 Size of Machine that Used

The machines and tools that used in production process can be seen in Table 4.3.

Table 4. 3 Size of Machine

Name of Machine	Size of Machine			
	Quantity	Length (m)	Width (m)	Diameter (m)
Chainsaw	2	0.5	0.3	
Table for gluing rattan	1	1.5	1	
Gas Cylinders (heating)	3			0.3
Compressor	2	0.5	1.2	

Table 4.3 shows that the size and quantity of each machine that used in CV. Rotan Asik Asik Jos. For chainsaw there are 2 pcs, for table there are 1 only, for gas cylinder there are 3 pcs and for compressor there are 2 pcs. Then the size of chainsaw is 0.5 m x 0.3 m, gas cylinder has diameter 0.3 m and soon.

4.1.8 Production Process Time

Time production process is a process for doing a job, the data processing time obtained by direct observation at each work station by using a stopwatch. From the research that has been conducted found the process time data in Table 4.4.

Table 4. 4 Time of Production Process

Order Code	Product Name	Time of process (minute/unit)				
		Cutting	Framework	Weaving	Finishing	Packing
PO 16	Pouff (WTH)	16	55	136	63	15
PO22	Osaka Pouff	16	50	125	54	14
SC 090	Madura AC	20	65	170	60	15
	Madura CT	18	60	150	50	14
SC 109	JuzyAC	20	65	224	70	16
	Juzy CT	22	80	215	65	15
EC 112	Amsterdam	20	65	175	55	14
BC 120	Cubano Relax Modified	20	68	218	68	15

Table 4. 4 Time of Production Process (Cont'd)

Order Code	Product Name	Time of process (minute/unit)				
		Cutting	Framework	Weaving	Finishing	Packing
SC 299	Surya AC	22	85	245	70	15
	Surya CT	16	55	145	50	14
EC 121	Pentagon Relax New	16	55	205	55	15
SC 502	IVY AC	22	86	325	77	18
	IVY CT	20	68	175	60	15
	IVY Sofa 2S	20	66	163	55	15
SC 191	Goose Chair	21	65	285	64	18
SC 153	Porto AC	25	95	315	85	18
	Porto CT	21	75	230	60	15
	Porto Sofa 2S	20	65	165	55	15
SC 514	Tasmania AC	24	90	345	82	17
	Tasmania CT	20	65	170	60	16
	Tasmania Sofa 2S	21	70	135	58	15

Table 4.4 shows the production time of 1 product in each station, can be seen that to make 1 product goose chair in cutting area need 21 minutes, in framework area need 65 minutes, in weaving area need 285 minutes, in finishing need 64 minute and in packing need 18 minutes.

4.1.9 Demand Data

To maintain its business CV. Rotan Asik Asik Jos produces several types of models of products according to customer orders. The products are often in the order or completed within 3 months of observation as in table 4.5.

Table 4. 5 Demand Data

Data in June 2016		
Order Code	Product Name	Quantity
SC 191	Goose Chair	250
P0 24	Osaka Pouff	250
SC 513	IVY AC	200
	IVY CT	100
	IVY Sofa 2S	100
Total		900
Data in July 2016		
Order Code	Product Name	Quantity
PO 16	Pouf (WTH)	100
SC 191	Goose Chair	200
SC 514	tasmania AC	100
	Tasmania CT	50
	Tasmania Sofa 2S	50
SC 109	Juzy AC	150
	Juzy CT	150
Total		800
Data in August 2016		
Order Code	Product Name	Quantity
SC 191	Goose Chair	200
EC112	Amsterdam	100
SC299	Surya AC	150
	Surya CT	150
EC 121	Pentagon Relax New	50
SC 090	Madura AC	100
Total		750

Table 4.5 shows that the types of products that are frequently performed and produced the greatest number is the yellow box which is product Goose Chair (250 units+ 200 units + 200 units = 650 units) within 3 months of observation in June 2016- August 2016. From the production data to make the calculation of production facility needed by using the products most frequently performed every month in the largest number as a reference which is Goose Chair.



Figure 4. 6 Goose Chair

4.2 Data Analysis

Layout data processing were done to determine the performance of the initial layout of the production facility in CV Rotan Asik Asik Jos right now. The Steps below as follows.

4.2.1 Production Capacity

From the data obtained workers employees work Monday to Saturday 08.00 - 16.00. Rest time is set for one hour, which is between the hours of 12:00 to 13:00 pm. So that the effective working hours Monday - Saturday is 7 hours (420 minutes). Within a month, there are 26 working days effective. From the above data it can be seen working capacity perstasiun working time per month.

Sample calculation:

For cutting station, hours of work a day = 7 hours = 420 minutes, and 26 days of work a month. Capacity of working time at the cutting station per month = (420 min x 26 days x 2 workers) = 21,840 minutes

Table 4. 6 Availability of Time Capacity

Code of Area	Work Station	Number of Resources	Availability of time capacity (minutes/ month)
C	Cutting	2	21,840
D	Framework	6	65,520
E	Weaving	24	262,080
G	Finishing	6	65,520
I	Packing	4 (2 Work Groups)	21,840

From Table 4.6 shows that time capacity in each work station per month. In cutting area there are 21,840 minutes with 2 workers, In Framework area there are 65,520 minutes with 6 workers, and soon.

Sample calculation production capacity for each work station:

Cutting work station (C), the availability of time capacity at the cutting station divided by processing time required for one unit of product for each work station.

$$= \frac{21,840 \text{ minutes}}{21 \text{ minutes / unit}} = 1,040 \text{ units}$$

Table 4. 7 Production Capacity for Goose Chair

Code of Area	Availability of time capacity	Process time of Goose Chair (minutes)	Production capacity in 1 month (units)
C	21,840	21	1,040
D	65,520	65	1,008
E	262,080	285	920
G	65,520	64	1,023
I	21,840	18	1,213

Table 4.7 shows that the total production capacity for Goose Chair in 1 month. In cutting area (C) the production capacity is 1,040 units in framework area (D) the production capacity is 1,008 units and so on.

4.2.2 Determine Frequency and Distance between Work Station

Determining the frequency of switching between work stations is how the number of unit / units that can be moved in once the movement and the movement of how many times is done in units of time (months). Data transfer can be seen as material in Table 4. 8.

Sample calculation:

- A to C,

At the cutting station products that can do is 1,040 units / month. In one chair frame unit requires an average 10 m rattan sticks, so rattan sticks required = 1,040 units x 10 m = 10,400 m. A capacity one haul is 16 m, then the frequency of haul per month = 10,400 m / 16 m = 520 times of haul / taking of raw rattan sticks.

