SHOPFLOOR LAYOUT DESIGN USING BLOCPLAN ALGORITHM TO REDUCE WASTE TRANSPORTATION ACTIVITY ON BIOFERTILIZER PRODUCTS PT. CENTRA BIOTECH INDONESIA KLATEN JAWA TENGAH

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UNIVERSITAS ISLAM INDONESIA

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2021

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(CASE STUDY: PT. CENTRA BIOTECH INDONESIA)

UNDERGRADUATE THESIS

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DEDICATION PAGE

Assalamu'alaikum Wr. Wb.

Al-hamdu lillahi rabbil 'alamin and Gratitude are presented to Allah *Subḥānahu* wataʿālā for blessing, love, opportunity, health, mercy, who granted the author primary inspiration and stamina all along to complete the Undergraduate Thesis which entitled "Shopfloor Layout design Using BLOCPLAN algorithm to reduce Waste Transportation activities on Biofertilizer products (Case Study: PT. Centra Biotech Indonesia". Greeting devoted to our beloved Prophet Muhammad *Sallā -llāhu ʿalayhī wa-ʾālihī wa-sallam,* who has brought humankind to the world full of knowledge as it is today.

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Yogyakarta, August 2021

Krisna Mu’tashim Azhar

MOTTO

"For indeed, with hardship [will be] ease." "Indeed, with hardship [will be] ease."

(Q.S. Al-Insyirah [94]: 5-6)

" Surely, we have made whatever is on the earth an embellishment for it, so that We may try them (as to) which of them is best in works."

(QS. Al-Kahf [18]: 7)

"Charity (Shadaqah) will close 70 doors of evil."

(HR. Thabrani).

ABSTRACT

PT. Centra Biotech Indonesia is a national company that produces and markets environmentally friendly biotechnology products with special microbial base ingredients as the main composition. PT. Centra Biotech Indonesia provides various biotechnology products in agriculture, livestock, fisheries, and so on, to support health and productivity. Currently, Facility layout at PT. Centra Biotech Indonesia has not used specific rules in the placement of equipment and machines used for the production process and does not pay attention to the flow of the production process. This results in limited space for workers, as well as repetition of activities that result in wasted time, inefficient production processes, thereby reducing productivity. The facility layout planning method used in this study is BLOCPLAN. BLOCPLAN is a program developed for facility layout design using a hybrid algorithm that combines a constructive algorithm and a repair algorithm. The objective function of BLOCPLAN is to minimize the distance between facilities or maximize the close relationship between each workstation. Based on the results of data processing, it can be concluded that Waste activities that have a direct impact on the material handling flow are in the Transportation Waste category, namely the distance between workstations. The proposed layout can reduce the distance between workstations by 32% and the distance Traveling Distance of Material Handling by 27%. This indicates that the layout of the proposal can be applied at PT. Centra Biotech Indonesia because it can decrease 32% of Waste of Transportation needed to transfer Material handling and distance for each workstation.

Keywords: *Facility Layout, BLOCPLAN, Traveling Distance, Waste of Transportation.*

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Shopfloor Layout design Using BLOCPLAN algorithm to reduce Waste Transportation activities on Biofertilizer products

(Case study: PT Centra Biotech Indonesia)

CHAPTER I

INTRODUCTION

1.1. Background

Business development in recent years is very fast, especially business in the manufacturing industry. For more than twenty years, the role of the manufacturing industry in the Indonesian economy has increased substantially (Kurniati, 2010). In Indonesia, the manufacturing industry is one of the mainstay sectors that drive economic growth, in the last 10 years the growth of the Indonesian manufacturing industry is in the range of 2.2-6.1% (Lestari, 2017). Rapid business development has an impact on very sharp and tight business competition in both the domestic and international markets. Along with the development of science and technology, it requires companies to participate in developing their businesses in order to be able to compete with other companies. Thus, companies are required to accept these developments because they lead to increased competition among companies. Increased competition between companies can pose a threat to companies that do not follow the development of science, especially in today's technology. To increase productivity, companies must reduce activities that are not necessary or categorized as Waste activities so that the time needed can be more optimal. Therefore, we must change the traditional supply chain view to become more modern based on customer orientation with long-term goals supported by adequate technology and good communication. (Murphy & Wood, 2003). In addition, value or added value to a product becomes very important. So that the product can compete with other competitors and must be done effectively and efficiently. (Virginia, 2013).

PT. Centra Biotech Indonesia is a national company that produces and markets environmentally friendly biotechnology products with special microbial base ingredients as the main composition. PT. Centra Biotech Indonesia provides various biotechnology products in agriculture, livestock, fisheries, and so on, to support health and productivity. During the company's development process, PT. Centra Biotech Indonesia is experiencing problems in the form of an increasing number of product requests so that the layout at PT. Centra Biotech Indonesia has not been fully organized optimally, and the placement of facilities that are not in accordance with the relationship between activities causes discomfort and ineffective movements to coordinate directly. Below is a table of the increase in product demand throughout 2020 based on PT. Centra Biotech Indonesia, between liquid fertilizer products and powder fertilizer products.

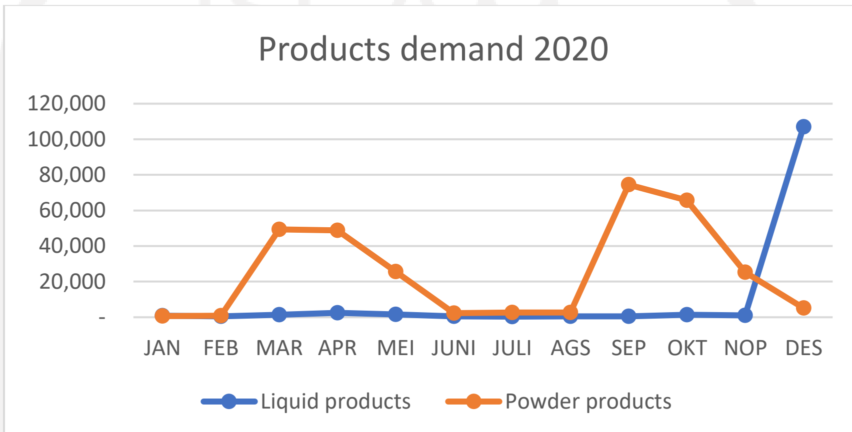


Figure 1.0.1 Products demand

Currently, Facility layout at PT. Centra Biotech Indonesia has not used specific rules in the placement of equipment and machines used for the production process and does not pay attention to the flow of the production process. This results in limited space for workers, as well as repetition of activities that result in wasted time, inefficient production processes, thereby reducing productivity. According to Susetyo et al. (2010), a material handling system that is less systematic can be a big problem and disrupt the overall production process. As a result of unsystematic planning for the layout of production facilities, the flow of the production process is hampered and there is a possibility of danger arising from the risk of the production process. Hazards arising from production activities can be in the form of accidents or health problems for employees. This is in accordance with the statement of Yuliantoro et al. (2014) that the smaller the value of traveling distance generated, the closer the worker travels to move to another facility, and the smaller the value of the safety index, the lower the accident rate experienced by workers passing through the hazard zone.

In addition, researchers found that there are activities that categorize as Transportation Waste caused by Material Handlings so that the time needed to carry out the production process becomes slower. Currently, the total distance between workstations found by researchers is 273.7 meters and the total Traveling Distance that must be done by the company to carry out the material handling process is 9117.6 meters or more than 9 kilometers, this can be categorized as waste in terms of transportation so that improvements can be made by designing facility layout.

Therefore, facility design needs to be carried out with the right strategy in order to benefit the company. The redesign of the layout was carried out by considering the relationship and optimizing the distance between areas so as to reduce the Waste. In redesigning the layout that pays attention to the relationship between areas using the Activity Relationship method. Where this method will help consider how important the relationship between areas, the flow of the production process, and optimizing the use of space so that an optimal layout can be created (Mayers & Stephens, 2005). The facility that is directly related to the product is the production floor. The production floor design is the key to an efficient production environment. The efficiency of a production process can be achieved with proper design. Several methods can be used to perform facility layout planning, such as Systematic Layout Planning (SLP), Computerized Relationship Layout Planning (CORELAP), Computerized Relative Allocation of Facilities Technique (CRAFT), BLOCPLAN, and others. The facility layout planning method used in this study is BLOCPLAN. BLOCPLAN is a program developed for facility layout design using a hybrid algorithm that combines a constructive algorithm and a repair algorithm. The objective function of BLOCPLAN is to minimize the distance between facilities or maximize the close relationship between each workstation.

The Lean Production concept is a concept of streamlining the production process by paying more attention to TQC (time, quality, and cost) (Rabbani, 2017). Lean Manufacturing (LM) is a production method that was first introduced by the Japanese company Toyota. (Khani, et al, 2018). The application of Lean Manufacturing principles and practices has become widespread, even in the context of today's increasing workforce demand, to achieve higher levels of quality and flexibility at lower costs (Tortorella, et al, 2018).

1.2.Problem Formulation

Based on the background that has been made, the formulation of the problem that will be applied is how to reduce waste transportation activities at PT. Centra Biotech Indonesia by designing the layout of the facility in the production process flow of biofertilizer products.

1.3.Research Limitation

In this study, it is necessary to have research limitations so that research can be more focused and on target. The limitations of the problem taken for this research are:

1. The skills of workers and production supervisors are considered the same.
2. The redesign of the facility layout is carried out only on the production floor
3. Ignoring the costs of redesigning the layout of the production facility
4. Human and environmental factors do not affect the condition of production results.
5. No damage occurred to the transportation system.
6. The results of the Facility Layout design are not compared with other methods.

1.4.Research Objective

By referring to the formulation of the problem above, the objectives to be achieved in this research are:

1. Analyze several activities in the company that are included in the Waste activity category and determine the main priorities that must be improved.
2. Redesign the layout of the facility in order to reduce the waste activities found in the company.

1.5.Research Benefits

The benefit of this research is that it can make the biofertilizer industry at the company PT. Centra Biotech Indonesia applies the principle of kaizen or continuous improvement so that it can increase productivity in the company and can carry out production activities optimally.

1.6. Systematic research writing

So that this research is easy to understand and fulfills the requirements, the writing is divided into several stages. These stages are:

CHAPTER II LITERATURE REVIEW

This chapter contains a review of previous research results that are relevant to the issues raised. The theoretical foundation directly supports the implementation of research and also becomes the basis or guideline in the discussion of problem-solving related to the analysis carried out in research.

CHAPTER III RESEARCH METHODOLOGY

This chapter contains a description of the research material, tools, research procedures, variables, and data to be studied as well as the analysis method used and the research flow chart.

CHAPTER IV COLLECTION AND PROCESSING DATA

Contains a description of the general description of the company, the data needed in problem-solving, and data processing from the research results according to the method used. In addition, the data were obtained from the results of interviews, observations, and direct measurement.

CHAPTER V DISCUSSION

This chapter discusses the results obtained in the research, and the suitability of the results with the research objectives so as to produce a recommendation.

CHAPTER VI CONCLUSIONS AND RECOMMENDATIONS

Contains conclusions on the analysis made, recommendations or suggestions on the results achieved, and problems found during the research, so that recommendations can be made to be studied in further research.

CHAPTER II
LITERATURE REVIEW

2.1. Inductive Study

This literature review is intended to study similar and related previous research so that the position of the research carried out can be known. The literature review of previous researchers include:

1. (Evi Febianti, Kulsum, Deby Pradifta, 2020) in a research journal entitled “Raw Material Warehouse Relayout Using CORELAP and CRAFT Methods at PT. XYZ". This study aims to provide suggestions for improving the layout of the factory by minimizing the distance traveled. The methods used are CORELAP (Computerized Relationship Layout Planning) and CRAFT (Computerized Relative Allocation Facilities Technique) methods. The CORELAP method is made by placing the most related activities based on the desired proximity and according to the required size. While the CRAFT method is made by exchanging the location of activities in the initial layout to find a better solution based on the activity relationship map. The calculation results show that the total mileage on the layout of the company's method is 55,072.05 meters, while the total mileage on the proposed layout with the CORELAP method is 41,067,02 meters and the layout of the proposed CRAFT method in the third iteration is 40,583.26 meters.
2. (Ukurta Tarigan, Robby Simbolon, Meilita T Sembiring, Uni Pratama P Tarigan, Nurhayati Sembirin, Indah R Tarigan, 2019) Conducted research with the title “Redesign and Simulation of Layout of Gripper Rubber Seal Production Facilities Using the Corelap Algorithm, Aldep, and Flexsim". PT. ABC is one of the companies that are engaged in manufacturing rubber seals. This company has a problem with the layout of its production floor, namely, it is cross-movement and the distance at some stations is also too far which causes the flow of materials to be disrupted. This problem can be solved by improving the layout of the production floor using the CORELAP and ALDEP methods and then doing a simulation with Flexsim software. This study aims to design the layout of the proposed facility that can minimize the distance of material transfer by comparing the efficiency of the displacement moment of the actual layout with the proposed layout. The results of this

study indicate a decrease in the total moment of displacement on the production floor of PT. ABC from 14,495.08 meters/month to 5930.19 meters/month using the CORELAP algorithm and 7,369.7 meters/month on the ALDEP algorithm. Distance efficiency in the proposed layout also increased from 53.67% to 93.74% on the CORELAP algorithm and 78.18% on the ALDEP algorithm. After doing a simulation to find the best method, the proposed layout was chosen which is the layout from the CORELAP algorithm with kilometers traveled per day of 1.9 km/day.

3. (Andi Rahayu Putri, Lely Herlina, Putro Ferro Ferdinant, 2017). Also conducted research with the title "Identification of Waste Using the Waste Assessment Model (WAM) in the Production Line of PT. KHI Pipe Industries". PT. KHI Pipe Industries is the largest company engaged in the manufacture of welded steel pipes in Indonesia. Based on reports on the manufacture of spiral gas pipes in the previous period, there were several types of waste such as overproduction originating from the number of reject pipes as many as 57 of the 885 pipes produced, which caused the production of pipes to have to be increased by 57 pieces to replace rejected pipe products, this also caused there is a waiting time for the pipe, the next process can be carried out, from the same production report found 1290 defects from 11 types of welding defects y. Waste identification is carried out on the next work order using the waste assessment model and the final percentage value for each waste is 27% for defects, 18% for overproduction, 14 for inventory, 13 for motion, 11% for transportation, 8% for process and 8% for waiting. The defect is the largest waste obtained from the calculation of the WAM questionnaire results, then the Value Stream Mapping Tools (VALSAT) used is quality filter mapping. The root of the problem from the existing defects is known by using Fault Tree Analysis (FTA), and from the root of the existing problems, suggestions for improvement are made using 5W1H tools, such as providing on the job training for operators, routine machine maintenance, periodic replacement of spare parts, improved storage and better material selection.

2.2. Production type

J.W.M Bertrand (1990) classifying manufacturing systems based on the type of production into 4 categories, namely:

a. Make to Stock (MTS)

In the MTS strategy, inventory is made in the form of a finished product that is ready to be packaged. The cycle begins when the company determines the product, then determines the raw material requirements, and makes it for storage. Consumers will order products if the price and product specifications are in accordance with their needs. Operations are focused on meeting the needs of inventory levels and orders that are not identified in the production process. The production system develops an inventory level based on future orders, not on current orders. In this strategy, inventory risk is greater. Examples of products: food, beverages, toys, and others.

b. Assemble to Order (ATO)

ATO strategy, all subassembly goes to inventory. When an order for a product arrives, companies can quickly assemble components into a finished product. This strategy is used by companies that have modular products, which can be assembled into several final products. This strategy has a 'moderate risk' to inventory investment. Operations are more focused on modules or parts. Examples of products: automobiles, electronics, commercial computers, fast food restaurants that provide several food packages, and others.

c. Make to Order (MTO)

Make-to-order is a term referring to companies that produce bespoke and customized products to particular customer specifications but not repeated on a regular basis or in a predictable manner (Hill, 2000). In the MTO sector, some or all of the production takes place after the customer order has been received. MTO companies have few standard products and difficult-to-predict, volatile demand (Waszkowski, 2016). Process activities begin when consumers submit the required product specifications and the company will help consumers prepare product specifications, along with prices and delivery times. Examples of products: machine components, computers for research, and others. Companies based on orders (make to order) have a stochastic pattern of order arrivals and changes in conditions on the factory floor that are difficult to predict. This situation often causes the initial schedule that has been prepared to be unable to accommodate these changing conditions.

d. Engineering to Order (ETO)

In the Engineer-To-Order (ETO) business a company designs and manufactures a new product based on customer requirements that demand a unique engineering design or significant customization of proven designs. ETO products are often highly complex, produced in low volume, and developed in close collaboration with the customer. One example for ETO products is production systems such as processing plants (Joergensen et al, 2010). In ETO, there is no inventory. The product has not been made before there is an order. When the order comes, the company will develop a product design along with the time and costs required. If the design is approved by the consumer, a new product is created. This strategy has no risk (zero risk) inventory. And suitable for new or unique products. For example Ships, computers for the military, prototypes of new machines, and others. Operations are more focused on the specifications of orders from consumers rather than the parts themselves.

2.3.Value Stream Mapping

Value Stream mapping method is a useful tool to describe the overall business processes of a company (Lee, 2006). In its manufacture using 4 groups of symbols, namely process, material, information, and general which can be seen in Figure 2.1.

