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Relayout of Palm Coconut Factories in West Sumatera

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A B S T R A C T

One of the plantation companies and palm oil mills in West Sumatera is part of the group and makes a positive contribution. In one of the palm oil factories in West Sumatra, there is a problem with the flow of the work process, where there is an accumulation of products of different sizes in the factory area. This hinders the product transfer process. In addition, this situation will affect the use of the land area. Therefore, it is necessary to consider how to make or change the layout of facilities more effectively and efficiently. An activity Relationship Chart will be used as a method to make recommendations for the layout design of palm coconut factories. The flow of the crude palm oil production process from the proposed layout design weighs the car and bunches of fresh fruits before heading to isolation until the bunches of ripe fruits are stored in the storage tank before being transferred to the transport car. Based on the proposed layout redesign, the management of the oil palm mill can consider improving the placement of the area in the boiler station, as well as the placement of production not too far from the production process.

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1. INTRODUCTION

Current industrial phenomena are characterized by increasingly high levels of competition among similar companies, increasingly diverse and customized customer demands, shorter product life spans, and increasingly limited available resources. This situation makes the industry, especially in Indonesia, need to have the flexibility to make changes in the midst of fluctuating global conditions, so that they can win global competition. One of the forms of flexibility in the industry is the flexibility of facilities and factory layouts because the ability to produce good and flexible facilities and layouts will affect the reduction of production costs and time, improve production quality, and the company's ability to make changes according to global market demands (Muhammad Arif, 2017). In general, a planned factory layout will determine the efficiency and maintain the survival or success of an industry. Expensive industrial equipment, sophisticated equipment, and good product design will mean nothing because of poorly planned layout planning. Because the production activity of a product can usually last a long time with a layout that may change, any mistake in planning this layout will cause losses (Pratiwi, *et al*, 2012).

The palm oil industry is known as an agricultural industry that contributes positively

to the economic growth of a country (Kramanandita, 2019). One of the plantation companies and Palm Oil Mills in West Sumatra is part of the group and makes a positive contribution. In one of the palm oil factories in West Sumatra, there is a problem with the flow of the work process, where there is an accumulation of products of different sizes in the factory area. This hinders the product transfer process. In addition, this situation will affect the use of the land area. Therefore it is necessary to consider how to make or change the layout of facilities more effectively and efficiently. Facility layout design is a factor that affects the performance of a company to support the smoothness of the production process (Suhardi, *et al*, 2019), the activity relationship chart method is used as a method to suggest the layout design of factory facilities (Suminar, *et al*, 2020), workshops facilities (Jamalludin, *et al*, 2020), production facilities (Darma Jaya, *et al*, 2017; Ramadhan, *et al*, 2020), manufacturing facilities (Durmusoglu, 2018). An activity Relationship Chart or Relationship Map is an activity between parts that illustrates the level of importance for the intimacy between parts or activities, in other words, it is structured to determine the level of relationship between parts or activities that occur in each area (Rosyidi, 2018). For this reason, an activity relationship chart will be used as a method to make recommendations for the layout design of Palm Coconut Factories.

2. LITERATURE REVIEW

Facility layout is the arrangement of everything required for the production of goods or delivery of services. Layout design generally depends on product variety and production volume. Four types of organization are intended, namely fixed product layout, process layout, product layout, and mobile layout (Khurana, 2015). The layout and movement of materials have the greatest influence on the productivity and profitability of an enterprise when compared to other factors. In addition, material handling is very influential as it accounts for 50% of the causes of accidents occurring in the industry and constitutes 40% of 80% of all operating costs. In practice, the layout and handling of materials have an inseparable relationship (Chaerul, *et al*, 2021). The layout is well designed for the initial state of the business, although as the company grows it must be adapted to internal and external changes through delivery. The reasons for re-layout are based on 3 types of changes, namely: changes in production volume, changes in process and technology, and changes in products. The relay frequency will depend on the process requirements. Possible symptoms to detect the need for re-layout are congestion and poor use of space, excess stock in process in the facility, long distances in the workflow process, congestion and simultaneous workstations with idle time, qualified workers performing too many simple operations, anxiety labor and discomfort, accidents in facilities and difficulties in controlling operations and personnel (Khurana, 2015). In addition, facility layout issues have a significant impact on the productivity and efficiency of the manufacturing system. In general, layout problems are related to the optimization of facility space and location (e.g.machines, departments) and are oriented towards optimizing system performance in the facility space (Al-Zubaidi, *et al*, 2021).