- Bto BR,

In the weaving station product that can do is 920 units / month., In one unit requires 3rolls of rope knitted water hyacinth, so that the number of rolls of knitted needed is = 920 units x 3 rolls = 2,760 units rolls. A capacity in the transportation of 2 units roll then the frequency of transportation of the roll units per month = 2,760/2 unit rolls = 1,380 times the transportation / taking raw materials knitted water hyacinth.

Table 4. 8 Frequency of Material Handling

From	To	Material handling equipment	Material handling capacity (unit)	Total frequency material handling/ month (times)
A	C	Manual	16 meter (**)	520
B	BR	Manual	2 rolls (*)	1,380
BR	E	Manual	2 rolls (*)	1,380
C	D	Manual	1	1,040
D	E	Manual	1	1,008
E	F	Manual	1	920
F	G	Pick up car	10	92
G	H	Manual	1	1,023
H	I	Manual	1	1,213
I	J	Manual	1	1,213

(*) = 1 unit product Goose Chair needs at least 3 rolls of knitted water hyacinth.

(**) = 1 unit product Goose Chair needs at least 10m rattan sticks with diameter at least 3cm

Table 4.8 shows that the frequency of material handling. Total frequency of material handling from area A to C is 520, total frequency material handling from B to BR is 1,380 and so on.

Based on figure 4.2 and figure 4.3 so the distance of area between one area to another can be determined, The determination of movement by using system which is rectilinear, so the distance measured from center facilities one to another. Each area calculate the center point (0,0) from x to y.

From the initial layout the total area of first company is 351.5 m² with length is 19m and width is 18.5m so the coordinate for length is (0,19) and width (18.5,0) and for the second company The length is (0,15) and width (8,0).

In the initial layout known that :

The area of raw materials storage rattan sticks (A) 22 m² with the center point (x1; y1), which is (16.5; 2.25)

The area of cutting station (C) 9 m² with the center point (x2; y2) which is (5.5, 5.5)

The distance between the storage area of rattan sticks with cutting station area (distance A-C) are as follows:

$$\begin{aligned} \text{Distance A-C} &= |x_2 - x_1| + |y_2 - y_1| \\ &= |5.5 - 16.5| + |5.5 - 2.25| = 14.25 \end{aligned}$$

So the distance of storage raw material area with cutting station is 14.25 meter. calculation results can be seen in the table 4.9 and the table 4.10.

Table 4. 9 Center Point Area of First Factory

First Company		
Station	x	y
A	16	2.25
B	12	12
C	5.5	5.5
D	12.75	16.75
E	3.5	9.5
F	16.5	7
BR	8.75	9

Table 4.9 shows that the center point of each area in first company. The coordinate x and y for station A are 16 and 2.25, The coordinate x and y for station B are 12 and 12 and so on.

Table 4. 10 Center Point Area of Second Factory

Second Company		
Station	x	y
H	2	4
I	5.5	13
J	5.5	6.5
G	1.5	10.5

Table 4.10 shows that the center point of each area in second factory. The coordinate x and y for station H are 4 and 2, the coordinate x and y for station I are 5.5 and 13 and so on.

Table 4. 11 Distance between Work Station in Current Layout

Area	From	To	Distance (m)
First Company	A	C	13.75
	B	BR	5.25
	BR	E	5.5
	C	D	18.5
	D	E	16.5
	E	F	15.5
(*)	F	G	2,000
Second Company	G	H	7
	H	I	12.5
	I	J	6.5
		Total	2,101

(*) = Distance station F (WIP Storage) in first company with station G (finishing) that exist in second company that separate 2,000 meter.

Table 4.11 shows that the distance between each station in current layout. The distance between A to C is 13.75 m, the distance between B to BR is 5.25 m, the distance between BR and E is 5.5 m and so on.

4.2.3 Determine Material Handling Cost from Initial Layout

Material handling costs for each carriage is determined based on the cost per meter of movement, which in these fees are already consider the cost of purchase of

equipment, labor costs and depreciation costs appliance. Data from existing material handling, the amount of material handling costs are determined as follows:

a) Material handling using manual.

The costs of moving that was done by manual is IDR 33.47 per meter with details that can be seen in Table 4.12.

Table 4. 12 The Length of Distance Material Handling Manually

From	To	Type of Transportaton	Frequency (times)	Distance (m)	Frequency x Distance (m)/month
A	C	Manual	520	13.75	7,150
C	D	Manual	1,040	18.5	19,240
B	BR	Manual	1,380	5.25	7,245
BR	E	Manual	1,380	5.5	7,590
D	E	Manual	1,008	16.5	16,632
E	F	Manual	919	14.5	13,325.5
G	H	Manual	1,023	11	11,253
H	I	Manual	1,213	12.5	15,162.5
I	J	Manual	1,213	5.5	6,671.5
		Total	9696	103	104,269.5

Table 4.12 shows that the total distance between work station in 1 month. Total distance from A to C is 7,150 m, total distance from C to D is 19,240 m, total distance from B to BR is 7,245 m, total distance from BR to E is 7590 and the total distance is 104,269.5 m.

The material handling operator cost for 1 employee per month = IDR 750,000
 In one month = 26 effective days, in 1 day = 7 hours (420 minutes). So the material handling operator cost per minute = $\text{IDR } 750,000 / (26 \times 420) = \text{IDR } 68.68$

Table 4. 13 Calculation Cost Material Handling Movement (Manual)

Work Station	Total process time Goose Chair (minutes)	Processing time (minutes)	Movement time (minutes)	MH operator cost/minute (IDR)	Cost of material movement (IDR)
		(a)	(b)	(c)	(c)*(b)=(d)
Cutting	21	16	5	68.68	343.4
Framework	65	55	10	68.68	686.8
Weaving	285	265	20	68.68	1373.6
Finishing	64	54	10	68.68	686.8
Packing	18	13	5	68.68	343.4

Table 4.13 shows that the cost material movement by material handling operator cost / minutes times by movement time. In cutting area the cost of material movement is IDR 343.3, in framework area the cost of material movement is 686.8, in weaving area the cost of material movement is IDR 1,373.6 and so on.