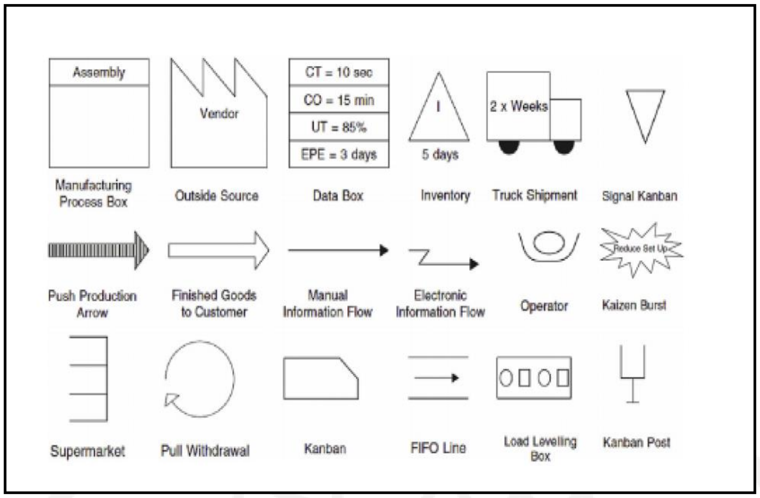


Figure 2.1 Value Stream Mapping Symbols

Value Stream Mapping will describe the entire business process so that it helps in making business process improvements. Where this is an advantage in this method compared to the waste relationship matrix (WRM) method which only focuses on the seven wastes, while VSM can identify the entire waste that occurs when needed. Waste assessment model (WAM), which consists of a waste relationship matrix (WRM) and a waste assessment questionnaire (WAQ). Which has advantages in the form of a simple matrix and a questionnaire that covers many things and is able to contribute to achieving accurate results in identifying every relationship and cause of the occurrence of waste. (Rawabdeh, 2005). A comparison of the advantages and disadvantages of the two methods can be seen in table 2.1

Table 2.0.1 VSM and WRM Comparison

Information	***Value Stream Mapping***	***Waste Relationship Matrix***
Strength	Assist in developing processes that are effective, efficient, and free from waste activities.	Having a comprehensive structure in analyzing the most dominant waste activities.
	Can see an overview of all process activities that are currently running and are easier to understand.	The simplicity of the matrix and the comprehensive questionnaire.
	Can see activities that occur stockpiling inventory.	Able to contribute in identifying the root causes of waste accurately.
Weakness	It is only used to check one product or one product group with the same process in each flow.	It is not enough to describe the relationship between each waste.

Information	*Value Stream Mapping*	*Waste Relationship Matrix*
	It is static and oversimplifies the problems that occur on the production floor.	Still need an analytical tool to reduce waste without giving a negative impact on other wastes.

The first stage in Value Stream mapping is the preparation of a state map. Analyzing the flow of materials in their current state will provide an overview and information about the process and its current state. Value Stream refers to all activities (value-added and non-value-added activities) that are essential to produce a particular product through the application of three critical management skills, namely information management, problem-solving, and physical transformation. VSM assists managers in differentiating value-added activities from non-value-added activities; also, it can be applied as a strategic tool for decision making applicable to redesigning processes and improving them continuously (Seyed Mojib Zahraee, 2020).

2.3.The Basic Concepts of Lean Manufacturing

Lean can be defined as a systemic approach to identify and eliminate waste or non-value-adding activities through radical continuous improvement by controlling products (materials, work in process, output) and information using a pull system from internal and external customers to pursue excellence and perfection (Gaspersz, 2011). Lean manufacturing focuses on eliminating and reducing waste that occurs in the company, which is done in two ways, namely simplifying procedures and speeding up the production process. The main principle of lean manufacturing is to make continuous improvements to increase value, value stream, flow, and pull in business operations (Lian, 2007). According to Womack and Jonas (2003) identifying and eliminating waste that exists in the design, production, and operation processes of both products and services, as well as supply chain management related to customers is the main goal or focus of the lean manufacturing concept.

Lean Manufacturing, also known as Lean Enterprise, Lean Production, or simply called "Lean" is a production practice methodology that focuses on the use and empowerment of resources to create value for customers, through eliminating waste that occurs. The process so that a more effective and efficient process occurs, with better output quality.

Lean is an activity or continuous improvement effort with the aim of (Gaspersz, 2008):

a) Eliminate waste.
b) Increase the added value of products (goods and/or services).
c) In order to provide value to customers (customer value).

2.4.Nine Waste

Waste can be defined as non-value adding activities when viewed from the customer's point of view (Hines & Taylor, 2000). According to Gaspersz (2008), there are two main types of waste, namely, type one waste and type two waste. Type one waste is all activities that do not add value in the process of transforming inputs into outputs along the Value Stream, but these activities cannot be avoided at this time. For example, inspection and sorting activities are activities that do not add value and are therefore referred to as waste, but these activities cannot be avoided. Type two waste is an activity that does not produce added value and needs to be eliminated immediately. For example, producing a defective product or making an error.

According to (Gaspersz, 2008) there are 9 types of waste found in the industry known as **E-DOWNTIME**, namely:

1. **Environmental:** health and safety EHS is a type of waste that occurs due to negligence in paying attention to matters related to EHS principles. For example, compressed air or water leaks that are often overlooked and how long the equipment is turned on.
2. **Defects** (Defective Products), are errors that occur in the manufacturing process, product quality problems, or low performance of goods/services delivery activities.
3. **Overproduction**, defined as production activities that are too much or too fast, resulting in disruption of the flow of information or goods, and excess inventory.
4. **Waiting** is a period in which there are no activities carried out by humans, information, or goods for a long period of time, resulting in disruption of flow and prolonging lead time.
5. **Not utilizing employees'** knowledge skills and abilities is a type of waste of human resources that occurs because of not using the knowledge, skills, and abilities of employees.

6. **Transportation,** is a waste caused by the movement of materials, goods, information, and people that causes a waste of time, energy, and costs.
7. **Inventory** (excess storage), is excessive storage and delays in information or products, causing increased costs and low customer service.
8. **Motion** (Unnecessary Movement), unnecessary movement can be caused by poor workplace organization which has an impact on the low level of ergonomics.
9. **Excess Processing**, is a waste caused by a work process that uses procedures and systems that are not in accordance with the capabilities of a work operation.

2.5.Facility Layout

A facility is something that is invested and intended to carry out an activity. In general, facility layout planning aims to simplify the course of activities, minimize material transfer, flexibility, maintain the turnover of semi-finished goods, minimize the use of building space, and provide convenience, safety, and comfort for workers in carrying out their work activities (Purnomo, 2004). According to Sritomo Wignjosoebroto (2009), factory layout can be defined as the procedure for setting up factory facilities to support the production process. This arrangement will be useful for the area of placement of machines or other production support facilities, movement of material movement, storage of materials both temporary and permanent, worker personnel, and so on. In order to achieve the objectives of facility layout planning, several criteria that need to be considered include:

1. The distance between facilities is minimal, so it can save energy, time, and material moving costs.
2. The material flow goes well and does not interfere with other processes that are running.
3. Effective use of building space by providing a distance between machines that is neither too wide nor too narrow.
4. Flexible layout so that it is easy to adjust in case of changes following the development of product type, quantity, quality, workforce, and so on.

Facility layout planning includes determining the location of the manufacturing system and facility planning which includes the design of facilities, layout, and handling of materials that support production activities in a company (Tompkins, et al., 2003). The layout is a major foundation in the industrial world. According to Wignjosoebroto (2003), factory layout or facility layout can be defined as the procedure for setting up factory facilities to support the production process.

There are two main things in facility planning, which are related to factory location planning and production facility design which includes factory structure design, facility layout design, and material handling. The location of the factory needs to be planned with the aim of providing support for the achievement of industrial goals on a macro basis. The location of the company is a location that is able to provide a minimum total cost and bring maximum profit. While the design of production facilities is to meet production capacity and quality requirements in the most economical way through effective and efficient arrangements and coordination. The design of this facility consists of Facility system design, production facility layout design, and material handling system design.

According to Heragu (1997), the type of facility layout based on the material flow system is divided into five, including:

1. Product Layout

   Also called flowline layout, production line layout, assembly line layout, and layout by product. In the product layout type layout, the arrangement of machines and workstations is determined based on the sequence of the production process. In general, this type is applied to manufacturing companies with a single product type or several types of products with high production quantities. The advantage of this type of layout is that it minimizes material transfer time, processing time, and ease of planning and monitoring. The weakness of the product layout is the lack of flexibility in the production process.

2. Process Layout

   Process layout is also known as layout by process or job-shop layout. This type of layout is applied to manufacturing companies with varied products and types of work, and low production quantities. In the process layout, the preparation of production machines is grouped into one department according to the type of machine or equipment used. The advantage of this type is that it supports work flexibility and provides opportunities for workers to become experts in their fields. The weakness of the process layout type layout can increase the cost of moving materials as well as the complexity in planning and supervision.

3. Fixed Position Layout

   In a fixed position layout, the product does not move from one place to another but occupies a fixed position. The production process and the use of machines adjust to the product. In general, this type of layout is used for products that are large and difficult to move around. The advantages of this type of layout are the minimization of production costs and the minimization of damage to the product. The weakness of this type of layout is the cost of moving machines and the lack of utilization of machines and equipment.

4. Group Technology-Based Layout

   In this type of layout, the production system is divided into several subsystems, where in the system there is a production process to produce various types of product parts.

5. Hybrid Layout

   In this type of layout, the company does not only adopt one type of layout, but also combines several types of layouts such as product layouts, fixed position layouts, and so on, according to production needs.

Facility layout design in a production process is the main key to increasing factory productivity. Facility layout is the most effective arrangement of placing a group of machines in a production floor or factory area so as to save Material Handlings by 20% -50%. The design can be used to reduce material handling costs and material transfer distances (Susetyo, 2010). The purpose of facility design, in general, is to determine how activities and production facilities can be arranged so as to support the achievement of the main production objectives effectively and efficiently (Wahyudi, 2010). As follows:

1. Simplify the manufacturing process.

   Good arrangement of machinery, equipment and workspace results in ease of production process.

2. Minimize the movement of goods.

   The effect of distance on material handling will affect the costs incurred. In addition, moving goods closer will have an impact on reducing production time.

3. Maintain flexibility.

   There are times when a factory demands a layout change due to a change (addition/reduction of facilities). This situation demands flexibility in the production process.

4. Maintain high turnover of semi-finished goods.

   Smooth material handling activities reduce the accumulation of goods at workstations. A small total circulation time will reduce the number of semi-finished goods which will result in lower production costs.

5. Lowering the cost of capital.

   Appropriate use of production facilities will reduce the cost of using unnecessary facilities and avoid duplication of equipment.

6. Saving factory space usage.

   Accuracy in the layout of the equipment used will save (efficiency) the space used.

7. Facilitate supervision.

   A good layout will make it easier in terms of supervision of the production activities carried out.

8. Improving safety for products and employees.

   Machines and equipment that are placed in the right place will reduce the occurrence of work accidents and damage to goods.

2.6. Distance Measurement Methods

According to James A Tompkins (2003), there are several methods used to measure the distance from one location to another. The method used depends on the availability of qualified personnel, the time to collect data, and the types of material transfer systems used.

1**. Euclidean distance**

Euclidean distance is the distance measured straight between the center of one facility to the center of another facility. Euclidean Distance is the metric that is most often used to calculate the similarity of two vectors (Sutoyo, 2010). Euclidean Distance formula is the root of square differences between 2 vectors. To determine the Euclidean distance from one facility to another, use the following formula:

$$\boldsymbol{d_{ij}} = \left[(X_i - X_j)^2 + (Y_i - Y_j)^2 \right]^{1/2} \tag{1}$$

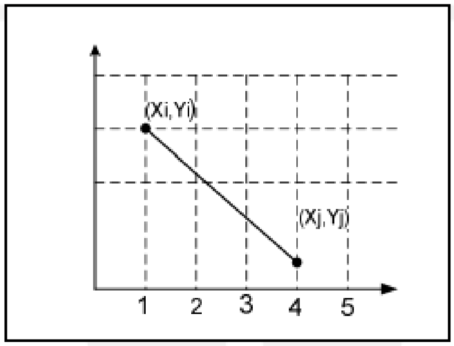


Figure 2.0.2 Euclidean Distance

where X_i = The coordinates of point X at the facility-i
Y_i = The coordinates of point Y at the facility-i
d_{ij} = Distance between facility center i and j

2. **Rectilinear Distance**

Rectilinear distance is the distance measured following a perpendicular path from one facility center point to another facility center point. Rectilinear distance measurement is often used because it is easy to calculate, easy to understand, and for some problems, it is more suitable, for example, to determine the distance between cities, the distance between facilities where material transfer equipment can only move perpendicularly. The formula used in measuring the distance is (Heragu, 2008):

$$\boldsymbol{d_{ij}} = |X_i - X_j| + |Y_i - Y_j| \tag{2}$$

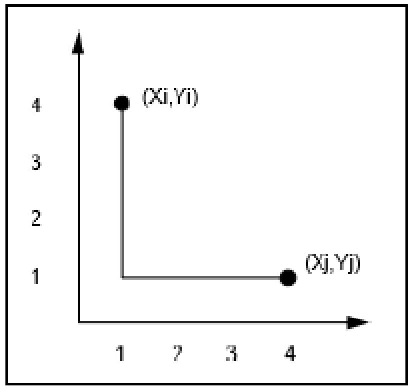


Figure 2.0.3 Rectilinear Distance

3. **Square Euclidean**

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

$$\boldsymbol{d}_{ij} = \left[\left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2\right] \qquad (3)$$

4. **Aisle Distance**

The size of the aisle distance is very different from other distance measures. Aisle distance will measure the distance along the path traversed by the material transfer vehicle. The aisle distance was first applied to the layout problem of the manufacturing process. In Figure 2.13 (a) the measure of the aisle distance between departments K and M is the sum of a, b, and d. Meanwhile, in Figure 4 (b) the aisle distance of department 1 and department 3 is the sum of a, c, f, and h. Aisle Distance was first applied to the layout problem of the manufacturing process.

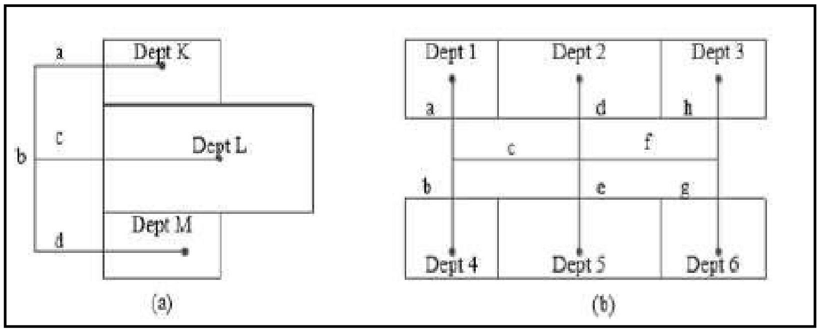


Figure 2.0.4 Aisle Distance

5. **Adjacency Distance**

Adjacency is a method of proximity between facilities or departments contained in a company. The weakness of the Adjacency distance measure is that it cannot make a real difference if there are two pairs of facilities, which are not close to each other.

2.7.BLOCPLAN Algorithm Calculation

BLOCPLAN (Block Layout Overview with Computerized Planning using Logic and Algorithm) is a facility layout design system developed by Donaghey and Pire at the Department of Industrial Engineering, University of Houston. This program creates and evaluates layout types according to the input data. The number of lines in BLOCPLAN is determined by the program and is usually two or three lines (Purnomo, 2004). The data used in the BLOCPLAN algorithm can be in the form of qualitative data formed using the Activity Relationship Chart (ARC) or quantitative data in the form of product flow and the size of the departmental area that will be occupied by the layout of the facility. After all the data is entered, a random layout will be generated until a better layout is achieved. However, in the block plan, the number of iterations is limited to a maximum of 20 iterations and can only analyze a maximum of 18 facility layouts.

According to Hari Purnomo (2004) the steps that must be taken in running the BLOCPLAN algorithm program are:

a. Number of facility layouts
b. Facility layout name
c. The area of each facility layout
d. Activity Relationship Chart (ARC)

BLOCPLAN has similarities with the CRAFT method in the arrangement of departments. The difference is that the BLOCPLAN method can use a linkage map as data input, while the CRAFT method only uses a from-to chart. Layout costs can be measured either by distance or by proximity. The layout design using the BLOCPLAN algorithm is determined based on the R-score, Adjacency score, and Rel-dist score. R-score is the efficiency value of a generated layout, Adjacency score is the proximity value of a facility based on a predetermined Activity Relationship Charta (ARC), Rel-dist score or rectilinear distance score is the total distance of material transfer between two facilities. The layout of the proposed facility is selected based on the largest R-score, then if there is the same R-score followed by the selection of the largest adjacency score, after being selected based on the highest score if there is still the same adjacency score, then proceeding with selecting based on the lowest Rel-dist score (Heragu, 2007).

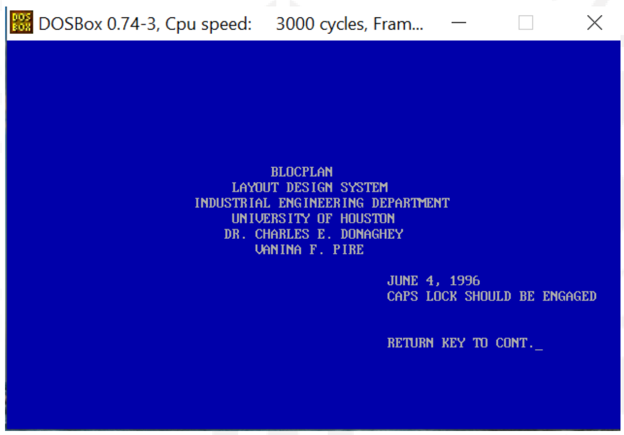


Figure 2.0.5 BLOCPLAN interface software

2.8.Relationship Works

Relationship Works is a relationship that occurs in a layout between departments in a factory in the form of quantitative and qualitative relationships and has the benefit of analyzing the current condition of the factory layout so that layout improvements can be made to better conditions.

2.8.1. Activity Relationship Chart

Activity relationship Chart means the relationship between the activities on the production of any industry. The relation between activities may be important, unimportant, or some time undesirable (Singh, 2009). The relationship is represented with some ratings, called closeness rating (J.A. Tomkins, 2010). For generating an activity relationship chart, it requires identification of the relationship between activities and resources. This information can be obtained from surveys/interviews. In the survey, the employees of the industry are asked, to identify where or who they will receive their work from and the destination of their work after completion. The results of these surveys are compiled into an activity relationship chart. The closeness rating is shown in Table 2.2

Table 2.0.2 ARC Closeness Rating

Rating	Closeness
A	Absolutely necessary
E	Especially important
I	Important
O	Ordinary closeness
U	Unimportant
X	Undesirable

If departments have A – relation, it means that it is Absolutely Necessary to put these closer to each on the shop floor, E – Relation means, it is Especially Important to put these closer, if possible, after putting the A - relation departments. I and O Relations shows Important and Ordinary closeness, it will be considered after E relationship. U and X Relations shows Unimportant and Undesirable relation respectively. Closeness ratings present an ordered preference for closeness. The most important rankings are A rating and X rating; hence any layout must satisfy these two ratings. An E rating is second-ranked, and most, if not all, E rating should be satisfied by the layout, and I rating is third-ranked, and as many as possible should be satisfied, without sacrificing A, E, or X ratings. In the same way, O ratings are fourth-ranked and they should be satisfied after A, E, X, or I ratings. U ratings can be ignored while designing the layout. Thus, A and X > E > I > O > U, where > means "more important or higher ranking than".