The use of an activity relationship Chart as a method in layout design has been used in various industrial fields, such as factory facilities (Suminar, et al, 2020), workshops facilities (Jamalludin, et al, 2020), production facilities (Jaya, et al, 2017; Ramadhan, et al, 2020), manufacturing facilities (Durmusoglu, 2018). ARC, commonly referred to as a link map, has the function of describing the relationship between certain activity departments so that it can be determined which activities must be close together and which activities must be far apart in the design of the facility layout. The determinations made in creating this linkage map use symbols. The symbols used are A, E, I, O, U, X (Pramesti, *et al*, 2019). The use of the ARC method has a positive effect on the design of the layout of the facility, because of the results obtained from the following studies such as obtaining space savings that can be used to open new spaces (Yulistio, *et al*, 2022), solving the problem of material flow that is wasted (Pratama, 2019) maximizing the use of space in the company (Suminar, *et al*, 2020), can reduce the number of employees in each department, so that the production process is more efficient (Rosyidi, 2018).

3. RESEARCH METHOD

Qualitative and quantitative methods were used

to redesign the layout of the facility with the following stages:

- The collection of data related to effectiveness issues including knowing the steps and processes in the industrial activity process are as follows: (i) Factory area, (ii) Initial layout, (iii) Floor area, (iv) Product size, (v) Production capacity, (vi) Time and working day data

  Interviews with employees were conducted to find out information about the operational process for each activity.
- Data processing is carried out using the Activity Relationship Chart method: (i) Check the site for the initial layout of the production floor (ii) Conduct research and collect data and information about the production process and the layout of the production floor by interview and observation methods, (iii) Calculate machine and support equipment requirements and extensive requirements of each station, (iv) Create an Activity Relationship Chart diagram, with degrees of closeness that can be seen in Table 1, (v) Compares the layout of each alternative and then selects the proposed layout that gets the greatest value, (vi) Making Conclusions and Recommendations as consideration for the industry

Table 1. Level of proximity

Level of Proximity	Information
A	Absolutely Necessary
E	Especially Important
I	Important
O	Ordinary
U	Unimportant
X	Undesiderable

Source: Safitri, *et al*, 2017

The following is the conceptual framework of this research:

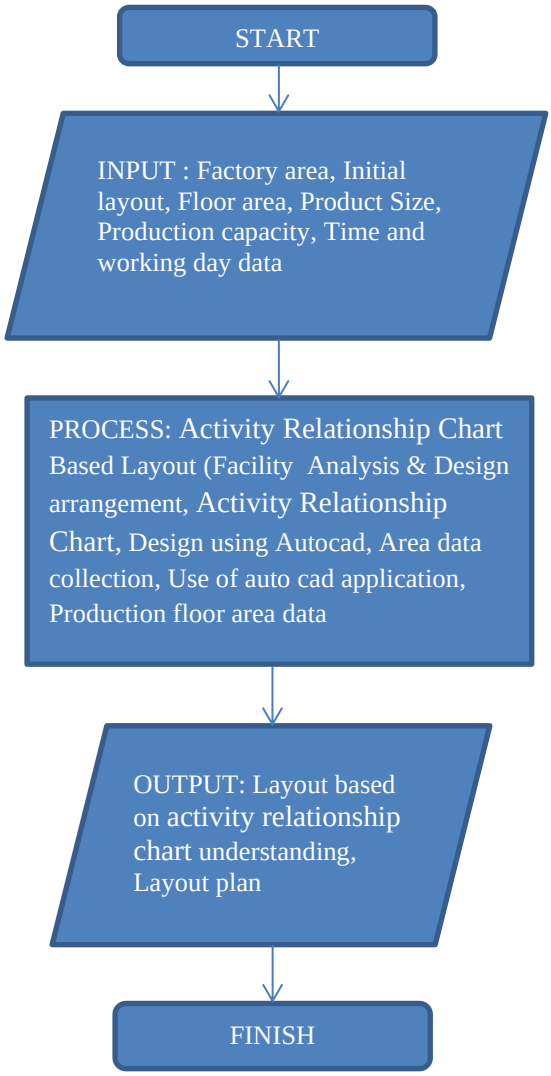

Fig. 1. Conceptual framework chart

4. RESULT AND DISCUSSION

Based on the data collection carried out, it was found that the area of the factory is 487 hectares with the area of each station which can be seen in Table 3. Apart from the station data and size, there is the capacity of production tools as input data which can be seen in Table 2 as well as the initial layout of the oil palm factory. The production capacity is 1000 tons/day of raw material for Fresh Fruit Bunches and has a working time of 10 hours/day.

Table 2. Capacity data and number of machines at factory

Machine	Capacity	Quantity
Weighbridge	50 ton	2
Loading ramp	600 ton	2
Transfer carriage	3 lori	2
Lori	17,5 ton	30
Sterilizer	4 lori	4
Tipper	1 lori	2
Thresher	5 ton	3
Digester	3500liter	8
Screw press	20 ton	8
Nut silo	40 ton	4
Boiler	40 ton	1

In redesigning the layout using conventional engineering methods, the first thing that needs to be done is to identify the existing facilities in the factory and determine the degree of the close relationship between those facilities to finally get a layout design proposal.

Table 3. Data station and size

Station	Dimensions		Area (m^2)
	Length (m)	Width (m)	
Fruit Receiving Station	100	40	4000
FLA Station	30	18	540
Tipper	12	8	96
Threser Station	10	9	90
Clarification Station	20	18	360
Seed Separation Station	10	9	90
Kernel Station	24	20	480
Boiler House	42	20	840
Power House	20	18	360
Palm Oil Storage	40	25	1000

In planning a network of activities certain things must be known, including the types of connections that exist between some activities that need to be identified first. To find out the relationship between the departments of the Palm Coconut Factories production floor can be seen in Figure 2 and Table 4.

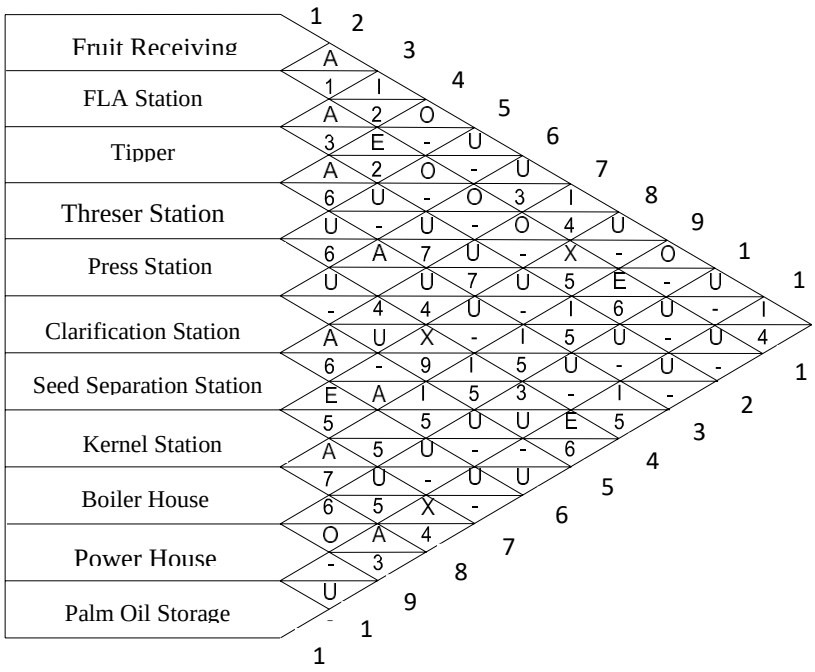

Fig. 2. Layout planning using an activity relationship chart

Information
1 = Process flow sequence
2 = Uses the same space

3 = Minimizes material movement
4 = Simplifies control
5 = Does not affect comfort
6 = Affects comfort