Table 4. 14 Calculation Cost Material Handling Movement per Month

Work Station	Cost of material movement (IDR)	Frequency of movement product	Cost movement per month (IDR)
	(c)*(b)=(d)	(e)	(d)*(e)
Cutting	343.4	1,040	357,136
Framework	686.8	1,008	692,294.4
Weaving	137.,6	919	1,262,338.4
Finishing	686.8	1,023	702,596.4
Packing	343.4	1,213	416,544.2
		Total	3,430,909.4

Table 4. 14 shows that the cost movement per month by calculate the frequency of movement times by cost of material displacement. In cutting area the cost movement/ month is IDR 357,135 then the cost movement/ month in framework area is 692,294.4 ad so on.

$$\begin{aligned}
 \text{Cost MH per meter} &= \text{Cost movement per month} / \text{Total distance} \\
 &= \frac{\text{IDR } 3,430,909.4}{104,269.5 \text{ m}} \\
 &= \text{IDR } 33.47 / \text{meter}
 \end{aligned}$$

b) Cost of Material Handling by Using Pick Up Car

- Purchasing cost = IDR 77.000.000
- Economic age = 15 years
- Number of car = 1 car
- 1 Month = 26 days, and 1 year = 312 days
- 1 day = 7 working hours
- Cost of tire = IDR 250.000/ pcs, lifetime 1 year
- Cost of lubricants + filter oil = IDR 160.000, lifetime 2 months
- Cost service = IDR 150.000/ 2 months
- Cost of fuel = IDR 4500/ liter

- Distace Company 1 and 2 = 2,000 meters
- Number of employee needed = 1 person
- material handling operator cost (driver) = IDR 750.000/ month

With using depreciation calculation, so the cost of pick up car can be calculate as follows :

- Depreciation pick up car = $\frac{77,000,000 \times 1 \text{ year}}{15 \text{ year} \times 312 \text{ days}} = 16,452.99/ \text{ day}$

- Cost service

$$\begin{aligned} \text{Changing tire} &= \frac{(\text{cost of tire} \times \text{number of tire}) \times \text{number of vehicle}}{312 \text{ days}} \\ &= \frac{(250,000 \times 4) \times 1}{312 \text{ days}} = \text{IDR } 3,205.12/ \text{ day} \end{aligned}$$

$$\begin{aligned} \text{Consumption of lubricants per 2 month} &= \frac{160,000}{78 \text{ days}} \\ &= \text{IDR } 2,051.28/ \text{ day} \end{aligned}$$

$$\begin{aligned} \text{Cost machine service per 2 months} &= \frac{150,000}{78 \text{ days}} \\ &= \text{IDR } 1,923.08/ \text{ day} \end{aligned}$$

$$\text{Total maintain cost (} 2,305.12 + 2,051.28 + 1,923.08 \text{)} = \text{IDR } 7,179.49/ \text{ days}$$

- Cost of fuel

Frequency of haul in 1 month = 92 times, the distance = 2 km x 92 = 184 km. Pick up transport by car can cover a distance at least 13 km / liter of fuel, the fuel price / liter = IDR 4,500.

So the cost of fuel per month = $\frac{184 \text{ km} \times 4,500}{13 \text{ km}} = \text{IDR } 63,692.30/ \text{ month.}$

$$\begin{aligned} &= \frac{63,692}{26 \text{ days}} = \text{IDR } 2,449.70 \end{aligned}$$

- Cost of labor

Number of labor needed = 1 person. So, per month for 1 employee = IDR 750,000. Total cost of labor per month :

$$= \frac{750,000}{26 \text{ days}} = \text{Rp. } 28,846.15/ \text{ days}$$

Table 4. 15 The Length of Distance Material Handling by Using Car

From	To	Material handling equipment	Frequency (times)	Distance (m)	Frequency x distance (m)/ month
F	G	Pickup	92	2,000	184,000

Table 4.15 shows that the total distance in 1 month from WIP storage to finishing is 184,000 m.

$$\text{Distance of movement in 1 day} = \frac{(\text{IDR } 184.000) \text{ m}}{26 \text{ days}} = 7,076.92 \text{ m/ day}$$

Cost material handling with pick up =

$$\begin{aligned} & \frac{(\text{depreciation} + \text{cost of tire maintenance} + \text{cost labor} + \text{cost fuel})}{\text{total distance of movement}} \\ & = \frac{16,452.99 + 7,179.49 + 28,846.15 + 2,449.70}{7,076.92 \text{ m/ day}} \text{ days} = \frac{54,875,08 \text{ days}}{7,076.92 \text{ m/ day}} \\ & = \text{Rp. } 7.75/ \text{ m} \end{aligned}$$

Based on the length of distance between work station, the amount of the frequency of the flow of materials and material handling costs per meter, then the material handling costs can be calculated monthly, more in Table 4.16.

Total cost material handling $A-C$ / month = frequency $A-C$ x distance $A-C$ x cost material handling $A-C$ / meter x IDR 33. 47 = IDR 248,012.70 / month

Table 4. 16 Total Distance

From	To	Material handling equipment	Frequency (times)	Distance (m)	Total Distance (m)
A	C	Manual	520	13.75	7,150
B	BR	Manual	1,380	5.25	7,245
BR	E	Manual	1,380	5.5	7,590
C	D	Manual	1,040	18.5	19,240
D	E	Manual	1,008	16.5	16,632
E	F	Manual	919	15.5	14,244.5
F	G	Pick Up Car	92	2000	184,000
G	H	Manual	1,023	7	7,161
H	I	Manual	1,213	12.5	15,162.5
I	J	Manual	1,213	6.5	7,884.5

Table 4.16 shows that the total distance that calculate by the distance between area times by frequency. Total distance from A to C is 7,150 m, total distance from B to BR is 7,245 m, total distance C to D is 19,240 m and so on. 7884.5

Table 4. 17 Total Cost Material Handling per Month

From	To	Total Distance (m)	Cost material handling / meter (IDR)	Total cost material handling/ month (IDR)
A	C	7,150	33.47	239,310.5
B	BR	7,245	33.47	242,490.2
BR	E	7,590	33.47	254,037.3
C	D	19,240	33.47	643,962.8
D	E	16,632	33.47	556,673
E	F	14,244.5	33.47	476,763.4
F	G	184,000	7.75	1,426,000
G	H	7,161	33.47	239,678.7
H	I	15,162.5	33.47	507,488.9
I	J	7,884.5	33.47	263,894.2
			Total	IDR 4,850,299

Table 4.17 shows that the total cost material handling in 1 month. The total material handling cost from area A to C is IDR 239,310.5 then the total cost material handling from area B to BR is IDR 242,490.5 and so on. Also can be seen that the

movement material that very far is area between F and G because of those area seperated far away so need the higher cost also.