There is always a reason behind the closeness rating between activities. It may be any reason, like the flow of materials, contact necessary, etc. some such reasons are shown in Table 3 (Monika Sharma, 2015).

Table 2.0.3 Reasons behind the Closeness rating

Code	Reasons
1	Flow of Material
2	Ease of supervision
3	Common personal
4	Contact necessary
5	Noise and disturbance
6	Similar type of equipment's

A relationship chart may be constructed as follow (Monika Sharma, 2015):

1. List all departments on the relationship chart.
2. Conduct interviews or surveys with persons from each department listed on the relationship chart and also with the management responsible for all departments.
3. Define the criteria for assigning closeness relationships and record the criteria as the reasons for the relationship values on the chart.
4. Establish the relationship value and the reasons for the values for all pairs of departments.
5. Allow everyone having input to the development of the relationship chart an opportunity to evaluate and discuss changes in the chart.

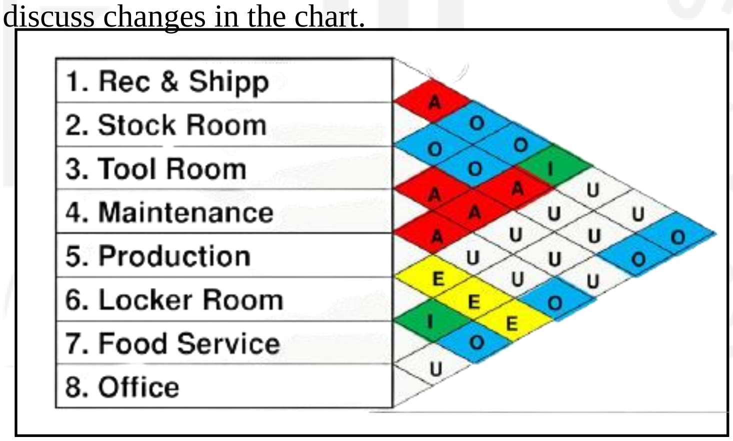


Figure 2.1 *Example of Activity Relationship Chart*

CHAPTER III
RESEARCH METHODOLOGY

3.1.Object of Research

This research was conducted at PT. Centra Biotech Indonesia, which is engaged in the biofertilizer manufacturing industry. PT. Centra Biotech Indonesia is located in Pasungan Village, Klaten, Central Java, Indonesia. The object of this research is the management of waste analysis, especially in the production process and layout management.

3.2.Data Type

In this study there are 2 types of data used, namely:

a. Primary data

Primary data is data obtained directly by researchers from the object to be studied. In this study, primary data were obtained in the form of production flow in the company, activities carried out during the production process, distance and area of factory layout, as well as an assessment of the relationship between departments in the company PT. Centra Biotech Indonesia. The data obtained came from interviews with employees and direct observations of researchers at the company's location.

b. Secondary Data

Secondary data is data obtained indirectly, such as data obtained through literature and general data regarding the internal company where the research is conducted.

3.3.Data collection

The data collection methods used to conduct this research are:

a. Interview

In this study, interviews were conducted with experts from PT. Centra Biotech Indonesia to find out the business processes, the waste activities that exist as well as the causes and impact in the production process of PT. Centra biotech Indonesia. In addition to the experts, interviews were also conducted with employees to complete other supporting information.

b. Live observation

In this study, direct observation was carried out to observe the running of business processes so that direct identification of the risks involved could be carried out. Field research data collection includes:

1. Product Type and Category Data
2. Production flow Data
3. Company Workstation
4. Production Process Time
5. Initial Production Layout

c. Questionnaire

In this study, a questionnaire was conducted to the director of the company PT. Centra Biotech Indonesia to find out the close relationship between the layout departments in the company using Activity relationship Chart (ARC) to be considered in calculating the proposed new facility layout.

d. Study of literature

Literature Review Literature study is a method of collecting data based on literature sources in the form of books, journals, and so on, which are related to the research topic. In this study, the literature used as a source of research includes books and research journals on Lean manufacturing and facility design.

3.5. Data Processing Method

This study aims to reduce waste activities by designing a new company facility layout by considering the layout area and the close relationship between departments in the company. Data processing is carried out through several stages, namely as follows:

3.5.1. Value Stream Mapping

Value Stream Mapping (VSM) is one of the methods of the Lean Manufacturing approach that is used to produce a production process flow and existing information flow from the supplier to the customers. From the current state of VSM, it can be seen the whole activities at PT. Centra biotech Indonesia.

3.5.2. Waste activities processing

At this stage, the selection of Waste activities that are directly related to the material handling flow and the layout of existing facilities at PT. Centra biotech Indonesia.

3.5.3. Activity Relationship Chart (ARC)

Relations between each workstation in the PT. Centra Biotech Indonesia can be described through the Activity Relationship Chart (ARC) derived from the results of direct observations and interviews by researchers. After obtaining the ARC, then the Total Closeness Rating (TCR) is calculated for each department in the company.

3.5.4. BLOCPLAN Calculation

After obtaining factory area data, distance data between departments and assessment of Activity Relationship Chart. Then the next step is to carry out the facility layout design process using the BLOCPLAN (Block Layout Overview with Computerized Planning using Logic and Algorithm) which converts qualitative data from ARC into quantitative data to determine the proposed facility layout. The BLOCPLAN algorithm functions by considering the area of each department and also the level of closeness of each section based on the Activity Relationship Chart (ARC). In the BLOCPLAN algorithm, it will produce a comparison of the R-score, Adjacency score, and Rail-dist score between the proposed layout iterations so that the best value for the best layout can be selected, this will result in the most optimal layout for PT. Centra biotech Indonesia. The BLOCPLAN algorithm also produces a brief analysis of the Activity Relationship Chart (ARC) in the company with the layout selected through BLOCPLAN.

The following are the steps in using the BLOCPLAN algorithm:

1) Open the DOSBox 0.74 application and enter the code to be able to use the BLOCPLAN algorithm.
2) Enter the appropriate number and area of workstations in the layout of PT. Centra biotech Indonesia.
3) Fill in the ARC section according to the data that has been obtained from the interview.
4) Choose a 1:2 layout ratio which is Length x Width.
5) Adjusting the layout of the facility.

6) Fill in as many as 20 alternative layouts or iterations to be performed.
7) Generate layout proposal by BLOCPLAN algorithm.
8) Choose the best layout iteration based on the r-score, adjacency score, and rel-dist score.
9) Analyze the selected layout iteration.

3.5.5. Design proposed layout

After selecting the best layout based on the R-score, Adjacency score, and Rail-dist score. The next step is to describe the facility layout design proposed by PT. Centra Biotech Indonesia visually with the appropriate size. The visual design of the proposed layout uses AutoCAD 2021 software and aims to be able to carry out further analysis of the proposed layout, especially regarding the distance between the workstations that will be generated.

3.5.6. Layout distance calculation.

The last stage of data processing in this research is to recalculate the factory area and the distance between departments on the layout proposed by the researcher, this is done to be able to find out the difference between the current facility layout and the new facility layout which has been recalculated based on the consideration of Waste activities and ARC assessments found by researchers at the company PT. Centra Biotech Indonesia.

3.6.Data Analysis Method

Initial data analysis in this study uses Value Stream Mapping to provide an overview of the flow of information and overall activities in the production process from raw materials to finished products at PT. Centra Biotech Indonesia. In addition, further analysis is carried out by selecting activities that are included in the category of Waste Transportation and Waste Waiting so that improvements can be made to the facility layout design.

At this stage, an analysis of the research results is carried out as follows:

1. Analysis of Value Stream Mapping and Waste activity

   Analysis of the overall production flow and Waste activities in PT. Centra biotech Indonesia can be done using Value Stream Mapping (VSM).
2. Analysis BLOCPLAN layout design

At this stage, an analysis of the results of the proposed layout is carried out through the BLOCPLAN algorithm. This analysis process includes sequences between facility layouts, R-score values, Adjacency scores, and Rail-dist scores, suitability of ARC in the proposed layout and the Total Closeness Rating (TCR) value obtained for each relationship.

3. Analysis of proposed facility layout

   The analysis process is carried out on the proposed facility layout which has been visually described using AutoCAD 2021 software in accordance with the sequence between the facility layouts and the layout size that has been proposed by the BLOCPLAN algorithm.

4. Analysis of layout distance

   The final analysis stage is to analyze the resulting distance between the initial layout and the proposed layout.

4.7.Research Flow

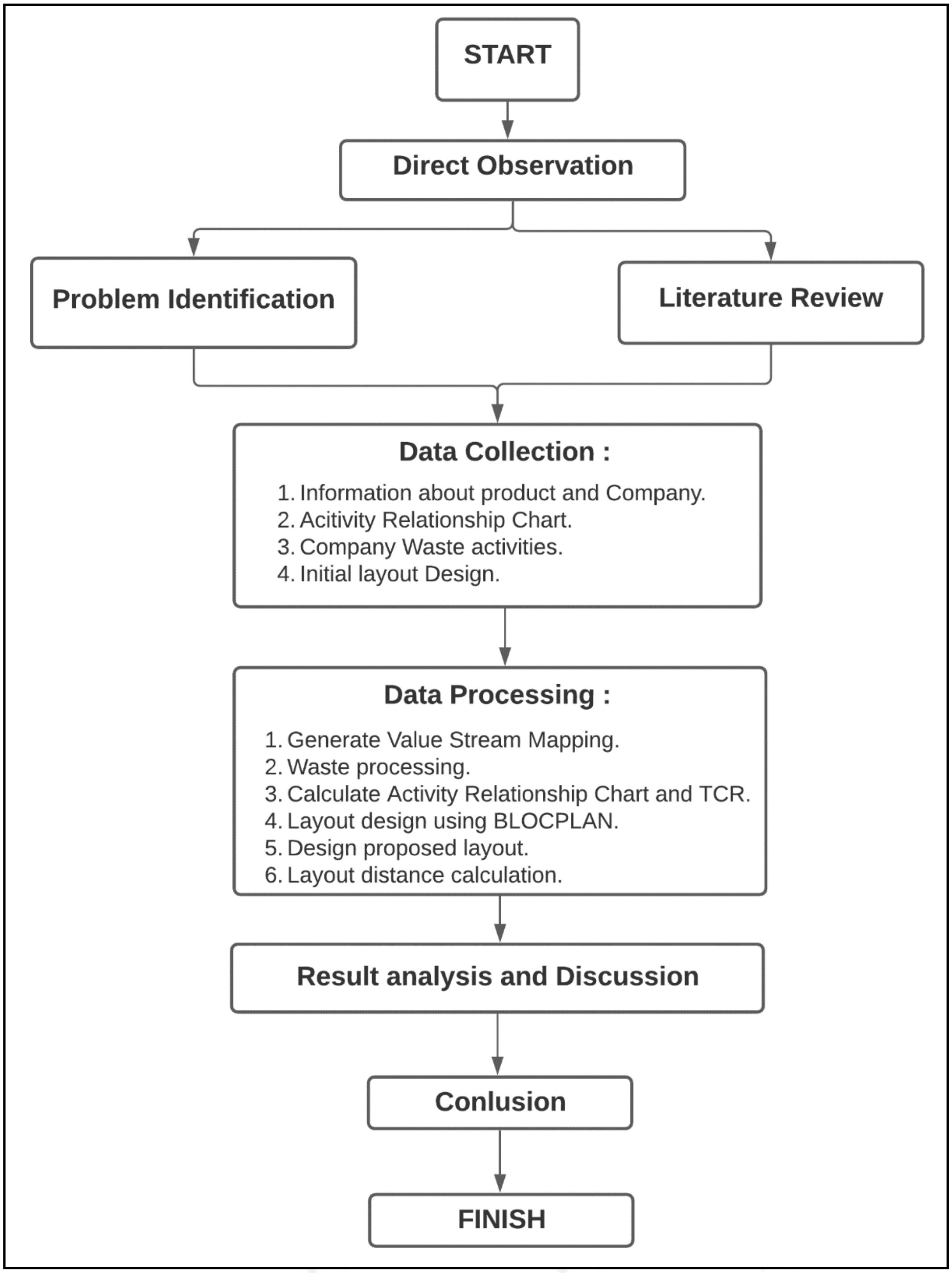


Figure 3.0.6 *Research Flowchart*

CHAPTER IV
COLLECTION AND DATA PROCESSING

This chapter will describe the observational data and data processing according to the method used. Data were obtained from interviews, observations, and direct measurements.

4.1. Data collection

Data collection was carried out using Interview methods, questionnaires, and direct observations at the company in carrying out all activities of the production process of Liquid Biological Fertilizer and Powdered Biological Fertilizer. This data collection activity aims to help researchers formulate existing problems at PT. Centra Biotech Indonesia and provides solutions in the form of redesigning the layout of the company's facilities.

4.1.1. Company Profile

PT. Centra Biotech Indonesia is a national company that produces and markets environmentally friendly biotechnology products with a special microbial base as the main composition. PT. Centra Biotech Indonesia provides various biotechnology products in the fields of agriculture, livestock, fisheries, and so on, to support health and productivity. PT. Centra Biotech Indonesia has three types of products consisting of agricultural, fishery, and livestock products. In each of these types of products, there are various types of products with varying sizes and bacterial ingredients.

This company was founded on February 10th, 2010, and received approval from the Minister of Justice and Human Rights of the Republic of Indonesia with a registration number: AHU-20782.AH.01.01. Tahun 2010. PT. Centra Biotech Indonesia, which has experts in the fields of microbiology and pharmacology, always creates and innovates to deliver quality products by combining technology, science, and selected natural ingredients in order to provide the best quality and useful products.

The production system at PT. Centra Biotech Indonesia uses the principle of make-to-order (MTO). In the make-to-order system, the company will carry out the production process after the consumer submits an order. The fulfillment of orders does not use stock products but is produced on demand.

Figure 4.0.1 Company Logo

4.1.2.Company Vision and Mission

Vision:

"Developing biotechnology products in the fields of livestock, agriculture, fisheries, and organic waste processing in order to maximize the potential of the nation as an agricultural country".

Mission:

1. Producing and marketing environmentally-friendly biotechnology products to support livestock, agriculture, and fisheries health.
2. Establish partnerships internally with research institutes, consultants, and establish partnerships externally with breeders, small, medium-scale farmers, and large companies.

4.1.3.Marketing Product

The company does not sell products directly to customers but through distributors/vendors and cooperation with local governments through E-catalogues. Products produced by PT Centra Biotech Indonesia are 1-liter liquid biological fertilizer and 250gram powder. These products are marketed in Central Java, East Java, Yogyakarta, Jakarta, and other regions. Overall, the marketing of PT. Centra Biotech Indonesia has spread to almost all regions of Indonesia, starting from the islands of Sumatra, Kalimantan, Java, Bali, NTT, NTB, Sulawesi and, Papua. In almost every province, there is a distributor from PT. Centra Biotech Indonesia. The distribution of the marketing area is divided by region and the ability of distributors to market a product. Between distributors, it is prohibited to market outside their territory. If they want to market products outside their territory, they must be licensed by the company. Distributors are free to take advantage of the lowest retail price provided by the company, but the company has set the highest retail price so that prices in the market can be orderly.

PT. Centra Biotech Indonesia has three types of products consisting of agricultural, fishery, and livestock products. Each of them has its market and way of marketing. The largest market for agricultural products is the government or the agriculture agency, which purchases agricultural products for package procurement needs. Apart from that, agricultural products are also marketed by distributors to farmer shops in certain areas. Furthermore, the largest market for fishery products is pond farmers, particularly shrimp ponds.

4.1.4. Location of PT. Centra Biotech Indonesia

Geographically, PT. Centra Biotech Indonesia is located in Pasungan village, Ceper sub-district, Klaten district, Central Java Province with coordinate points - *7.7025379, 110.663634*. The area is occupied by PT. Centra Biotech Indonesia is still in a rural area where the area is still surrounded by vast expanses of rice fields. The distance from the city of Klaten to PT. Centra Biotech Indonesia takes approximately 15-20 minutes with fairly easy access. Even though it is located in rural areas, container trucks for transporting products can still access the road to the factory without difficulty.

The company's location is on the outskirts of the village so it is very close to residential areas. Employees of PT. Centra Biotech Indonesia has easy access to companies. Even when there are factory needs, employees who are near the factory can easily complete these needs. The company's land area is around 2000m2 which consists of separate factories and warehouses, offices and laboratories in the same location.

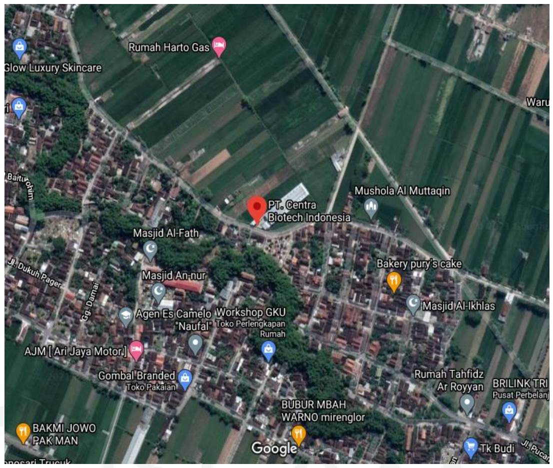


Figure 4.0.2 Geographical Location of PT. Centra Biotech Indonesia

Figure 4.0.3 Company Building

4.1.5.Organization Structure

The organizational structure is a framework that shows the relationship between workers in completing tasks of a company or an organization. To achieve company goals, it needs a good organization, where there is a relationship between people who carry out activities in an organization by their respective activities and functions.