Table 4. 18 From To Chart

	A	B	BR	C	D	E	F	G	H	I	J
A	X			239,3 10.50							
B		X	242,4 90.20								
B R			X			254,0 37.30					
C				X	643,9 62.80						
D					X	556,6 73					
E						X	476,7 63.40				
F							X	1,426 ,000			
G								X	239,6 78.70		
H									X	507,4 88.90	
I										X	263,8 94.20
J											X

Table 4.18 shows the from to chart. The total material handling cost from area A to C is IDR 239,310.5 then the total cost material handling from area B to BR is IDR 242,490.5 and so on. Also can be seen that the movement material that very far is area between F and G because of those area seperated far away so need the higher cost also.

4.2.4 Designing The Purposed Layout

- a) The initial step in the design of the layout with the initial data collection such as steps to produced the product and other data related to the production process. These data is obtained from the shape of the operation process chart at 4.1 and the stage of data collection.
- b) Analysis Material Flow
Material flow analysis is a quantitative measurement analysis for each movement of material movements between departments or operational

activities. In analyzing the material flow using a flow diagram have more meaning in trying to analyze the layout of the factory and transfer of materials, as herein described not only in the form of the process stream but also the actual layout of the existing plant or planned. By observing the direction of the track / process flow will be visible considerations on work location where the critical work location (location where the track intersection occurs).

c) Create Activity Relationship Chart

Create the Activity Relationship Chart obtained from the data sequence of activities in the production process to be attributable in pairs to determine the relationship between the level of such activity. These relationships are reviewed from several aspects including the corresponding relationships in the organization, material flow, used equipment, people, information, and environmental linkages. Relation Activity Chart is a linkage map activity in the form of a rhombus composed of two parts, namely the top that shows the degree symbol linkages between the two departments, while the bottom is the reason that is used to measure the degree of relatedness.

In preparing the Relation Activity Chart (ARC) there are some considerations as follows:

- Storage of raw materials rattan sticks absolute close to the cutting work station because the process is in sequence and for ease of supervision.
- Cutting stations must be close to the framework station because the process in sequence.
- Framework station must be close to the weaving station because the process in sequence.
- Weaving station must be close to wip storage because the process is in sequence.
- Storage rattan knitted, woven rope water hyacinth and woven rope banana leaves must be close to the soaking tub because the process is in sequence.
- Soaking tub must be close to the weaving station because the process in sequence.
- WIP storage must be close with finishing because the process in sequence.

- Finishing must be close with packing because the process in sequence and hopefully not to close to the soaking tub because the place is humid and will disturb drying process.
- Packing must be close to the finished good storage because the process in sequence.

How to determine the worksheet is presenting a worksheet of questions ARC in summary form, it can be seen that the work station A has associated degree of relationship E with work station B, the degree of relationship A with work station C, the degree of relationship U with work stations BR, D, E, F, G, H, I, and J so on. The worksheet details of which can be seen in table 4.19

Table 4. 19 Worksheet of Linkage Map Between Department

Work Station	Code	B	Br	C	D	E	F	G	H	I	J
	Area	2	3	4	5	6	7	8	9	10	11
Storage rattan sticks	A	E	U	A	U	U	U	U	U	U	U
Storage knitted rattan, water hyacinth, banana leafes	B		A	U	U	U	U	U	U	U	U
Soaking tub	Br			U	U	A	U	U	X	U	U
Cutting	C				A	U	U	U	U	U	U
Framework	D					A	U	U	U	U	U
Weaving	E						A	U	U	U	U
Storage WIP	F							A	U	U	U
Finishing	G								A	U	U
Drying	H									A	U
Packing	I										A
Storage FG	J										

Table 4.19 shows that the degree of closeness of each station. Area A must be close to area B, Area B must be close to area BR, area Br must be close to area E. The closeness can be determine based on flow process.

d) Determine area needed

Before designing the proposed layout first must pay attention to the determination of the need spacious room, things that are required in determining the needs of their area required is production rate needed, equipment needed for production processes and employees needed.

In determining the area of production process needed using "method of industrial facilities" which is the method of determining the needs of their rooms based on production facilities and support facilities of production process that used. Room area is calculated from the size of each type of machine or equipment used multiplied by the number of machine and plus by allowance for operator and ally. For each machine or support facilities used tolerance 0.75 to 1 meter on each side of the machine, and for allowance for operator 50%. The following will be given calculation to determine the area required as follows:

- Area A (Storage rattan sticks)

Receiving of raw materials was performed 1 month once because of the cost of delivery is high. Average diameter rattan sticks 3 cm, then the volume of rattan sticks = $\pi \times r^2 = 3.14 \times 1.5^2 \text{ cm} = 7.07 \text{ cm}^2$. Goose Chair require rattan rod with an average length of 10 meters (1,000 cm).

- For one unit of product requires = $7.07 \times 1,000 \text{ cm} = 7,070 \text{ cm}^3$ rattan sticks.
- Within a month of production at the cutting station to cut 1,040 unit (parts 1 unit to create one product unit chair) = $7,070 \times 1,040 = 7,352,800 \text{ cm}^3$.
- So, the room when rattan rods are stored in: 25 bars stack height = $25 \times 3 \text{ cm} = 75 \text{ cm}$ and 100 length rows of bars = $100 \times 3 = 300 \text{ cm}$.
- Volume = length x width x height
 $7,352,800 \text{ cm}^3 = 300 \times l \times 75$
Width = $326.79 \text{ cm} \sim 3.27 \text{ m}$
- So, the requirement of room area is $3 \text{ m} \times 3,27 \text{ m} = 9.81 \text{ m}^2$.
- After plus by allowance 50 % = $9.81 \times 150\% = 14.715 \text{ m}^2$.

- Area B (Storage knitted rattan, water hyacinth, banana leafes)

The delivery of raw rattan knitted, water hyacinth knitted and banana leave knitted received every week in the form of roll of rope knitted. In the first roll of rope knitted with diameter 30 cm and height of 20 cm rolls weighing $\pm 15 \text{ kg}$, product Goose chair need 3 rolls of rope knitted water hyacinth / banana leave.

- Volume 1 roll of rope water hyacinth
 $= (3.14 \times 15^2) \text{ cm} \times 20 \text{ cm} = 14,140 \text{ cm}^3$.
- In weaving station per month can produce 920 unit, so need 3 rolls x 920 unit = 2,760 rolls rope.
- In 1 month there are 26 days to work, then in 1 day need $2,760/26 = 106.15$ rolls.
- For 1 week need $106.15 \times 6 = 636.9$ rolls or 637 rolls.
- Volume of rolls for 6 days = $14,149 \text{ cm}^3 \times 637 \text{ rolls} = 9,007,180 \text{ cm}^3$.
- Total area if store in: 6 high stack = $6 \times 20 \text{ cm}$ (height of 1 rolls) = 120cm and 15 long lines = $15 \times 30\text{cm}$ (diameter 1 roll) = 450 cm.
- Volume = length x width x height
 $9,007,180\text{cm}^3 = 450 \text{ cm} \times \text{width} \times 120 \text{ cm}$
Width = 166.79 cm or 1.67 m
- The requirement of room area is = $4.5 \text{ m} \times 1.67 \text{ m} = 7.52 \text{ m}^2$
- Area After plus by allowance 50 % = $7.52 \text{ m}^2 \times 150 \% = 11.28 \text{ m}^2$
- Area BR (soaking tub)
The area of soaking tub is not changing, the initial size assumed already good enough and can provide knitted rope water hyacinth to dyeing process.
 - The area of soaking tub is $1.5 \text{ m} \times 1 \text{ m} = 1.5 \text{ m}^2$
 - Area After plus by allowance 50% = $1.5 \text{ m}^2 \times 150 \% = 10.80 \text{ m}^2$
- Area C (cutting station)
In cutting station used 2 machine of cutting saws with size $0.50 \text{ m} \times 0.30 \text{ m}$. Allowance in every side of machine plus by 0.75 m
 - Total area for 2 machines is $2 \text{ m} \times 1.8 \text{ m} \times 2 \text{ machines} = 7.2 \text{ m}^2$
 - Area After plus by allowance of room 50% = $7.2 \text{ m}^2 \times 150\% = 10.80 \text{ m}^2$
- Area D (Framework station)
In framework station there are 1 table with size $1.5 \text{ m} \times 1 \text{ m}$.
 - Tolerance in every side of table plus 0.75 became $3 \text{ m} \times 2.5 \text{ m} = 7.5 \text{ m}^2$
 - Area after givig allowance 50% = $7.5 \text{ m}^2 \times 150\% = 11.25 \text{ m}^2$
For 1 heating machine using 1 gas cylinder 12 kg with funnel that has diameter 0.3 m
 - Area heating machine = $3.14 \times 0.15^2 = 0.071 \text{ m}^2$

- After giving the allowance 50% = $0.071 \text{ m}^2 \times 150\% = 0.11 \text{ m}^2$
In area assembly, there are 4 operators to assembly the Goose chair with size (1.2 m x 0.6 m x 0.85 m). Allowance for operator plus by 0.75 m in every side.
- Area of 1 machine/ operator = $2.7 \text{ m} \times 2.1 \text{ m} = 5.67 \text{ m}^2$
- Area for 4 operators = $5.67 \text{ m}^2 \times 4 = 22.68 \text{ m}^2$
- After giving allowance 50% = $22.68^2 \times 150\% = 34.02 \text{ m}^2$
In temporary storage of framework in 1 month there are 1,008 unit's product
- In 1 day = $1008 \text{ unit} / 26 \text{ days} = 39 \text{ units}$.
- Area temporary storage of framework Goose chair (1.2 m x 0.6 m x 0.85 m) = $0.72 \text{ m}^2 \times 39 \text{ units} = 28.08 \text{ m}^2$
- If store in: 2 high stack = $0.85 \text{ m} \times 2 = 1.70 \text{ m}$ and if 1 long lines = $1.2 \text{ m} \times 1 = 1.2 \text{ m}$. The volume 39 chairs = $28.08 \times 0.85 = 23.6\text{m}^3$
- Volume = length x width x height
 $23.86\text{m}^3 = 1.2\text{m} \times \text{width} \times 1.70\text{m}$
Width = $23.86 \text{ m}^3 / 2.04 \text{ m}^2 = 11.7\text{m}$
- Area temporary storage $1.2 \text{ m} \times 11.7 \text{ m} = 14.04 \text{ m}^2$
- Total Framework area = $11.25 \text{ m}^2 + 0.11 \text{ m}^2 + 34.02 \text{ m}^2 + 21.06 \text{ m}^2$
- Area E (Weaving station)
In weaving station, there are 24 operators.
 - Area of 1 machine / operator = $2.7 \text{ m} \times 2.1 \text{ m} = 5.67 \text{ m}^2$
 - Area for 24 operators = $5.67 \text{ m}^2 \times 24 = 136.08 \text{ m}^2$
 - After giving allowance 50% = $136,08 \text{ m}^2 \times 150\% = 204,12 \text{ m}^2$
 - The area for compressor machine to run the nailgun with size $1.5 \text{ m} \times 0.5\text{m} = 0,75 \text{ m}^2$
 - After giving allowance 50% = $0,75 \text{ m}^2 \times 150\% = 1,125 \text{ m}$
 - Area of tools = 1.5 m^2
 - Total area of weaving = $204.12 \text{ m}^2 + 1,125 \text{ m}^2 + 1.5 \text{ m}^2 = 206.75\text{m}^2$

- Area F (WIP storage station)

In 1 month (26 days) the production is 920 products that can be done in weaving station.

- Quantity per day = $920 / 26 = 35$ units.
- Area for 35 unit's products (1.2 m x 0.6, x 35 m) = 25.2 m^2
- After giving allowance 50 % = $25,2 \text{ m}^2 \times 150\% = 37.8 \text{ m}^2$

- Area G (Finishing station)

There are 6 employees who do inspection of defect, clear up the fuzz and paint the wip.

- Area of 1 machine / operator = $2.7 \text{ m} \times 2.1 \text{ m} = 5.67 \text{ m}^2$
 - Area for 6 operators $5,67 \text{ m}^2 \times 6 = 34,02 \text{ m}^2$
 - After giving allowance 50% = $34,02 \text{ m}^2 \times 150 \% = 51,03 \text{ m}^2$
- There are 2 heating machine to clear up the fuzz that using 2 cylinders' gas 12 kg with a funnel that has diameter 0.3 m
- Area of 1 heating machine ($3,14 \times 0,15^2$) = 0.071 m^2
 - Area of 2 heating machine $0.071 \text{ m}^2 \times 2 = 0.141 \text{ m}^2$.
 - Area 2 machine after giving allowance 50% = $0,141 \text{ m}^2 \times 150 \% = 0,21 \text{ m}^2$
 - Total area finishing = $51.03 \text{ m}^2 + 1,125 \text{ m}^2 + 0.21 \text{ m}^2 + 5 \text{ m}^2 = 57.37 \text{ m}^2$

- Area H (Drying station)

In 1 month (26 days) the production is 920 products that can be done in weaving station.