The organizational structure at PT. Centra Biotech Indonesia consists of the President Director, Finance Director, Operational Manager, R&D Manager, Marketing Manager, Division of each division, and Distributors who are external to the company. Each of them has their respective roles and responsibilities, which consist of:

1. President Director: Leading the company, compiling future business plans and strategies, ensuring each division is doing its job well, evaluating the company.
2. Finance Director: Arranging money rounds in the company, compiling company books, managing money matters.
3. Operational Manager: Manage and lead the activities in the factory or related to the course of production such as determining raw materials, quantities, and production methods.
4. R&D Manager: Leading product research and development activities as well as conducting quality control of products to be marketed by the company.
5. Marketing: Manage incoming orders and send goods to distributors or consumers and coordinate with distributors.
6. Distributors: Selling products and looking for market opportunities that exist in the field ranging from farmers, private companies, to the government.

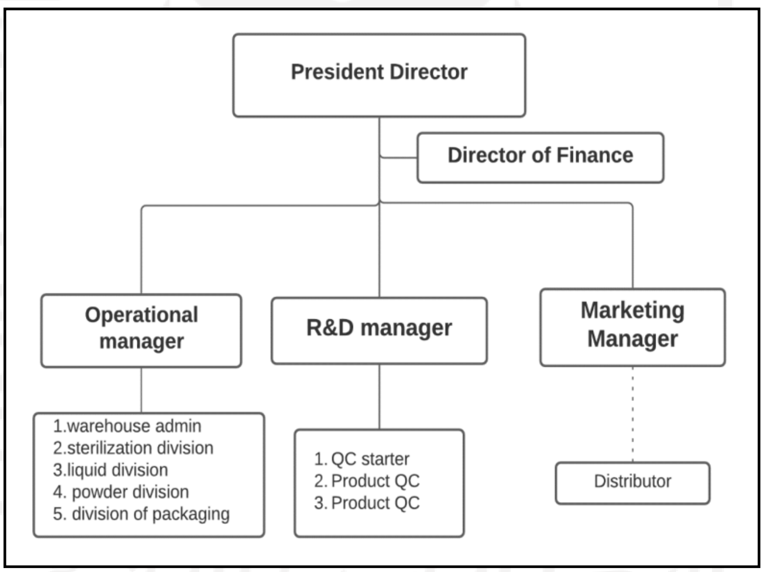


Figure 4.0.4 Organizational structure

4.1.6.Employment of PT. Centra Biotech Indonesia

PT. Centra Biotech Indonesia has 16 permanent factory employees plus several additional employees who adjust based on orders. The number of employees is adjusted to the needs of the company so that performance can run efficiently. One of the uniqueness of the composition of employees at PT. Centra Biotech Indonesia is the existence of the family and relatives of the company owner (director) in it. 8 families are filling the staffing composition in the company. That number is half of the total number of employees so that the number of family employees and non-family employees in the company has the same number. That is quite a number because of the comparison between family employees and not having the same amount.

4.1.7.Products Type

PT. Centra Biotech Indonesia is a national company that produces and markets environmentally friendly biotechnology products with a special microbial base as the main composition. PT. Centra Biotech Indonesia provides various biotechnology products in the fields of agriculture, Livestock, fisheries, and so on, to support health and productivity. In general, this company produces biological fertilizers using biological bacteria for use in agriculture, animal husbandry, fisheries. The product description is described in Table 4.

Table 4.0.1 Product Type

No.	Product Type	Product Description
1	Agriculture	It is a biological fertilizer product that is packaged in powder or liquid form and is specialized in the field of Agriculture.
2	Fishery	It is a biological fertilizer product that is packaged in powder or liquid form and is specialized in the field of the Fishery sector.
3	Livestock	It is a biological fertilizer product that is packaged in powder or liquid form and is specialized in the field of the Livestock sector.

Some of the company's products are explained below.

A. LIVESTOCK

1. BioOne-Poutry : Poultry special probiotics
2. BioOne-Ruminant : A special probiotic for ruminants
3. Bioenzyme : Enzyme to improve feed quality
4. BioVitamino : Combination of Probiotics, Vitamins, and minerals
5. BioProtector : Combination of Probiotics, Vitamins, and Selenium
6. Killat : Fly killer for Livestock’s farming
7. Biolarva : Control of cage fly larvae
8. Taburi : Decomposer and deodorizer of livestock manure
9. Jawara-Medeica : Treating special diseases of birds
10. Jawara-Stamina : Increase the bird's special stamina
11. Jawara-Breeding : Increasing the production of bird livestock
12. Jawara-Probiotic : Normalize digestion of bird livestock
13. Jawara-Feed : A bird feed

B. AGRICULTURE

1. FloraOne : Biofertilizer for all crops
2. Floraone-Rizobium : Biological fertilizer specifically for legumes
3. FloraOne-Padi : Biological fertilizer specifically for rice plants
4. FloraOne-Jagung : Biofertilizer specifically for maize plants
5. FloraOne-Bulai : Bio-fertilizers specifically for downy mildew corn
6. FloraOne-Sawit : Biofertilizer specifically for oil palm plants
7. FloraOne-Cabe : A special bio-fertilizer for chili plants
8. FloraOne-MST : Biofertilizer specifically for melon, watermelon, cucumber
9. FloraOne-KTT : Special biological fertilizers for potato, tomato, and eggplant
10. FloraOne-Biolada : Special biological fertilizer for Pepper plants
11. FloraOne-Tricolada : Biological agents controlling pepper plant diseases

12. FloraOne-Hamalada : Biological agents to control pests of pepper plants
13. FloraOne-K : Biological fertilizer + potassium to improve production
14. FloraOne-Calcium : Biofertilizer + Calcium to meet calcium and production

C. FISHERY

1. BioAquatic : Probiotic for pond waters
2. BioStimulant : Probiotics for the digestive health of fish/shrimp

Figure 4.0.5 Example of Company Products

4.1.8. Product Categories

Product categorization is done by grouping products based on liquid and powder types. This needs to be done because the bacterial ingredients needed to work on each type of product have almost the same production process, while the product variations consist of the Liquid type in 1-liter bottles and the Powder type in 250 grams and 50 grams. So that in this study, categorization was carried out based on powder and liquid.

Table 4.0.2 Product Category

No.	Product Category	Description
1	Powder Category	Product category of powdered biological fertilizers used in agriculture, Livestock, fisheries and packaged in 250-gram and 50-gram pack sizes.
2	Liquid Category	Product category Liquid biofertilizer used in agriculture, Livestock, fisheries and is packaged in liquid form with 1-liter bottle size.

4.1.9. Product Analysis

Product Analysis at the company PT. Centra Biotech Indonesia has a production process starting from the beginning to the last stage, namely the process of preparing bacterial media to the packaging of biofertilizer products. The following is an analysis of the components of the liquid biofertilizer and powdered biological fertilizer products at PT. Centra Biotech Indonesia.

Table 4.0.3 Liquid Fertilizer Product analysis

PARTS LIST				
	Product: Liquid Fertilizer Products			
No.	**Part name**	**Amount**	**Material**	**information**
1	Plastic bottles	1	HDPE Plastics	Buy
2	Product label sticker	1	paper	Buy
3	Bacteria	5	bacteria	make
4	Water	1	H2O (Water)	Make
5	bacterial media	1	molasses mix	Buy and make
6	packaging	1	carton packaging	Buy

It can be seen in the Product analysis table, that the liquid biological fertilizer product has six materials used, and the manufacturing process is carried out on bacterial raw materials, bacterial media, and water. In packaging materials, the company cooperates with suppliers providing plastic bottles, sticker labels, and packaging boxes.

Table 4.0.4 Powder Fertilizer Product Analysis

PARTS LIST				
	Product: Powder Fertilizer Products			
No.	**Part name**	**Amount**	**Material**	**information**
1	Plastic bottles	1	HDPE Plastics	Buy
2	Product label sticker	1	paper	Buy
3	Bacteria	5	bacteria	make
4	Water	1	H2O (Water)	Make
5	Powder	1	Kaolin	Buy
6	bacterial media	1	molasses mix	Buy and make
7	Packaging	1	carton packaging	Buy

It can be seen in the Product analysis table that the liquid biological fertilizer product has seven materials used, and the manufacturing process is carried out on bacterial raw materials, bacterial media, and water. On packaging materials, the company cooperates with suppliers providing plastic bottles, sticker labels, kaolin powder and packaging cardboard.

4.1.10. Production Process Flow

The stages of the production process carried out are in the form of product manufacturing activities at PT Centra Biotech Indonesia. There are two types of products produced, namely powder products and liquid products. The following is the production process of the two types of products.

A. Powder Fertilizer Products

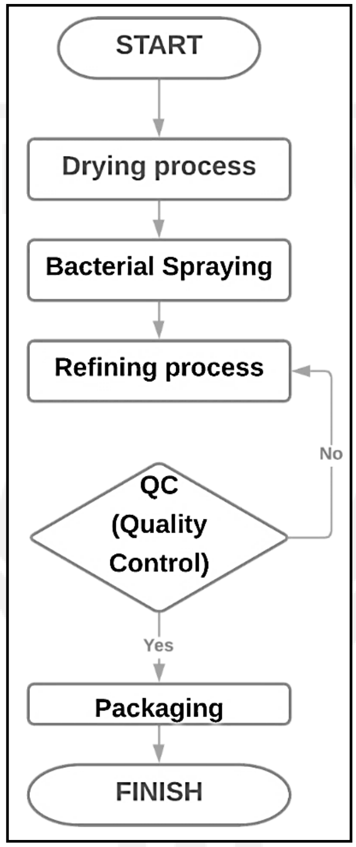


Figure 4.0.6 Powder Process flow

The production process of powder fertilizer products is as follows:

1. Drying

   Drying is a process when the main raw material of powder fertilizer in the form of lumps of flour is using a drying machine that uses firepower so that initially the moist lumps become powder.

2. Bacterial Spraying & Cooling

   Spraying and Cooling Process is the process of giving bacteria in liquid form by spraying on solid raw materials that have been powdered, as well as cooling using room temperature so that bacteria can seep into the powdered solids and reduce the temperature of the powdered solids in the drying process

3. Smoothing

   Refining is the process of reducing solid lumps into a finer powder using a flour milling machine.

4. QC (Quality Control)

   Quality Control is a process of checking the results of certain processes so that the products produced meet predetermined or desired standards.

5. Packaging

   Packaging is the process of inserting finished fertilizer products into aluminum foil roll packaging that already has a label from the company using a vertical packaging machine.

6. Packing

   The Packing process is the packing of fertilizer products that have been packaged into cardboard boxes to facilitate the process of product distribution.

The following is a table of activities in the production process of powdered fertilizer products.

Table 4.0.5 Powder production process

No	Activity	Machine Type	Cycle Time (s)	Precedence
1	Processing of bacterial media	stove	1.51	-
2	Process of Bacterial culture	bacterial culture reservoir	1.42	1
3	process of mixing bacterial type	mixing reservoir	5.05	2
4	Raw Kaolin media drying	drying machine	2.49	-
5	Mixing bacteria into kaolin media	manual by employee	0.86	4
6	kaolin media drying	drying board	2.49	5
7	filtering and grinding of kaolin media	filter and grinder Machine	0.98	6
8	Product packaging 250 grams	packaging filling machine	3.25	7
9	Product packaging 50 grams	packaging filling machine	2.60	7
10	Labeling and quality checking	labeling machine	2.10	8,9
11	product packaging into cartoon containers	manual by employee	1.31	10

The following is a sequence of precedence diagrams on the powder fertilizer production process at PT. Centra Biotech Indonesia.

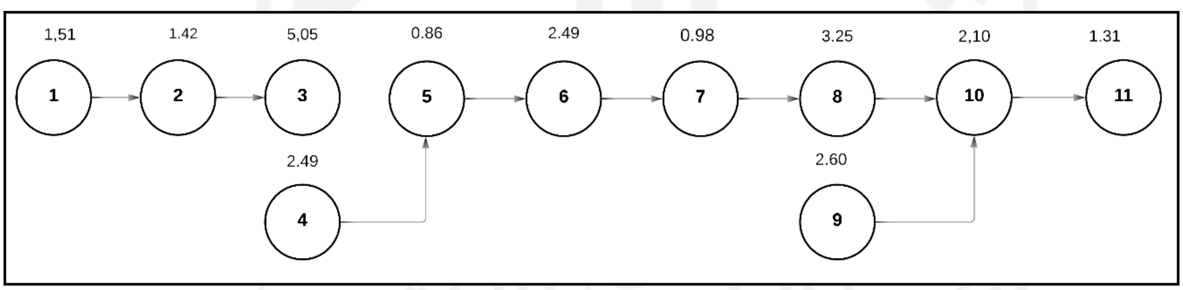


Figure 4.0.7 Powder product precedence diagram

B. Liquid Fertilizer Products

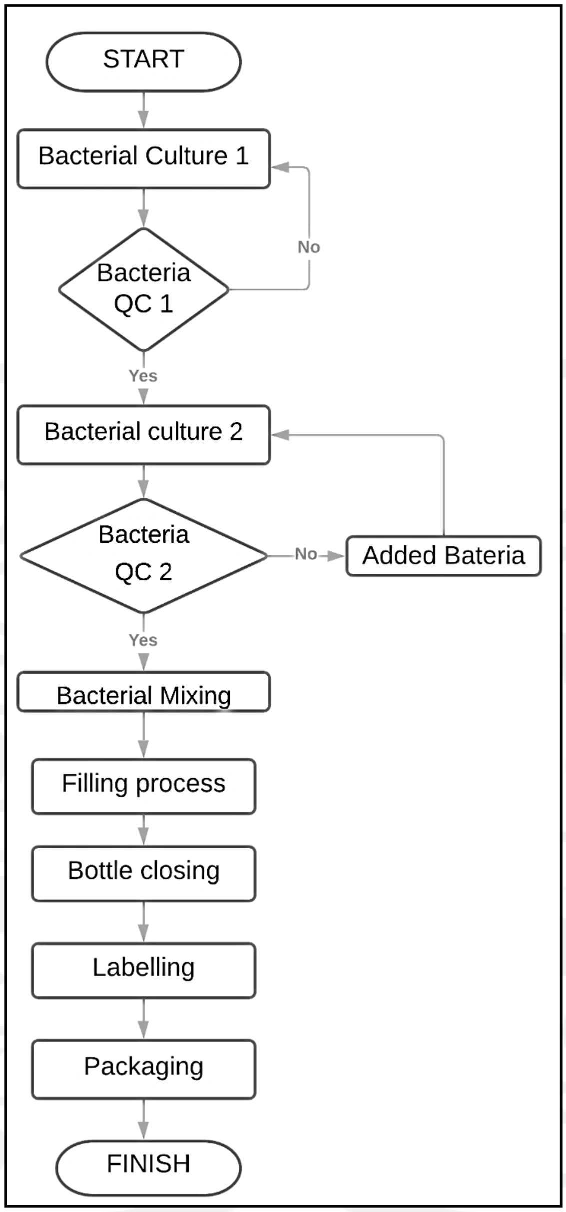


Figure 4.0.8 Liquid process flow

The production process of liquid fertilizer products is as follows:

1. Bacterial Breeding 1

   Bacterial Breeding 1 is the process of cultivating bacteria starting from starter bacteria or bacterial master sheets from the laboratory into a special sterile room for approximately 1 week with several containers that have been specially designed for initial bacterial breeding.

2. Bacterial Breeding 2

   Bacterial propagation 2 is the process of cultivating bacteria using tendons, which consist of 2 types of reservoir volumes, namely 1000L and 5000L. processed by fermentation in the reservoir for approximately 10 days. Processing by adding ingredients for bacterial growth such as cassava, water, etc.

3. Bacterial Mixing

   In this Bacterial Mixing process, namely mixing several bacteria that are ready to be harvested or have gone through the previous process perfectly into 1 5000L sized reservoir. mixing bacteria based on the type of fertilizer to be produced so that the process of mixing bacteria follows the liquid fertilizer product to be made.

4. QC (Quality Control)

   Quality Control is a process of checking the results of certain processes so that the products produced meet predetermined or desired standards.

5. Filling

   The filling process is to put the liquid fertilizer into a bottle using a faucet that is connected to a PVC-type Parallon pipe with a 5000L capacity reservoir filled with bacterial liquid that is ready to be packaged.

6. Bottle Closing

   The Bottle Closing process is the provision of a seal or seal made of silicone so that liquid does not spill or come out of the bottle and also the provision of a bottle cap to seal the damage caused from the outside.

7. Labeling

   The labeling process is the giving of labels or descriptions of product specifications, procedures for use, and company logos in the form of sticker paper affixed to the bottle body.

8. Packing

The Packing process is the packing of fertilizer products that have been packaged into cardboard boxes to facilitate the process of product distribution.

The following is a table of activities in the production process of liquid fertilizer products.

Table 4.0.6 Liquid production process

No	Activity	Machine Type	Cycle Time (s)	Precedence
1	Processing of bacterial media	stove	1,51	-
2	Process of Bacterial culture	bacterial culture reservoir	1,42	1
3	process of mixing bacterial type	mixing reservoir	5,05	2
4	Bottle filling of reservoirs A and B	filling reservoir	5,18	3
5	Bottle filling	filling tap	2,4	4
6	Sealing	manual by employee	3,1	5
7	bottle closure	manual by employee	2,4	6
8	adhesive label installation process	manual by employee	1,95	7, 10
9	Labeling and quality checking	manual by employee	2,1	8, 11
10	mounting stickers on cardboard packing	manual by employee	1,08	-
11	Cardboard folding	manual by employee	3,3	-
12	Product packing	manual by employee	3,35	9, 11

The following is a sequence of precedence diagrams in the production process of powder fertilizer at PT. Centra Biotech Indonesia.