- Quantity per day = $920 / 26 = 35$ units.
- Area of 1 chair ((1,2 m x 0,6 m x 0,85 m) = $1,2 \times 0,6 = 0,72 \text{ m}^2$
- Area for 35 unit's products = $0.72 \text{ m}^2 \times 35 = 25.2 \text{ m}^2$
- In drying must be dried under the sun and the need time about 2 days so its need the place for the finished good for next day = 25.2 m^2
- Area for drying = $25,2 \text{ m}^2 + 25,2 \text{ m}^2 = 50,4 \text{ m}^2$
- Area after giving allowance 50% = $50.4 \text{ m}^2 \times 150\% = 75.6 \text{ m}^2$
- Area for keep 35 products plus by allowance = $25.2 \text{ m}^2 \times 150\% = 37.8 \text{ m}^2$

- Total area of drying station = $75,6 \text{ m}^2 + 37,8 \text{ m}^2 = 113.4 \text{ m}^2$
- Area I (Packing station)

There are 4 operators in packing station and divided into 2 group of works

 - Area of 1 machine / operator = $2.7 \text{ m} \times 2.1 \text{ m} = 5.67 \text{ m}^2$
 - Area for 2 grop = $5,67 \text{ m}^2 \times 2 = 11,34 \text{ m}^2$
 - Area after giving allowance 50% = $11.34 \text{ m}^2 \times 150\% = 17.01 \text{ m}^2$
 - Area for keep the cardboard and tools = 5 m^2
 - Total area of packing station = $17.01 \text{ m}^2 + 5 \text{ m}^2 = 22.01 \text{ m}^2$
- Area J (Storage of finished good)

In 1 month (26 days) the production is 920 products that can be done in weaving station.

 - Quantity per day = $920 / 26 = 35$ units.
 - Quantity for 6 days = $35 \times 6 = 210$ units
 - Area for 210 units of Goose chair ($1.2 \text{ m} \times 06 \text{ m} \times 0.85 \text{ m}$) = $0.72 \text{ m}^2 \times 210 \text{ units} = 151.2\text{m}^2$
 - If its store in: 2 high stack = $2 \times 0.85\text{m} = 1.70 \text{ m}$ and 10 long lines = $1.2 \text{ m} \times 10 = 12 \text{ m}$
 - Volume product = length x width x height
 $128.35\text{m}^3 = 12\text{m} \times \text{width} \times 1.70\text{m}$
 Width = 6.3m
 - Area for finished good = $12\text{m} \times 6.3\text{m} = 75.5\text{m}^2$
 - Area after giving allowance 50 % = $75.5\text{m}^2 \times 150\% = 113.25\text{m}^2$

The total area needed for production facilities completely can be seen in table 4.20 below.

Table 4. 20 Worksheet of Calculating Total Production Facilities Area Needed

Code	Work Station	Total Area Required (m²)
A	Storage rattan sticks	14.715
B	Storage knitted rattan, water hyacinth, banana leaves	11.2725
BR	Soaking tub	2.25
C	Cutting	10.8
D	Framework	66.435
E	Weaving	206.745
F	StorageWIP	37.8
G	Finishing	56.03
H	Drying	113.4
I	Packing	22.01
J	Storage FG	113.25
	Total	654.7075

Table 4.20 shows that the total area required for each works station. For storage rattan sticks the total area required is 14.715 m². For storage knitted rattan, water hyacinth, banana leaves the total area required is 11.2725 m². For soaking tub the total area required is 2.25 m². The total are required for cutting is 10.8 m² ad so on.

e) Perform the alternative purposed layout by using type of product layout and s-shaped line flow.

Because this type of job of the company is flow shop so the type of the layout that suitable for this company is product layout and s-shaped line flow. For the layout purposed can be seen in Figure 4.7.

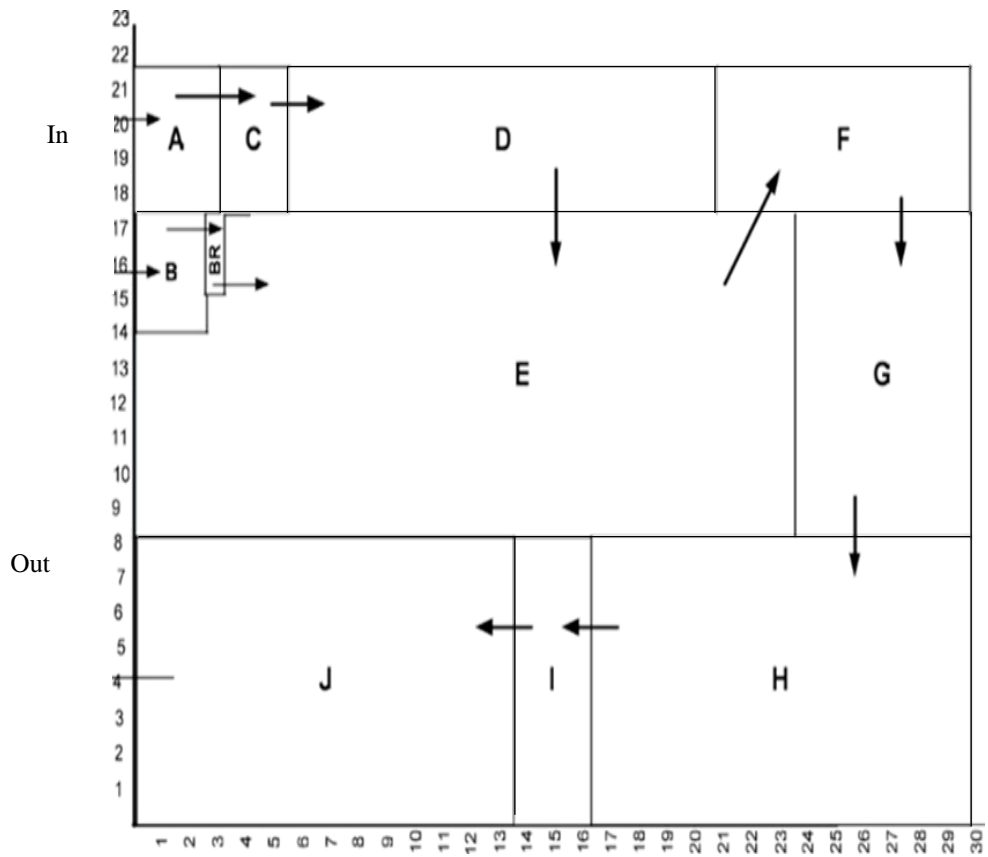


Figure 4. 7 The Purposed Layout

Table 4. 21 Coordinate Purposed Layout

No	Work Station	Centroit		Length (m)	Width (m)
		X	Y		
1	A	1.69	19.86	3.4	4.4
2	B	1.5	15.91	3	3.72
3	Br	3.5	16.77	1	1.86
4	C	4.62	19.86	2.5	4.4
5	D	13.47	19.86	15.2	4.4
6	E	12.53	13.02	22.2	9.3
7	F	26.68	19.86	8.7	4.4
8	G	26.61	13.02	6.1	9.3
9	H	22.97	4.18	13.6	8.4
10	I	14.87	4.18	2.6	8.4
11	J	6.78	4.18	13.6	8.4

From Table 4.21 shows that the coordinate and the size of each station. Can be seen that the coordinate of work station A is 1.69 and 19.86 with the length and width are 3.4 m and 4.4 m. The coordinate of B is 1.5 and 15.91 with the length and width are 3 m and 3.72 m and so on.

- Determine distance of movement material handling

Based on table 4.20 can be determine distance between one work station to another. Determine the distance by using central point (centroid) of each work station, then calculate the distance by using rectilinear.

From the purposed layout known: Area A with centroid (x1, y1) is (1.69; 19.86) and Area C with centroid is (4.62;19.86). So, the distance between

$$\begin{aligned}
 \text{A and C} &= |x_2 - x_1| + |y_2 - y_1| \\
 &= |4.62 - 1.69| + |19.86 - 19.86| \\
 &= 2.93 \text{ m}
 \end{aligned}$$

The complete result can be seen in Table 4.22.

Table 4. 22 Distance Between Work Station from Purposed Layout

From	To	Distance (m)
A	C	2.93
B	BR	2.86
BR	E	12.78
C	D	8.85
D	E	7.78
E	F	20.99
F	G	6.77
G	H	10.48
H	I	8.1
I	J	8.09
TOTAL		89.63

Table 4.22 shows the distance between A to C is 2.93 m, the distance between B to BR is 2.86 m, the distance between BR to E is 12.78 m, the distance between C to D is 8.85 m, the distance between D to E is 7.78 m and so on.

- Calculate cost of material handling from purposed layout

From the table 4.25 so that can be calculate how much the cost of material handling in purposed layout so that can determine the cost of material handling that cn be seen in Table 4.23.

Table 4. 23 Total Cost Material Handling per Month from Purposed Layout

From	To	Material Handling	Frequency	Distance (m)	Frequency x distance	Cost MH / meter (IDR)	Total Cost MH / month (IDR)
			[1]	[2]	[3] = [1]*[2]	[4]	[5] = [3]*[4]
A	C	Manual	520	2.93	1,523.6	33.47	50,994.89
B	BR	Manual	1,380	2.86	3,946.8	33.47	132,099.40
BR	E	Manual	1,380	12.78	17,636.4	33.47	590,290.31
C	D	Manual	1,040	8.85	9,204	33.47	308,057.88
D	E	Manual	873	7.78	6,791.94	33.47	227,326.23
E	F	Manual	919	20.99	19,289.81	33.47	645,629.94
F	G	Manual	920	6.77	6,228.4	33.47	208,464.55
G	H	Manual	1,023	10.48	10,721.04	33.47	358,833.21
H	I	Manual	1,213	8.1	9,825.3	33.47	328,852.79
I	J	Manual	1,213	8.09	9,813.17	33.47	328,446.80
		Total		89.63	89,510.06		3,178,996

Table 4.23 shows that total material handling cost per month from purposed layout. The total cost material handling from A to C is IDR 50,994.89, the total cost material handling from B to Br is IDR 132,099.40, the total cot material handling from BR to E is 590,290.31 and so on.

4.2.5 Determination Purposed Layout that Accepted

From the processing data above that purposed layout can be accept because the distance of purposed layout shorter than the current layout and also the cost of material handling was decrease. The comparison cost of material handling from initial layout with cost of material handling from purposed layout can be seen in table 4.24.

Table 4. 24 Comparison Cost MH between Initial and Purposed Layout

From	To	Initial Layout			Purposed layout		
		Material Handling	Total Distance (m)	Cost MH (IDR)	Type of MH	Total Distance (m)	Cost MH (IDR)
A	C	Manual	7,150	239,310.50	Manual	1,523.6	50,994.892
B	Br	Manual	7,245	242,490.20	Manual	3,946.8	132,099.40
Br	E	Manual	7,590	254,037.30	Manual	17,636.4	590,290.31
C	D	Manual	19,240	643,962.80	Manual	9.204	308,057.88
D	E	Manual	16,632	556,673	Manual	6,791.94	227,326.23
E	F	Manual	14,244.50	476,763.40	Manual	19,289.81	645,629.94
F	G	Pick Up Car	184,000	1,426,000	Manual	6,228.4	208,464.55
G	H	Manual	7,161	239,678.70	Manual	10,721.04	358,833.21
H	I	Manual	15,162.50	507,488.90	Manual	9,825.3	328,852.79
I	J	Manual	7,884.5	263,894.2	Manual	9,813.17	3,284,467.80
		Total	286,309.5	4,850,299		89,510.06	3,178,996

From the table 4.24 the total distance from initial layout is 279,159.50 m and the total distance from purposed layout is 89,510.06 m. The cost MH from initial layout is IDR 4,850,299 and the cost MH from purposed layout is IDR 3,178.996.

4.2.6 Modification of Purposed Layout and Add Supporting Facilities

From the adaptation layout from blocplan add some supporting facilities such as office room, toilet and fitting room. The calculation as follows:

- For 3 toilets (standard for 42 workers) = $1.44 \text{ m}^2(\text{standard toilet}) \times 3 = 4.32 \text{ m}^2$
- Area after giving allowance 50 % = $4.32 \text{ m}^2 \times 150\% = 6.48 \text{ m}^2$
- For Locker (0.3 m x 0.375 m) for 42 employees = $0.3 \text{ m} \times 0.375 \text{ m} \times 42 = 4.72 \text{ m}^2$
- Area locker after giving allowance 50% = $4.72 \text{ m}^2 \times 150\% = 7.08 \text{ m}^2$
- For 4 fitting room = $0.81 \text{ m}^2 (\text{standard fitting room}) \times 4 = 3.24 \text{ m}^2$
- Area fitting room after giving allowance = $3.24 \text{ m}^2 \times 150\% = 4.86 \text{ m}^2$
- For the office, the calculation can be seen in table 4.25.