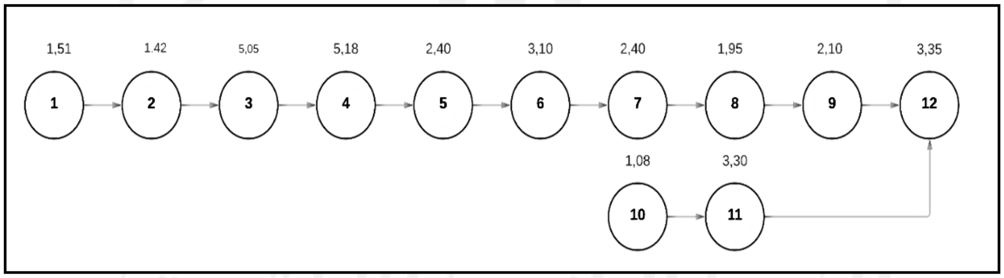


Figure 4.0.9 Liquid Fertilizer Precedence Diagram

4.1.11. Production Demand

PT. Centra Biotech Indonesia in carrying out its activities uses the Make To Order (MTO) production type where the company carries out the production process according to the number of products ordered by the customer each month, this makes the number of products produced by the company always change every month.

The following is data on the number of products that have been produced by PT. Centra Biotech Indonesia starting from January 2020 to December 2020.

Table 4.0.7 Production data in 2020

Product Type	Product Category	JAN	FEB	MAR	APR	MAY	JUN	JUL	AGS	SEP	OCT	NOV	DEC	TOTAL
Agriculture	Liquid products	828	515	1371	2503	1536	446	353	503	490	1355	994	107073	117967
	Powder products	642	875	49413	48782	25585	2299	2605	2679	74454	65699	25262	5214	303509
Livestock	Liquid products	377	448	307	102	128	286	215	225	115	142	254	121	2720
	Powder products	1901	8043	2366	7108	2638	3824	2593	2953	1243	2872	2924	2575	41040
Fishery	Liquid products	12	708	0	0	0	0	48	60	199	248	1893	292	3460
	Powder products	0	25	0	-	50	-	-	-	2	170	235	101	583

The following is the total number of products produced by PT. Centra Biotech Indonesia in the 2020 period, it can be seen in the table below that the total number of products in each category is 469,279 units.

Table 4.0.8 Total Production in 2020

Product Category	Liquid	Powder	Production units
Fishery	3.460	583	4.043
Agriculture	117.967	303.509	421.476
Livestock	2.720	41.040	43.760
TOTAL			469.279 Units

4.1.12. Waste activities

In this stage, the identification of waste aims to determine the wastes that occur during the production process of biological fertilizers at PT. Centra Biotech Indonesia in determining this waste will be categorized based on nine wastes according to (Mostafa, 2015), namely defects, overproduction, waiting, non-utilized talent, transportation, motion wasted, extra-processing, and environmental waste. The identification of waste in this research is focused on the production process of liquid biological fertilizers and powdered biological fertilizers, which are divided into five core processes, namely media preparation, bacterial culture, product filling, quality checking and packaging.

Table 4.0.9 Waste activities

No.	Waste Type	Waste description
1	Defects	contaminated bacteria there is gas in the bottle and the seal is broken
2	Overproduction	-
3	Waiting	dryer preparation and packaging filling mixing reservoir
4	Non-Utilized Employee	labeling process waiting for exact orders per period
5	Transportation	Kaolin media transfer on milling machine transfer of finished products to warehouse
6	Inventory Excess	Long Material Handling packaging bottle storage excess packing cardboard product arrangement in warehouse
7	Motion Waste	repetitive maintenance filling machine
8	Extra Processing	process of refreshing bacteria periodic bacterial checks
9	Environmental Waste	milling machine maintenance lubrication on packaging machines

4.1.13. Production Layout

The following is the layout of the biological fertilizer production line at PT. Centra Biotech Indonesia:

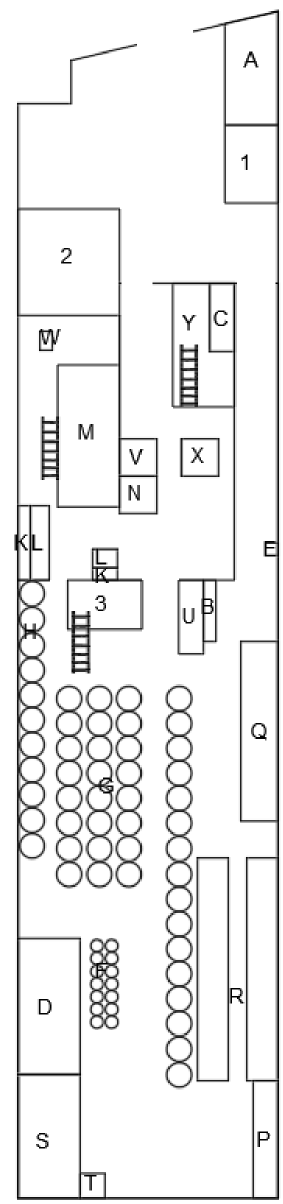


Figure 4.0.10 Initial Layout

Table 4.0.10 Workstation Code

No.	Workstation	Code
1	Bacterial laboratory	A
2	Raw Material Storage	B
3	Cooking Room	D
4	Water sources	E
5	Bacteria Culture Room	G
6	Mixing reservoir	H
7	Filing Station	K
8	Temporary Storage of Liquid Fertilizer Products	M
9	Bottle Closing Station	N
10	Spraying and Drying Station	R
11	Refining Station	S
12	Powder Fertilizer Packing Station	U
13	Packing Station	X
14	Finished Material Warehouse	Y
15	Employee parking	1
16	Office	2
17	Toilet and kitchen	3

The production process begins with taking raw materials for bacteria in the laboratory. Then the process is carried out sequentially from the bacterial media, bacterial culture, bottle filling, QC, and packaging. Finally, the finished product is stored in the output storage area.

Table 4.0.11 Initial Layout areas

No.	Department	Code	Length	Wide	Width (m2)
1	Bacterial laboratory	A	8.4	4.22	35.45
2	Raw Material Storage	B	3.3	1.5	4.95
3	Cooking Room	D	12.5	6.2	77.50
4	Water sources	E	0.3	0.7	0.21
5	Bacteria Culture Room	G	60	13.5	810.00
6	Mixing reservoir	H	70.7	3.6	254.52

No.	Department	Code	Length	Wide	Width (m2)
7	Filing Station	K	2.2	2.5	5.50
8	Temporary Storage of Liquid Fertilizer Products	M	7.1	5.7	40.47
9	Bottle Closing Station	N	2.4	2.4	5.76
10	Spraying and Drying Station	R	30.4	4.2	127.68
11	Refining Station	S	10.6	6.4	67.84
12	Powder Fertilizer Packing Station	U	4.2	2.32	9.74
13	Packing Station	X	1.8	2.13	3.83
14	Finished Material Warehouse	Y	13.21	3.45	45.57

4.1.14. Frequency of initial Material Handling

During the observation, the researcher carried out two different product categories processes, namely powder fertilizer and liquid fertilizer.

The following is a material handling frequency table of the entire production process at PT. Centra Biotech Indonesia

Table 4.0.12 Product Frequency of Material Handling

No	FROM	TO	Frequency
1	Bacterial laboratory	Bacteria Culture Room	1
2	Raw Material Storage	Cooking Room	10
3	Cooking Room	Bacteria Culture Room	1
4	Water sources	Bacteria Culture Room	1
5	Bacteria Culture Room	Mixing reservoir	1
6	Mixing reservoir	Filing Station	1
7	Filing Station	Temporary Storage of Liquid Fertilizer Products	480

8	Temporary Storage of Liquid Fertilizer Products	Bottle Closing Station	480
9	Bottle Closing Station	Packing Station	40
10	Spraying and Drying Station	Refining Station	10
11	Refining Station	Powder Fertilizer Packing Station	10
12	Powder Fertilizer Packing Station	Packing Station	10
13	Packing Station	Finished Material Warehouse	27

4.1.15. Initial Layout Material Handling

This section will present data regarding the calculation of Production Traveling Distance on the initial layout of facilities in the production area.

The measurement of the rectilinear distance that must be done is to determine the coordinates of each work station. Table 4.13 shows the Work Station Coordinate Points.

Table 4.0.13 Initial Layout Coordinate

No	Workstation	Coordinate	
		X	Y
1	Bacterial laboratory	69	141
2	Raw Material Storage	70	55
3	Cooking Room	52.3	66
4	Water sources	70.5	102
5	Bacteria Culture Room	56.6	84
6	Mixing reservoir	51.2	89.6
7	Filing Station	50.5	103
8	Temporary Storage of Liquid Fertilizer Products	55.6	112
9	Bottle Closing Station	60	107
10	Spraying and Drying Station	67.7	68.9
11	Refining Station	52.7	54.8
12	Powder Fertilizer Packing Station	64.1	97.3
13	Packing Station	64.6	110
14	Finished Material Warehouse	64.5	121

After obtaining the coordinates at each workstation, the Material Handling of each workstation is calculated on the corresponding initial layout, using the rectilinear formula, namely:

$$d_{ij} = |X_i - X_j| + |Y_i - Y_j|$$

As an example of a calculation, the coordinates of the work station from the laboratory (69;141) to the Bacteria culture Room (56.6;84) work station can be calculated using a rectilinear formula, so that the distance between the Laboratory work station and the Bacteria culture room work station is 69.4 meters. The complete calculation results for all workstations can be seen in Table 4.14.

Table 4.0.14 Initial layout distance

No	FROM	TO	Distance (Meters)
1	Bacterial laboratory	Bacteria Culture Room	69.4
2	Raw Material Storage	Cooking Room	6.7
3	Cooking Room	Bacteria Culture Room	22.3
4	Water sources	Bacteria Culture Room	32.3
5	Bacteria Culture Room	Mixing reservoir	0.2
6	Mixing reservoir	Filing Station	12.9
7	Filing Station	Temporary Storage of Liquid Fertilizer Products	14.2
8	Temporary Storage of Liquid Fertilizer Products	Bottle Closing Station	1.1
9	Bottle Closing Station	Packing Station	7.6
10	Spraying and Drying Station	Refining Station	29.1
11	Refining Station	Powder Fertilizer Packing Station	53.9
12	Powder Fertilizer Packing Station	Packing Station	12.5
13	Packing Station	Finished Material Warehouse	11.5

The Traveling Distance of Material Handling is measured by multiplying the material handling frequency. The following is a measurement of the Traveling Distance of Material Handling in the initial layout.

Table 4.0.15 Initial Traveling distance

No	FROM	TO	Distance	Frequency	Traveling Distance of Material Handling
1	Bacterial laboratory	Bacteria Culture Room	69.4	1	69.4
2	Raw Material Storage	Cooking Room	6.7	10	67
3	Cooking Room	Bacteria Culture Room	22.3	1	22.3
4	Water sources	Bacteria Culture Room	32.3	1	32.3
5	Bacteria Culture Room	Mixing reservoir	0.2	1	0.2
6	Mixing reservoir	Filing Station	12.9	1	12.9
7	Filing Station	Temporary Storage of Liquid Fertilizer Products	14.2	480	6816
8	Temporary Storage of Liquid Fertilizer Products	Bottle Closing Station	1.1	480	528
9	Bottle Closing Station	Packing Station	7.6	40	304
10	Spraying and Drying Station	Refining Station	29.1	10	291
11	Refining Station	Powder Fertilizer Packing Station	53.9	10	539
12	Powder Fertilizer Packing Station	Packing Station	12.5	10	125
13	Packing Station	Finished Material Warehouse	11.5	27	310.5
				TOTAL	9117.6

4.1.16. Activity Relationship Chart

Activity Relationship Chart is the activity relationship between each part that illustrates the importance of the closeness between activities. In other words, Activity Relationship Chart (ARC) is a map compiled to determine the level of relationship between activities that occur in each area with one another. This diagram aims to link activities in pairs so that each activity can be identified the level of importance of the relationship and can help to determine the placement of each facility. The following is an Activity Relationship Chart diagram for each facility in the company. The following ARC results are obtained from the results of the questionnaire filled in by the Production Manager at PT. Centra Biotech Indonesia.

Table 4.0.16 ARC data Collection

Workstations	Laboratory	Mat Storage	Cooking Room	Water sources	Bacteria Room	Mixing	Filing	Temporary Storage	Bottle Closing	S&D Station	Refining	Powder Packing	Packing Station	Material Warehouse
Laboratory		U	X	O	U	U	U	0	O	U	U	U	U	U
Mat Storage	U		A	U	U	U	U	U	U	U	U	U	U	U
Cooking Room	X	A		E	O	O	U	U	U	U	U	X	U	X
Water sources	O	U	E		I	O	O	O	O	U	U	U	O	O
Bacteria Room	U	U	O	I		E	O	U	O	U	U	U	O	U
Mixing	U	U	O	O	E		O	U	O	U	U	O	O	U
Filing	U	U	U	O	O	O		I	O	U	U	U	O	O
Temporary Storage	0	U	U	O	U	U	I		A	U	U	U	O	O
Bottle Closing	O	U	U	O	O	O	O	A		U	U	U	O	O
S&D Station	U	U	U	U	U	U	U	U	U		A	O	U	U
Refining	U	U	U	U	U	U	U	U	U	A		I	U	U
Powder Packing	U	U	X	U	U	O	U	U	U	O	I		E	U
Packing Station	U	U	U	O	O	O	O	O	O	U	U	E		E
Material Warehouse	U	U	X	O	U	U	O	O	O	U	U	U	E	

4.2. Data Processing

Data processing describes the data that has been obtained based on direct observation activities and interviews with PT. Centra Biotech Indonesia. The data processing is carried out after all the required data has been met such as production process activities, weighting on the Activity Relationship Chart (ARC), and initial layout conditions.

4.2.1. Value Stream Mapping

The first stage in value stream mapping is the preparation of a state map. Analyzing the flow of material in its current state will provide an overview and information about the current process and state. Value stream refers to all activities (value-added activities and non-value-added ones) that are essential to produce a certain product through the implementation of three critical management skills, i.e., information management, problem-solving, and physical transformation. VSM helps the managers in differentiating value-added from non-value-added activities; also, it can be applied as a strategic tool for decision making applicable to redesigning processes and improving them continuously (Seyed Mojib Zahraee, 2020).

The information obtained on the map of the state of biological fertilizer production is Cycle Time, Available Time, and Upper Time.

Table 4.0.17 Value Stream Mapping Liquid Fertilizer product

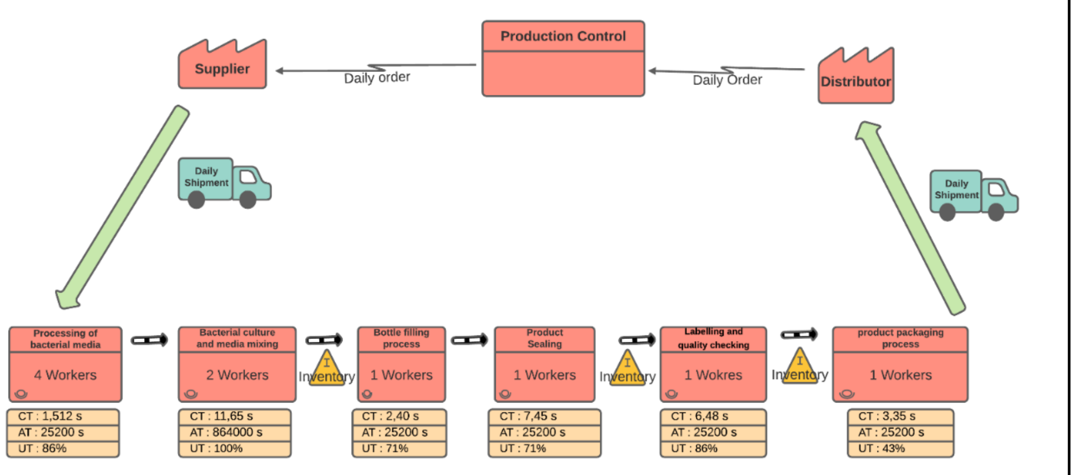


Table 4.0.18 Value Stream Mapping Powder Fertilizer product

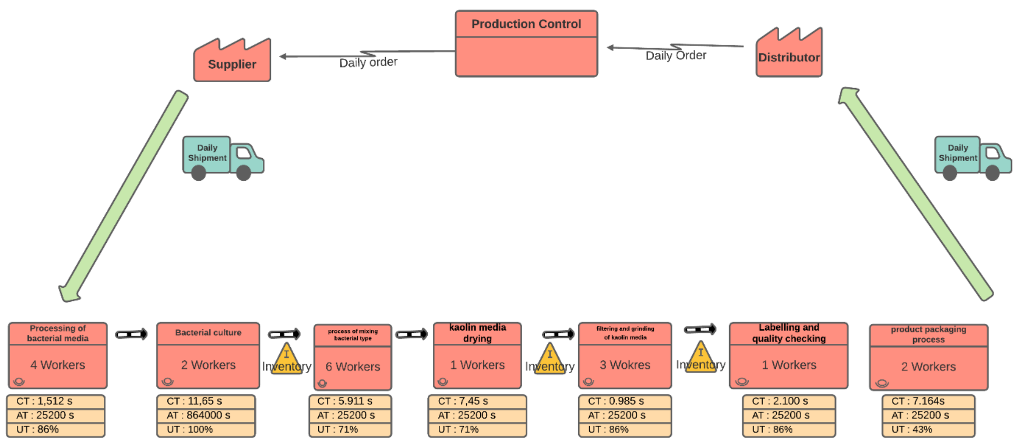


Table 4.0.19 Value Stream Mapping Table

OP	: Operation Time
CT	: Cycle Time
AT	: Available Time
UT	: Upper Time
Maks Inventory	: 185.200 unit
Maks water container	: 575.000 Liters

The picture above illustrates the initial conditions of the production process at PT. Centra Biotech Indonesia. Based on the picture above, information is obtained that in the production process of 1 piece of the liquid product has a Cycle Time of 32.84 seconds and in the production process of one powdered product has an average Cycle Time of 24.07 seconds.

4.2.2. Waste Processing

After obtaining all activities which are Waste in the data collection process at PT. Centra Biotech Indonesia, then the next step is to select the most influential Waste activities in the company, affect the material handling flow and can be solved using the facility layout design method. The following is a Waste activity selected by the researcher.

Table 4.0.20 Transportation Waste

Waste Category	Description
Transportation	In production activities, there is a category of waste in material transportation, especially in the distance between the finished product to the warehouse or storage area. This makes the production process at PT. Centra Biotech Indonesia has difficulty working optimally.

According to Damanhuri (2010), waste transport activities are one of the important components and require careful calculation where the target is to optimize the transport time required in the system. The process of costs incurred in the transport system. Inefficient routes will cause longer distances, thus a higher cost for fuel. In determining the route can affect the required haul time to the landfill. Inefficient route selection can also result in addition; the transportation process will also affect the surrounding environmental conditions, associated with exhaust emissions of waste transport vehicles. Good domestic waste transport system services with optimal routes will reduce the adverse impacts of these activities on the environment. The most significant reason for implementing network analysis and transport route planning is because businesses are interested in determining the best route to minimize cost and time (Clifford, 2008).

Transportation wastage occurs because of a poor production layout that requires moving goods from one place to another or from one process to another. The location of the warehouse that is far from production is one example of waste caused by transportation. Bringing the warehouse closer to the production area is one way to reduce this waste.

4.2.3. Activity Relationship Chart

Activity Relationship Chart is the activity relationship between each part that illustrates the importance of the closeness between activities. In other words, Activity Relationship Chart (ARC) is a map compiled to determine the level of relationship between activities that occur in each area with one another. This diagram aims to link activities in pairs so that each activity can be identified the level of importance of the relationship and can help to determine the placement of each facility. The following is an Activity Relationship Chart diagram for each facility in the company. The following ARC results are obtained from the results of the questionnaire filled in by the Production Manager at PT. Centra for Biotech Indonesia.

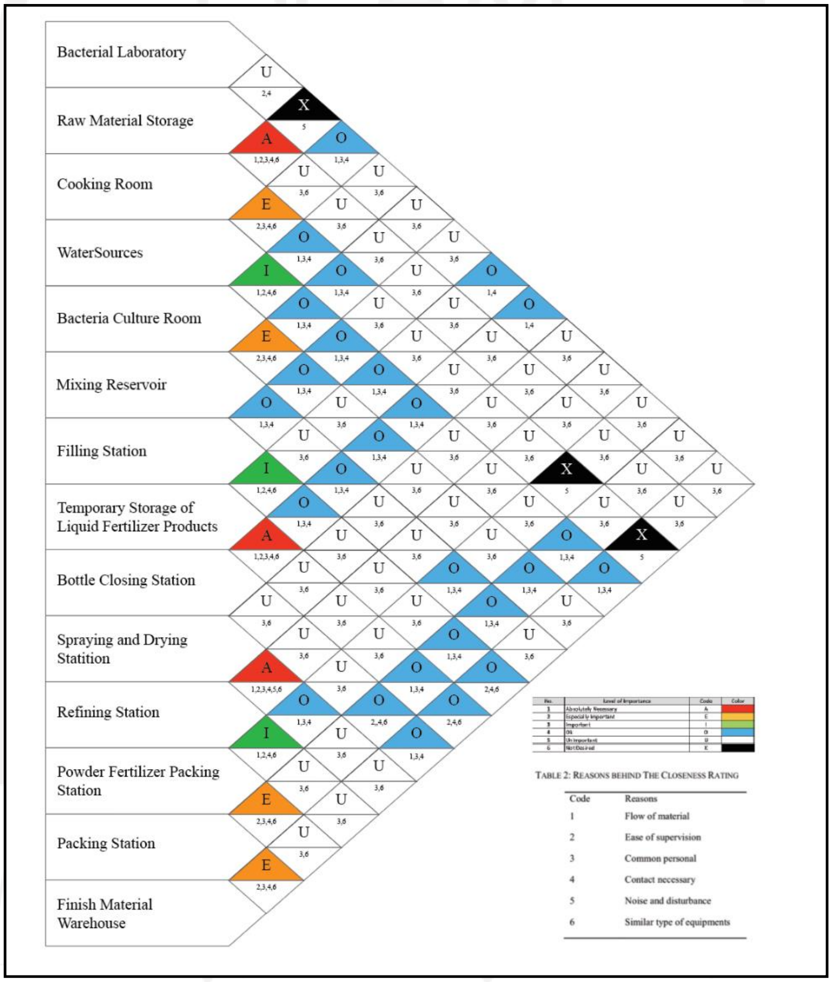


Figure 4.0.11 Activity Relationship Chart Result

4.2.4. Total Closeness Rating

Total Closeness Rating (TCR) is obtained by weighting each connection between workstations. The following are the TCR values.

Table 4.0.21 Total Closeness Rating

No.	Facilities	A	E	I	O	U	X	Total	TCR
		5	4	3	2	1	0		
1	Bacterial laboratory	0	0	0	3	9	1	13	15
2	Raw Material Storage	1	0	0	0	12	0	13	17
3	Cooking Room	1	1	0	2	6	3	13	19
4	Water sources	0	1	1	7	4	0	13	25
5	Bacteria Culture Room	0	1	1	4	7	0	13	22
6	Mixing reservoir	0	1	0	6	6	0	13	22
7	Filing Station	0	0	1	6	6	0	13	21
8	Temporary Storage of Liquid Fertilizer Products	1	0	1	4	7	0	13	23
9	Bottle Closing Station	1	0	0	7	5	0	13	24
10	Spraying and Drying Station	1	0	0	1	11	0	13	18
11	Refining Station	1	0	1	0	11	0	13	19
12	Powder Fertilizer Packing Station	0	1	1	2	8	1	13	19
13	Packing Station	0	2	0	6	5	0	13	25
14	Finished Material Warehouse	0	1	0	4	7	1	13	19

4.2.5. Layout design using BLOCPLAN

Facility layout design at PT. Centra Biotech Indonesia is carried out using the Blocplan algorithm software (Block Layout Overview with Layout Planning). This algorithm was chosen because it can analyze the problem in terms of both qualitative and quantitative terms, namely based on the frequency of material transfer and the degree of closeness between interconnected departments on the Shopfloor. So by using this algorithm, it can be considered a proposed layout that has a regular material flow with a small distance between operations so as to produce a minimum displacement moment. The main advantage of Block plan algorithm software is that it is user-friendly. This allows the user to make changes to the data that has been entered, correct the position of the department, and enter it manually to the desired location.

The following are the steps involved in performing calculations using the BLOCPLAN algorithm.

1) Added the number of workstations, the area of the workstation, and the name of each workstation.

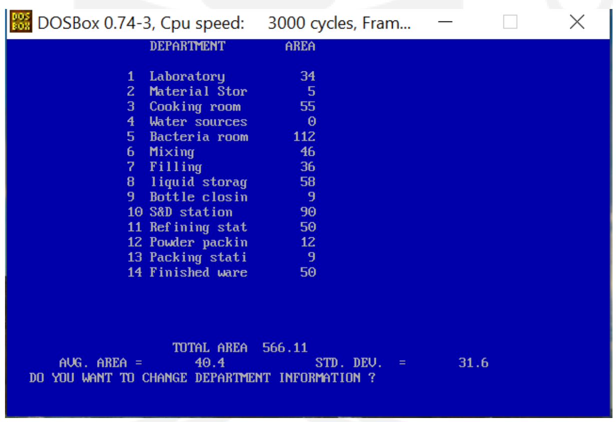


Figure 4.0.12 Workstation BLOCPLAN input

2) Input the value of the Activity Relationship Chart (ARC) that has been obtained in the data collection process.

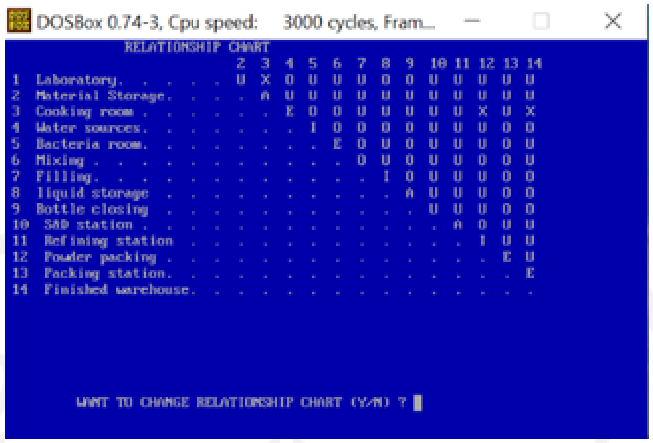


Figure 4.0.13 ARC input using BLOCPLAN

3) Adjusting the layout so that it can be applied by the company.

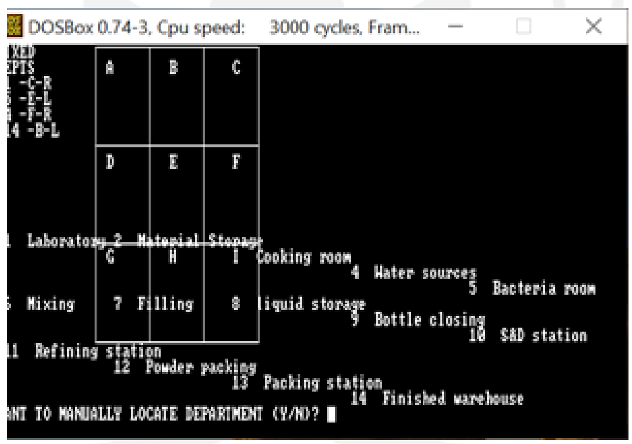
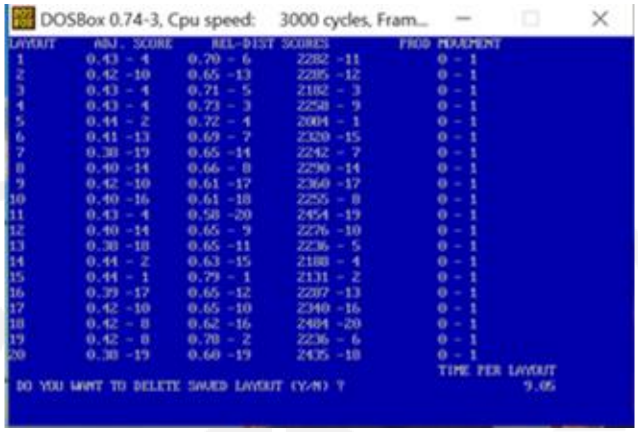


Figure 4.0.14 Adjusting proposed layout

4) Selecting the best layout iteration which are number 15, because it has the most optimal value compared to other layout iterations.



DOSBox 0.74-3, Cpu speed: 3000 cycles, Fram...

LAYOUT	ADJ. SCORE	REL-DIST	SCORES	PROD MOVEMENT
1	0.43 - 4	0.70 - 6	2282 -11	0 - 1
2	0.42 -10	0.65 -13	2285 -12	0 - 1
3	0.43 - 4	0.71 - 5	2182 - 3	0 - 1
4	0.43 - 4	0.73 - 3	2258 - 9	0 - 1
5	0.44 - 2	0.72 - 4	2004 - 1	0 - 1
6	0.41 -13	0.69 - 7	2320 -15	0 - 1
7	0.38 -19	0.65 -14	2242 - 7	0 - 1
8	0.40 -14	0.66 - 8	2290 -14	0 - 1
9	0.42 -10	0.61 -17	2360 -17	0 - 1
10	0.40 -16	0.61 -18	2255 - 8	0 - 1
11	0.43 - 4	0.58 -20	2454 -19	0 - 1
12	0.40 -14	0.65 - 9	2276 -10	0 - 1
13	0.38 -18	0.65 -11	2236 - 5	0 - 1
14	0.44 - 2	0.63 -15	2188 - 4	0 - 1
15	0.44 - 1	0.79 - 1	2131 - 2	0 - 1
16	0.39 -17	0.65 -12	2287 -13	0 - 1
17	0.42 -10	0.65 -10	2340 -16	0 - 1
18	0.42 - 8	0.62 -16	2484 -20	0 - 1
19	0.42 - 8	0.78 - 2	2236 - 6	0 - 1
20	0.38 -19	0.60 -19	2435 -18	0 - 1

TIME PER LAYOUT
9.05
DO YOU WANT TO DELETE SAVED LAYOUT (Y/N) ?

Figure 4.0.15 Proposed layout iteration

4.2.6. Design Proposed Layout

After selecting the layout with the best iteration value on the BLOCPLAN algorithm, the next step is to design the proposed layout by considering the calculations from the BLOCPLAN algorithm.

The following are the layout calculation in the 15th iteration.

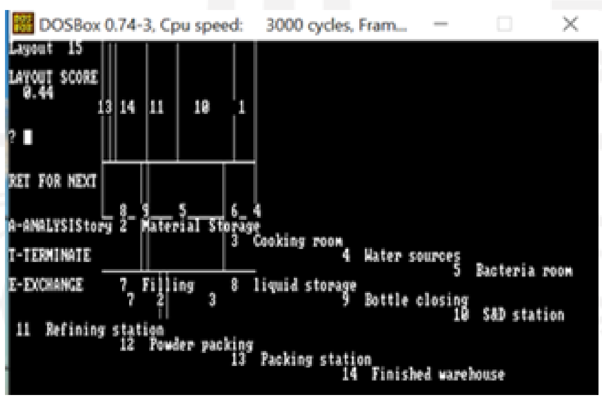


Figure 4.0.16 Layout analysis number-15

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The following is a visualization of the proposed layout using AutoCAD2021 software.

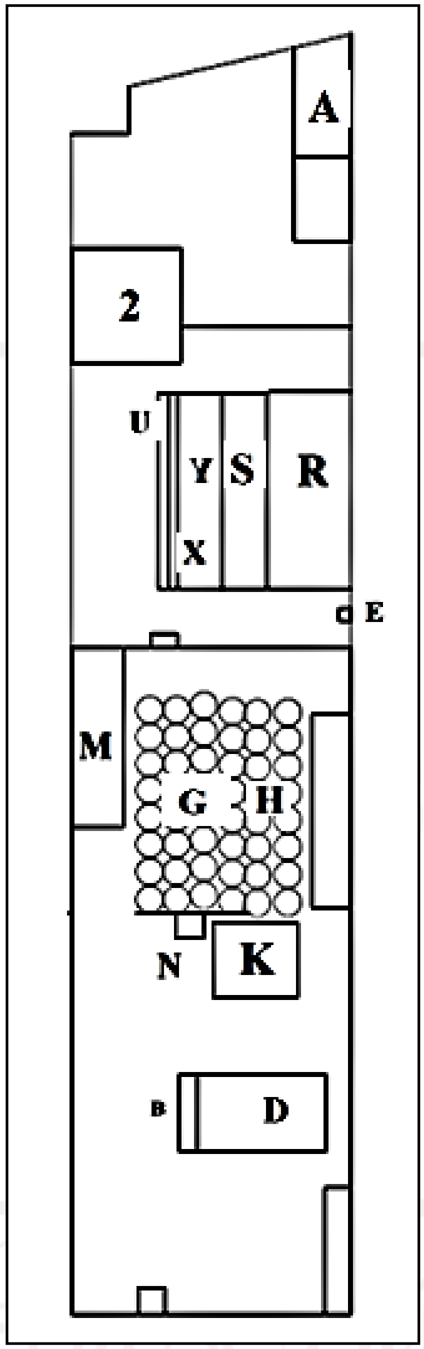

Figure 4.0.17 Proposed Layout

4.2.7. Layout distance calculation

After obtaining the coordinates on the proposed layout of each workstation, the next step is to calculate the Material Handling between the related Proposed layout departments, using the rectilinear formula.

As an example of a calculation, the coordinates of a workstation from the laboratory (68.9;142) to the Bacteria culture Room (58.9;87.6) work station can be calculated using a rectilinear formula, so that the distance between the Laboratory work station and the Bacteria culture room work station is 63.9 meters. The complete calculation results for all workstations can be seen in Table 23.

Table 4.0.22 coordinates of Proposed Layout

No	Workstation	Coordinate	
		X	Y
1	Bacterial laboratory	68.9	142
2	Raw Material Storage	58.7	65.4
3	Cooking Room	64.4	65.4
4	Water sources	70.5	103
5	Bacteria Culture Room	58.9	87.6
6	Mixing reservoir	64.9	87.6
7	Filing Station	63.9	76.8
8	Temporary Storage of Liquid Fertilizer Products	51.8	93.3
9	Bottle Closing Station	59	80
10	Spraying and Drying Station	67.8	112
11	Refining Station	63	112
12	Powder Fertilizer Packing Station	56.8	112
13	Packing Station	57.6	112
14	Finished Material Warehouse	59.5	112

Furthermore, the calculation of the Traveling Distance of Material Handling is carried out by multiplying it by the frequency of material handling. The following is the measurement of the Traveling Distance of Material Handling in the initial layout.

Table 4.0.23 Distance and Traveling Distance of Proposed Layout

No	FROM	TO	Distance	Frequency	Traveling Distance
1	Bacterial laboratory	Bacteria Culture Room	63.9	1	63.9
2	Raw Material Storage	Cooking Room	5.7	10	57
3	Cooking Room	Bacteria Culture Room	16.7	1	16.7
4	Water sources	Bacteria Culture Room	26.5	1	26.5
5	Bacteria Culture Room	Mixing reservoir	6	1	6
6	Mixing reservoir	Filing Station	11.8	1	11.8
7	Filing Station	Temporary Storage of Liquid Fertilizer Products	4.4	480	2112
8	Temporary Storage of Liquid Fertilizer Products	Bottle Closing Station	6.1	480	2928
9	Bottle Closing Station	Packing Station	30.9	40	1236
10	Spraying and Drying Station	Refining Station	4.8	10	48
11	Refining Station	Powder Fertilizer Packing Station	6.2	10	62
12	Powder Fertilizer Packing Station	Packing Station	0.8	10	8
13	Packing Station	Finished Material Warehouse	1.9	27	51.3
TOTAL			185.7	1072	6627.2

CHAPTER V
DISCUSSION

5.1 Analysis of Value Stream Mapping and Waste activity

This stage describes the analysis of Value Stream Mapping and Waste Activities that have been processed by researchers. Analyzing the flow of material in its current state will provide an overview and information about the current process and state. Value stream refers to all activities (value-added activities and non-value-added) that are essential to produce a certain product through the implementation of three critical management skills, i.e., information management, problem-solving, and physical transformation.