Table 4. 25 Office Area Requirement

Position	Table and Chair (m ²)	Bench work (m ²)	Rack for file (m ²)	Long Chair (m ²)	Book Rack (m ²)	Etc.(m ²)	Area (m ²)
Director	2.7	0.9	0.6	0.72	0.27		5.19
Finance		0.9	0.6				1.5
Marketing		0.9	0.6				1.5
Supervisor		0.9	0.6				1.5
Production Staff		0.9	0.6		0.27		1.77
WC						2.25	2.25

Table 4.25 shows that the detail of the items inside the office. Can be seen that the area for director only need 5.04 m². The area need for finance, marketing and supervisor is 1.35 m². The area needed for production staff 1.62 m² and the area needed for toilet is 0.45 m²

Table 4. 26 Office Area Requirement after allowance

Position	Number of people / room	Total Area (m ²)	Area with allowance 50% (m ²)
Director	1	5.19	7.785
Finance	2	3	4.5
Marketing	4	6	9
Supervisor	1	1.5	2.25
Production Staff	2	3.54	5.31
WC	2	4.5	6.75

Table 4.26 shows that the total people who work in office and the allowance. For director need 7.785 m². The area for finance need 4.5 m². The area for marketing need 9 m². The area for supervisor need 2.25 m². The area for production staff need 5.31 m². The area for toilet need 6.75 m².

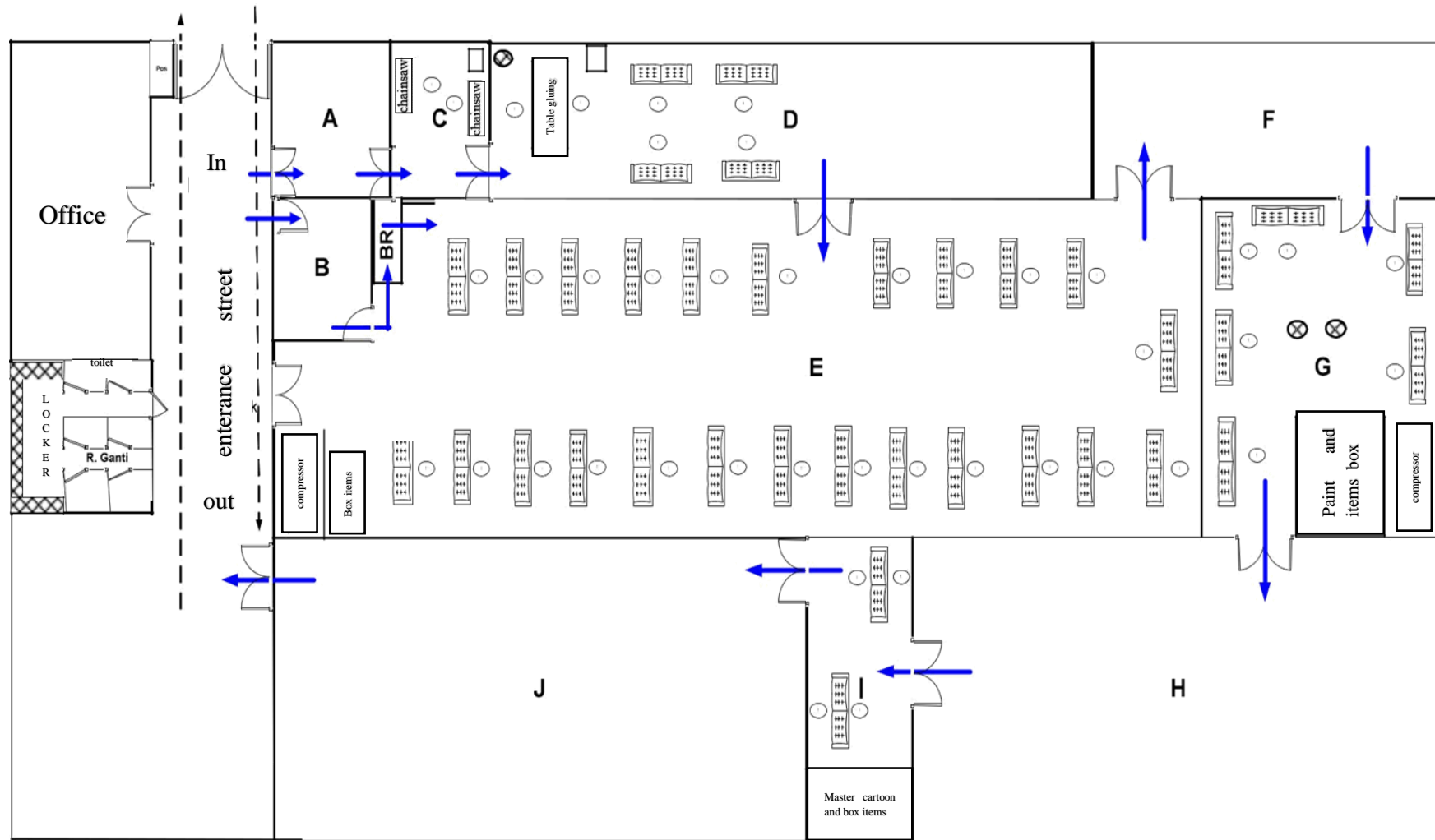


Figure 4. 8 The Picture of Purposed Layout with Supporting Facilities

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion after collecting and processing data obtained from CV. Rotan Asik Asik Jos can be concluded that:

- a) Distance movement (material handling) in the initial condition that is equal to 286,309.5 m and the distance movement for purposed layout is equal to 89.510.06 m. So, purposed layout can reduce 69% from initial layout.
- b) The material handling cost in initial layout is equal to IDR 4,850,299 and the cost material handling in purposed layout is equal to IDR 3,178,996. So, purposed layout can reduce around 34%.

5.2 Recommendation

As the suggestions that are very constructive and useful for students as well as for CV. Rotan Asik Asik Jos, can perform data processing and analyzing more specifically in order to research the layout of factory facilities better also this method can be implement to the company in order make beneficial for the company.

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