Based on the Value Stream Mapping that has been made, it was found that the production process at PT. Centra Biotech Indonesia has two product categories, namely, liquid biofertilizer products and powdered biofertilizer products. For Liquid product, it has the average Cycle time of 32.84 seconds per product and for Powder product has an average Cycle time of 24.07 seconds per product.

In addition, several activities fall into the waste category and the researcher focuses on overcoming the waste category in transportation activities. This is done because transportation activities have a direct impact on the production flow and the layout of the facility, so that waste can be overcome by making a proposal for the layout design of existing facilities at PT. Centra Biotech Indonesia.

5.2 Analysis BLOCPLAN layout design

The design of the proposed facility layout at PT. Centra Biotech Indonesia uses the BLOCPLAN algorithm to be able to provide the best layout proposal based on the number and area of workstations, as well as weighting with the Activity Relationship Chart (ARC).

In the analysis process, there are a total of 20 iterations of the layout displayed by the BLOCPLAN algorithm along with the R-score, adjacency score, and rel-dist score in each iteration. The next step is to choose the 15th layout iteration because it has the highest R-score and Adjacency score, which means that the iteration is the most optimal for layout proposals to PT. Centra Biotech Indonesia.

In addition, the BLOCPLAN algorithm also produces an analysis of the relationship between the ARC value and the suitability of the selected layout. The following is the analysis of the ARC relationship by the BLOCPLAN algorithm.

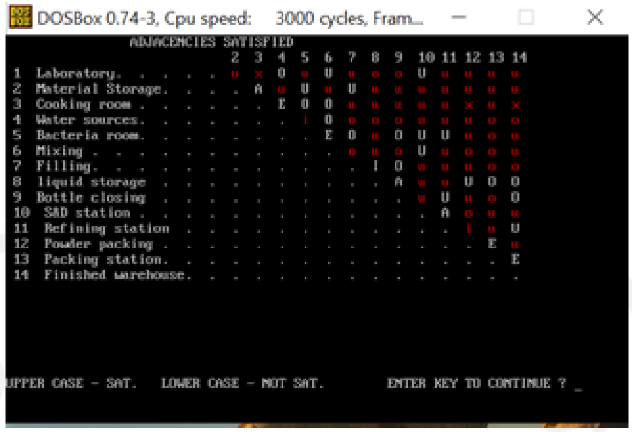

Figure 5.1 ARC Analysis using BLOCPLAN

It can be seen from the ARC figure above, that there are several relationships on each workstation that are not in accordance with the level of proximity to the Activity Relationship Chart (ARC) obtained by the researcher, this can be a consideration for the company to evaluate the close relationship between the required Workstations.

5.3 Analysis of proposed facility layout

The analysis of the proposed facility layout in this study has a focus only on reducing the distance of transportation waste activities that exist at PT. Centra Biotech Indonesia by using the BLOCPLAN algorithm, so in this study, there is a part that must be carried out in calculating the costs incurred in implementing the proposed new facility layout.

Based on calculations using the BLOCPLAN algorithm, a visualization of the proposed facility layout is made using AutoCAD 2021 software. Layout visualization using AutoCAD 2021 software to be able to adjust the calculations on the BLOCPLAN algorithm with the layout conditions proposed to PT. Centra Biotech Indonesia by considering the area of the current factory layout. After that, the Material Handling calculation for the proposed layout using the rectilinear method is 185.7 meters and the Traveling Distance of Material Handling is 6627.2 meters.

5.4 Analysis of layout distance

The layout distance analysis in this study uses the rectilinear distance calculation method. Rectilinear distance measurement is often used because it is easy to calculate, easy to understand and for some problems it is more suitable, for example to determine the distance between cities, the distance between facilities where material transfer equipment can only move perpendicularly. Calculations using this rectilinear distance are carried out in order to determine the level of distance reduction at each facility after the design of the proposed new facility layout with the BLOCPLAN algorithm.

The following is a comparative analysis between the initial layout and the proposed layout.

Table 5.1 Comparison Analysis

Comparison	Total Distance (meters)	Total Traveling Distance (meters)
Initial Layout (meters)	273.7	9117.6
Proposed Layout (meters)	185.7	6627.2
Difference (meters)	88	2490.4
Percentage (%)	32%	27%

Based on the comparison analysis above, it can be seen that the Total Distance for each Workstation between the Initial Layout and Proposed Layout has a difference of 32%, and in the Total Traveling Distance of Material Handling, there is a difference of 27%.

CHAPTER VI

CONCLUSIONS AND SUGGESTIONS

Based on the results of data processing, it can be concluded that Waste activities that have a direct impact on the material handling flow are in the Transportation Waste category, namely the distance between workstations. Furthermore, to reduce the distance, a redesign of the facility layout at PT. Centra Biotech Indonesia uses the BLOCPLAN algorithm to select the layout iteration with the most optimal R-score values, Adjacency scores, and Rail-dist scores.

After calculating the BLOCPLAN algorithm, visualization of the proposed layout is carried out to be able to find out the proposed layout pattern, the distance between workstations, and the Traveling Distance of Material Handling in the proposed layout. Based on data analysis, it can be concluded that the proposed layout can reduce the distance between workstations by 32% and Traveling Distance of Material Handling by 27%. This indicates that the layout of the proposal can be applied at PT. Centra Biotech Indonesia because it can decrease 32% Waste of Transportation needed to transfer Material handling and distance for each workstation.

Suggestions for improvement related to the problems discussed in this report are as follows:

1. PT. Centra Biotech Indonesia is advised to apply a new design of the facility layout to reduce the Distance for each Workstation that currently exists based on rectilinear distance measurement.
2. This study focuses only on waste activities that occur in the company PT. Centra Biotech Indonesia and the proposed facility layout design for calculating the distance between workstations, so the authors suggest for other parties to calculate the cost requirements in designing the proposed facility layout. This is needed in order to overcome problems in implementing the new facility layout.
3. This study requires further research by conducting a simulation method of the proposed facility layout to be able to determine the value of productivity and the number of products specifically that will be produced by the company PT. Centra Biotech Indonesia when implementing the proposed facility layout designed by the researcher.

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APPENDIX

	PT. CENTRA BIOTECH INDONESIA Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah	No. Dok.	001/RNP/CBI/IV/2021
		Tgl. Terbit	1 April 2021
		Revisi	00
	RINCIAN NAMA PRODUK **PUPUK HAYATI "PERTANIAN"**	Tgl. Revisi	00
		Halaman	1 dari 1
		Disahkan	

No.	**Nama Produk**		**Sediaan Produk**		**No.**	**Nama Produk**	**Sediaan Produk**	
			Liquid	**Powder**			**Liquid**	**Powder**
1	FloraOne		√	√				
2	FloraOne	Bawang	√	√				
3	FloraOne	Bawang Merah	√	√				
4	FloraOne	Beve-Z	√	√				
5	FloraOne	Biolada	√	–				
6	FloraOne	Botani	√	–				
7	FloraOne	Cabe	√	–				
8	FloraOne	Decomposer	√	√				
9	FloraOne	Deka	√	–				
10	FloraOne	Hamalada	√	–				
11	FloraOne	Hormon	√	–				
12	FloraOne	Jagung	√	√				
13	FloraOne	Jannet	–	√				
14	FloraOne	K+	√	–				
15	FloraOne	Kedelai	√	–				
16	FloraOne	KTT	√	–				
17	FloraOne	Lanasid	√	–				
18	FloraOne	MST	√	–				
19	FloraOne	Multi GIB	√	–				
20	FloraOne	P+	√	–				
21	FloraOne	Padi	√	√				
22	FloraOne	PGPR	√	–				
23	FloraOne	POC	√	–				
24	FloraOne	Power	–	√				
25	FloraOne	Protector	√	√				
26	FloraOne	Rizobium	√	√				
27	FloraOne	Sawit	√	√				
28	FloraOne	Seed	–	√				
29	FloraOne	Soyaku	–	√				
30	FloraOne	Super KT	√	–				
31	FloraOne	Symbios	–	√				
32	FloraOne	Tricoderma	√	√				
33	FloraOne	Tricolada	√	–				
34	FloraOne	Tricotech	√	–				
35	FloraOne	Trico Z	–	√				
35	FloraOne	Glio-Z	–	√				
35	FloraOne	Tebu	√	√				
35	FloraOne	E-Tuntas	√	–				
35	FloraOne	Bulai	√	–				

Appendix 1

	PT. CENTRA BIOTECH INDONESIA Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah	No. Dok.	002/RNP/CBI/IV/2021
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		Revisi	00
	RINCIAN NAMA PRODUK PROBIOTIK "PETERNAKAN"	Tgl. Revisi	00
		Halaman	1 dari 1
		Disahkan	

No.	Nama Produk		Sediaan Produk		No.	Nama Produk	Sediaan Produk	
			Liquid	Powder			Liquid	Powder
1	BioOne	Bio Bats	√	√				
2	BioOne	Bio Enzyme	√	√				
3	BioOne	Bio Killer	–	√				
4	BioOne	Bio Larva	–	√				
5	BioOne	Bio Monkey	–	√				
6	BioOne	Bio Protector	√	–				
7	BioOne	Bio Protector Forte	–	√				
8	BioOne	Bio Satwa	√	√				
9	BioOne	Bio Poultry	√	√				
10	BioOne	Bio Ruminant	√	√				
11	BioOne	Climax	√	–				
12	BioOne	Isolat	√	√				
13	BioOne	Isolat Bioaktifator	–	√				
14	BioOne	Isolat Liquid	√	–				
15	BioOne	Jawara Breeding	√	–				
16	BioOne	Jawara Master	√	–				
17	BioOne	Jawara Medica	√	–				
18	BioOne	Jawara Probiotic	√	–				
19	BioOne	Jawara Stamina	√	–				
20	BioOne	Jawara Swot	√	–				
21	BioOne	Megabio	–	√				
22	BioOne	Megabio Ruminant	–	√				
23	BioOne	Nolat	√	–				
24	BioOne	Nutribio Poultry	√	√				
25	BioOne	Nutribio Ruminant	√	√				
26	BioOne	Taburi	–	√				
27	BioOne	Megatox	–	√				

Appendix 2

	PT. CENTRA BIOTECH INDONESIA Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah	No. Dok.	003/RNP/CBI/IV/2021
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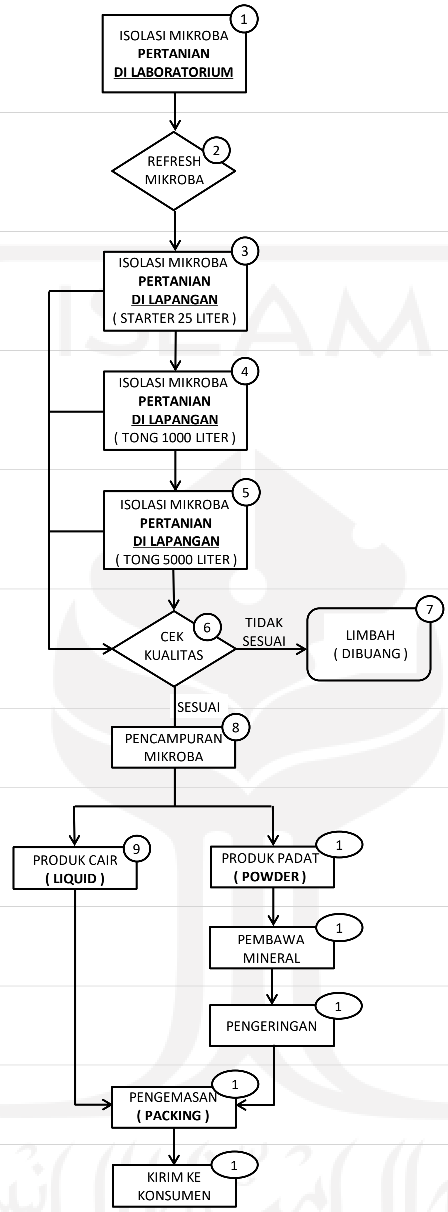
		Revisi	00
	RINCIAN NAMA PRODUK PROBIOTIK "PERIKANAN"	Tgl. Revisi	00
		Halaman	1 dari 1
		Disahkan	

No.	Nama Produk		Sediaan Produk		No.	Nama Produk	Sediaan Produk	
			Liquid	Powder			Liquid	Powder
1	BioOne	Bio Aquatic	√	√				
2	BioOne	Bio Stimulant	√	√				
3	BioOne	Aqua-Mix	√	√				
4	BioOne	RajaMina Aquatic	√	√				
5	BioOne	Rajamina Stimulant	√	√				
6	BioOne	Pro Aquatic	√	√				
7	BioOne	Pro Stimulant	√	√				

Appendix 3

	PT. CENTRA BIOTECH INDONESIA Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah	No. Dok.	001/SOP/CBI/IV/202
		Tgl. Terbit	1 April 2021
		Revisi	00
	STANDARD OPERATION PROCEDURE (SOP)	Tgl. Revisi	00
	PUPUK HAYATI "PERTANIAN"	Halaman	1 dari 1
		Disahkan	

FLOWCHART	**DESKRIPSI**



- Pupuk Hayati
- Insecticida Hayati
- Fungisida Hayati
- Bacterisida Hayati

Setiap 6-12 Bulan

Untuk Mencegah Kontaminasi Bagian Penutup Derigen Diberi Solatif dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK.

Untuk Mencegah Kontaminasi Bagian Penutup Tong Diberi Lapisan Plastik dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK.

Untuk Mencegah Kontaminasi Bagian Penutup Tong Diberi Lapisan Plastik dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK.

Cek kualitas meliputi :
- Permeriksaan Jumlah CFU
- Pemeriksaan Pencemaran

Pencampuran mikroba sesuai dengan spesifikasi jenis produk.

Jenis Sediaan Produk

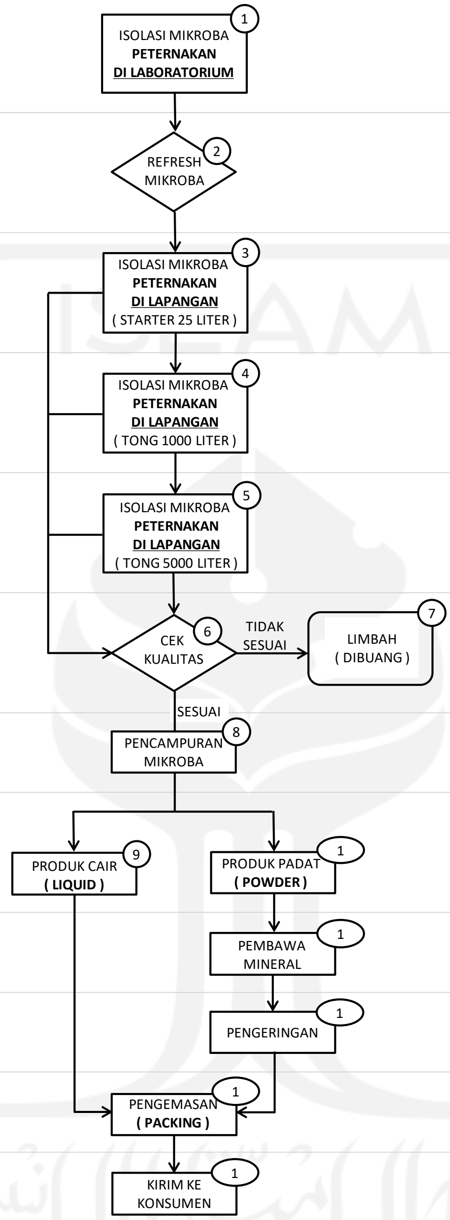
Pembawa Mineral Sebelumnya Sudah Disterilkan Dengan Menggunakan Mesin Pengering.

Pengemasan Sesuai Jenis Produk dan Permintaan Konsumen

Pengiriman Sesuai Kebutuhan Konsumen

Appendix 4

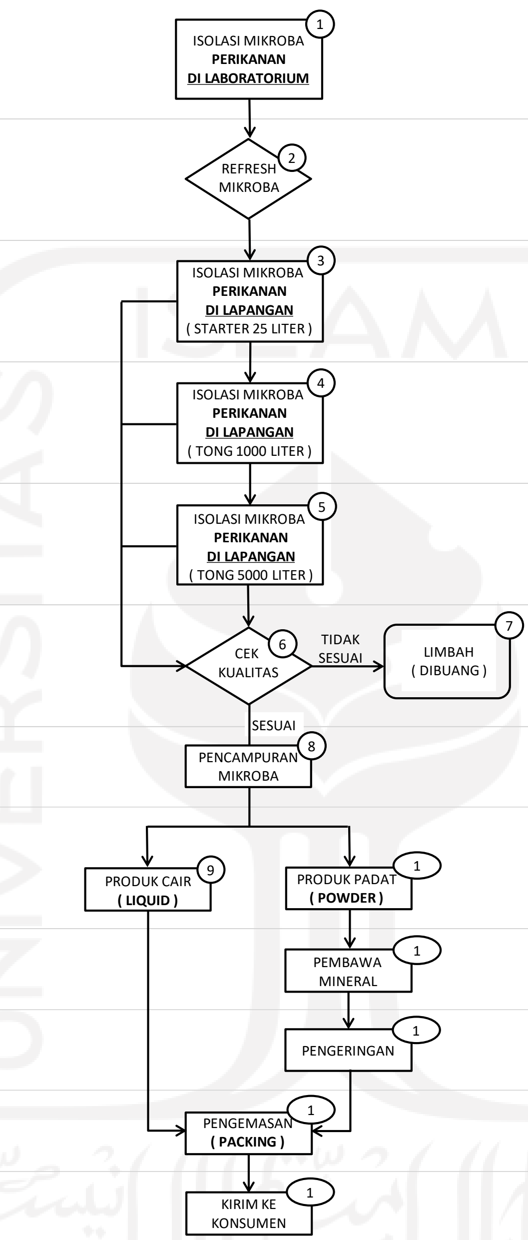
PT. CENTRA BIOTECH INDONESIA Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah	No. Dok.	002/SOP/CBI/IV/202
	Tgl. Terbit	1 April 2021
	Revisi	00
STANDARD OPERATION PROCEDURE (SOP)	Tgl. Revisi	00
	Halaman	1 dari 1
PROBIOTIK "PETERNAKAN"	Disahkan	

FLOWCHART	DESKRIPSI
	- Probiotik Unggas - Probiotik Sapi Setiap 6-12 Bulan Untuk Mencegah Kontaminasi Bagian Penutup Derigen Diberi Solatif dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK. Untuk Mencegah Kontaminasi Bagian Penutup Tong Diberi Lapisan Plastik dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK. Untuk Mencegah Kontaminasi Bagian Penutup Tong Diberi Lapisan Plastik dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK. Cek kualitas meliputi : - Permeriksaan Jumlah CFU - Pemeriksaan Pencemaran Pencampuran mikroba sesuai dengan spesifikasi jenis produk. Jenis Sediaan Produk Pembawa Mineral Sebelumnya Sudah Disterilkan Dengan Menggunakan Mesin Pengering. Pengemasan Sesuai Jenis Produk dan Permintaan Konsumen Pengiriman Sesuai Kebutuhan Konsumen

Appendix 5

	PT. CENTRA BIOTECH INDONESIA Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah	No. Dok.	003/SOP/CBI/IV/202
		Tgl. Terbit	1 April 2021
	STANDARD OPERATION PROCEDURE (SOP)	Revisi	00
		Tgl. Revisi	00
	PROBIOTIK "PERIKANAN"	Halaman	1 dari 1
		Disahkan	

FLOWCHART



DESKRIPSI

- Probiotik Udang/Ikan
- Mikroba Pengurai Kolam

Setiap 6-12 Bulan

Untuk Mencegah Kontaminasi Bagian Penutup Derigen Diberi Solatif dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK.

Untuk Mencegah Kontaminasi Bagian Penutup Tong Diberi Lapisan Plastik dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK.

Untuk Mencegah Kontaminasi Bagian Penutup Tong Diberi Lapisan Plastik dan Bagian Sirkulasi Udara Diberi Desinfektan dan Larutan PK.

Cek kualitas meliputi :
- Permeriksaan Jumlah CFU
- Pemeriksaan Pencemaran

Pencampuran mikroba sesuai dengan spesifikasi jenis produk.

Jenis Sediaan Produk

Pembawa Mineral Sebelumnya Sudah Disterilkan Dengan Menggunakan Mesin Pengering.

Pengemasan Sesuai Jenis Produk dan Permintaan Konsumen

Pengiriman Sesuai Kebutuhan Konsumen

Appendix 6

PT. CENTRA BIOTECH INDONESIA

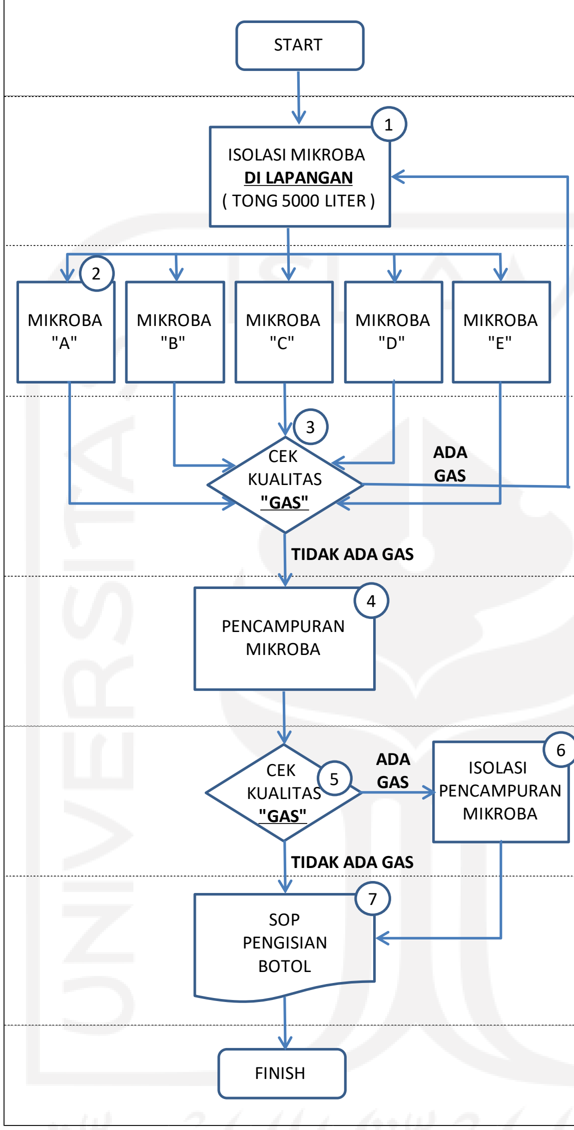
Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah

STANDARD OPERATION PROCEDURE (SOP)

KONTROL PRODUK JADI

No. Dok.	004/SOP/CBI/III/202
Tgl. Terbit	24 Maret 2021
Revisi	00
Tgl. Revisi	-
Halaman	1 dari 1
Disahkan	

FLOWCHART



Langkah	PIC	DESKRIPSI
START		
1	Leader atau P/J Isolasi Mikroba	Untuk mencegah kontaminasi bagian penutup tong diberi lapisan plastik dan bagian sirkulasi udara diberi desinfektan dan larutan PK.
2	Leader atau P/J Isolasi Mikroba	Masing-masing tong untuk isolasi mikroba berisi 1 (Satu) jenis mikroba.
3	Leader atau P/J Isolasi Mikroba	Metode pengecekan berupa pengambilan sample 1 Botol yang diisi 1 (satu) jenis mikroba yang akan dicampur kemudian ditutup seal dan dikocok-kocok. Setelah tutup seal dibuka check apakah terdapat kandungan gas.
4	Leader atau P/J Isolasi Mikroba	Pencampuran mikroba dilakukan setelah dipastikan pengecekan masing-masing jenis mikroba yang akan dicampur **TIDAK MENGANDUNG GAS.**
5, 6	Leader atau P/J Isolasi Mikroba	Metode pengecekan berupa pengambilan sample 1 (satu) Botol yang disi mikroba yang sudah dicampur kemudian ditutup seal dan dikocok-kocok.
7	Operator Pengisi Botol	Pengisian ke botol dilakukan setelah dipastikan pengecekan mikroba yang sudah dicampur **TIDAK MENGANDUNG GAS.**
FINISH		

Appendix 7

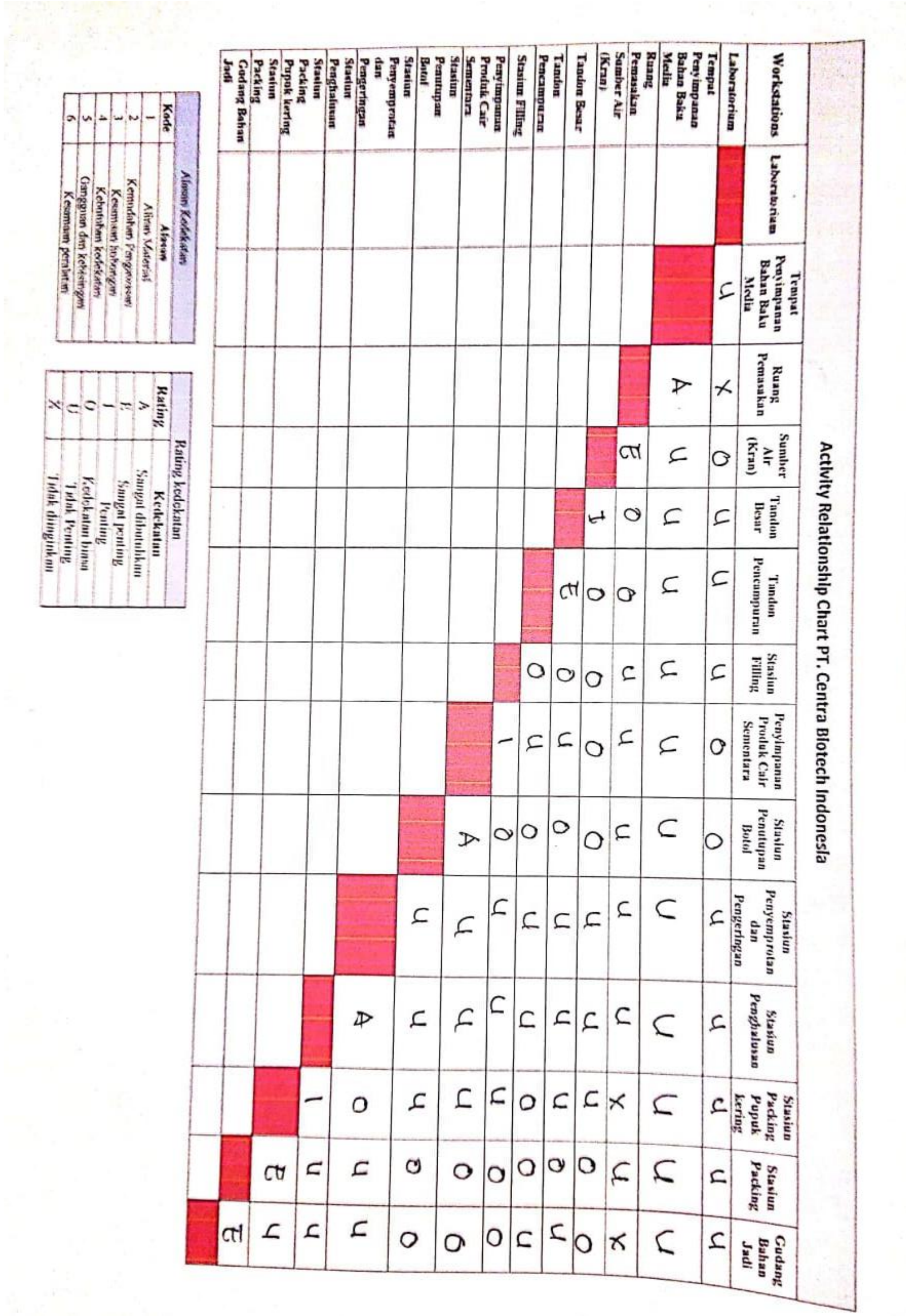
	PT. CENTRA BIOTECH INDONESIA Jl. Griya Lusah Pratama B6, Jogonalan, Klaten, Jawa Tengah	No. Dok.	005/SOP/CBI/III/2021
		Tgl. Terbit	24 Maret 2021
		Revisi	00
	STANDARD OPERATION PROCEDURE (SOP)	Tgl. Revisi	-
	"PENGISIAN BOTOL"	Halaman	1 dari 1
		Disahkan	

FLOWCHART	PIC	DESKRIPSI
START	Team	Sebelum bekerja pastikan botol, seal, lap dan peralatan lainnya sudah tersedia di area kerja.
(1) CHECK BAK TAMPUNG → ADA KONTAMINASI → (2) BAK TAMPUNG DISTERILKAN (DICUCI); TIDAK ADA KONTAMINASI	Operator Pengisi Botol	Pastikan bak tampung tidak terdapat kontaminasi. Jika terdapat kontaminasi, bak tampung disterilkan dengan cara dicuci.
(3) PASANG BOTOL KOSONG PADA KRAN YANG TERSEDIA	Operator Pengisi Botol	Pastikan selang pada kran masuk pada lubang botol dan posisinya tidak miring.
(4) ISI BAK TAMPUNG	Operator Pengisi Botol	Mengisi bak tampung dengan membuka handle pengisi bak sampai batas atas masing-masing penyekat.
(5) BUKA KRAN PENGISI BOTOL	Operator Pengisi Botol	Setelah dipastikan isi bak sudah sesuai (batas atas masing-masing penyekat), buka kran pengisi botol.
(6) TUTUP KRAN PENGISI BOTOL	Operator Pengisi Botol	Setelah dipastikan isi bak sudah terisi ke masing-masing botol atau pada kondisi tertentu tutup kran pengisi botol.
(7) TURUNKAN BOTOL YANG SUDAH TERISI	Operator Pengisi Botol	Hati-hati saat menurunkan botol yang sudah terisi untuk menghindari isi botol tumpah.
(8) PASANG BOTOL KOSONG PADA KRAN YANG TERSEDIA	Operator Pengisi Botol	Pastikan selang pada kran masuk pada lubang botol dan posisinya tidak miring.
(9) CHECK ISI/VOLUME BOTOL → TIDAK SESUAI → (1) ISI/VOLUME BOTOL DISESUAIKAN; SESUAI	Operator Penutup Seal	Pastikan isi/volume botol sesuai. Jika isi/volume botol kurang di tambah atau jika isi/volume botol lebih dikurangi.
(1) TUTUP BOTOL DENGAN SEAL	Operator Penutup Seal	Menutup botol dengan seal (tutup bagian dalam) setelah dipastikan isi/volume botol sesuai.
(1) CHECK KEBOCORAN BOTOL → ADA → (1) GANTI BOTOL / GANTI SEAL; TIDAK ADA	Operator Penutup Seal	Mengecek kesesuaian botol dengan seal setelah diisi apakah terdapat kebocoran dengan posisi botol di miringkan.
(1) AREA STOCK	Operator Penata/Penyusun Botol	Menata/menyusun botol yang sudah terisi pada area stock yang telah ditentukan.
FINISH	Team	Setelah bekerja pastikan area kerja sudah dirapikan dan dibersihkan .

Point Penting!

- Utamakan Keselamatan Kerja.
- Sebelum Meninggalkan area kerja (Istirahat, Jam Pulang, Jam Lembur) check kondisi area kerja. Pastikan kran dalam kon menutup dan dipasang botol kosong, kipas dalam kondisi mati/off dan hal lain yang berpotensi menimbulkan bahaya.

Appendix 8



Activity Relationship Chart PT. Centra Biotech Indonesia

Workstations	Laboratorium	Tempat Penyimpanan Bahan Baku Media	Ruang Pemasakan	Sumber Air (Kran)	Tandon Besar	Tandon Pencampuran	Stasiun Filling	Penyimpanan Produk Cair Sementara	Stasiun Penutupan Botol	Stasiun Penyemprotan dan Pengeringan	Stasiun Penghalusan	Stasiun Packing Pupuk kering	Stasiun Packing	Gudang Bahan Jadi
Laboratorium		U	X	O	U	U	U	O	O	U	U	U	U	U
Tempat Penyimpanan Bahan Baku Media			A	U	U	U	U	U	U	U	U	U	U	U
Ruang Pemasakan				E	O	O	U	U	U	U	U	X	U	X
Sumber Air (Kran)					I	O	O	O	O	U	U	U	O	O
Tandon Besar						E	O	U	O	U	U	U	O	U
Tandon Pencampuran							O	U	O	U	U	O	O	U
Stasiun Filling								I	O	U	U	U	O	O
Penyimpanan Produk Cair Sementara									A	U	U	U	O	O
Stasiun Penutupan Botol										U	U	U	O	O
Stasiun Penyemprotan dan Pengeringan											A	O	U	U
Stasiun Penghalusan												I	U	U
Stasiun Packing Pupuk kering													E	U
Stasiun Packing														E
Gudang Bahan Jadi														

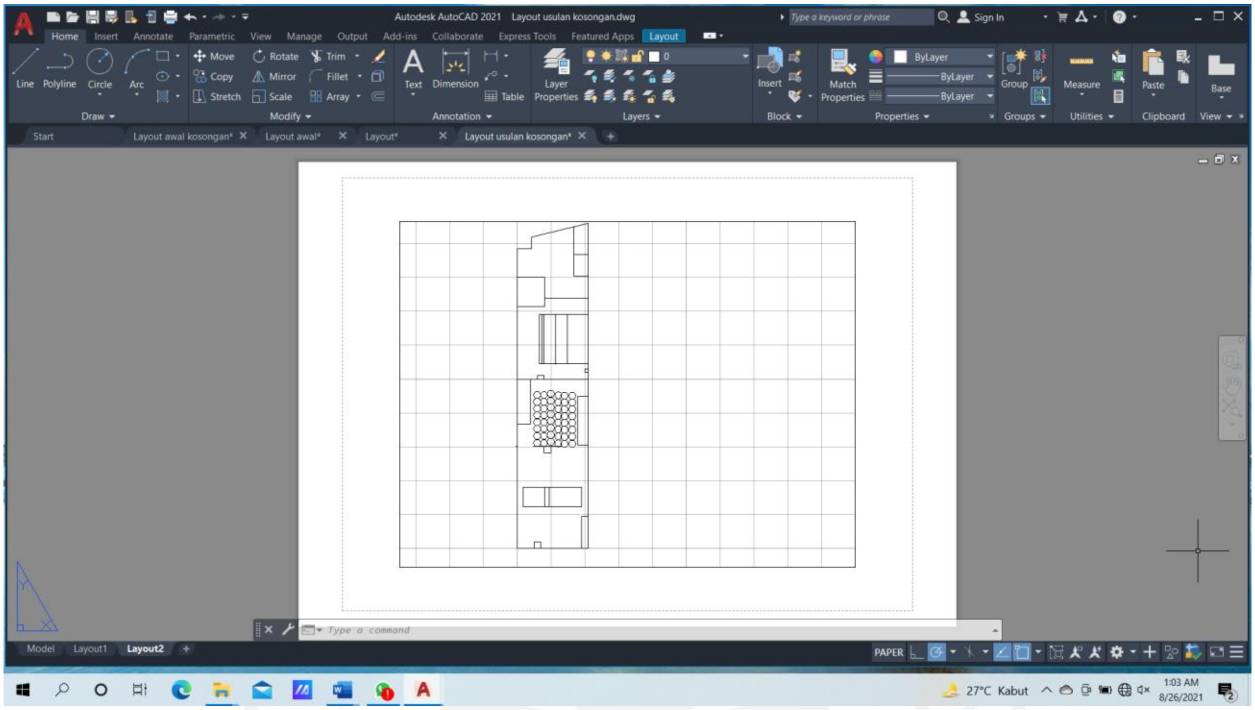
Alasan Kedekatan

Kode	Alasan
1	Aliran Material
2	Kemudahan Pengawasan
3	Kesamaan hubungan
4	Kebutuhan kedekatan
5	Gangguan dan kebisingan
6	Kesamaan peralatan

Rating kedekatan

Rating	Kedekatan
A	Sangat dibutuhkan
E	Sangat penting
I	Penting
O	Kedekatan biasa
U	Tidak Penting
X	Tidak diinginkan

Appendix 9



Appendix 10 AutoCAD 2021 proposed layout