Table 4. Level of proximity relationship between stations

No	Area	Level of Proximity					
		A	E	I	O	U	X
1	Fruit Receiving Station	2		3,7,11	4,9	5,6,8,10	
2	FLA Station	2	3,8		4,5,6	10,11	7
3	Tipper	2		7		3,4,5,6,8,9	
4	Threser Station	2,3		6,8		4,5,7	
5	Press Station		7	5	2	2,3,6	4
6	Clarification Station	2,3		4	2	5	
7	Seed Separation Station		8	1		9,10,11	
8	Kernel Station	2,3	8	4,5,6,7	9	3	8
9	BoilerHouse	3			2,9	7,6,4,3,2,1	9
10	PowerHouse	8			9	11,7,6,5,4,3,2,1	
11	PalmOilStorage		5	4,1		10,7,6,3,2	9,8

In making an Activity Relation Chart data is obtained from the sequence of activities in the production process which will be connected in pairs to determine the level of relationship between the activities. This relationship is seen from several aspects including organizational relationships, material flow, equipment used, people, information, and environmental relationships. In carrying out the preparation, the considerations used in the preparation of the Activity Relationship Chart are as follows:

a. The place for the raw materials is really close to the boiling station so that the processing time for the workers does not take much time when boiling.
b. The place of the boil (FLA Station) should be very close to the place where the production is placed so that it does not take up unnecessary areas when the boil is finished.
c. The tippler does not have a problem with the place where the result boils due to the ease of access.
d. The press station and the refining station do not need to be next to each other because the pressing process is very long.
e. At the seed separation station, it is also important to be close to the press station because the results from the press dregs go directly to the seed separation station.
f. The seed separation station really needs to be close to the kernel station so that it doesn't take much time during the process.
g. Boiler house with power house is quite important in the area near the station to facilitate the process.
h. Palm oil storage is not so important near power center.

The following is the flow of the crude palm oil production process from the proposed layout design in Figure 3:

1. Weigh the car and Bunches of Fresh Fruits before heading to isolation with a time of 4-7 minutes using the same layout as the previous layout
2. Bunches of fresh fruit are sorted within 20 - 60 minutes with the results stored in the loading ramp
3. Bunches of Fresh Fruits at the Loading Ramp will be transferred using a conveyor to go to the boiling process. The time required to transfer a bunch of ripe fruit to the boiling process is 10 minutes faster than using the previous layout. The distance between the loading ramp and the boiling station based on the re-design is 80 meters, while the distance between the loading ramp and the boiling station based on the previous layout is 100 meters.
4. Bunches of fresh fruit enter the FLA station for boil with a processing time of 86

minutes. The boiled products are placed in the boiling area, with the aim of not using the area outside the station that is not needed when the boiling is finished. This placement was not found in the previous layout, because in the previous layout, the boiling result did not have a temporary storage area. The Bunches of Ripe Fruits goes to Tippler to turn the Truck so Bunches of Ripe Fruits goes to Thresher.

5. The Cooked Bunch Truck will go to Tippler which is adjacent to the FLA station. The closeness between these areas in the previous layout is according to the results of the analysis, with the aim of transfer facilitating access. The next process is a digester and press to remove the oil in the loose fruit.
6. At the Thresher station, the bunches of ripe fruit will be processed to separate the fruit from the bunch. This station is not close to the tippler to avoid congestion/density of production material that will enter the thresher station. the step that can be taken is to extend the displacement distance. The output from the thresher station is transferred to the press station which needs to be approached because the station is a continuous process flow.
7. The loose fruit will go to the pressing station to enter the Digester and Press machine to extract the oil in the loose fruit. The press station and clearing station do not need to be close together because the pressing process is very long. this is done by extending the Crude Oil Gutter (COG) which is a means of transfer without having to change the layout of the previous station
8. The oil obtained from the pulp that has been processed at the Press station will go to the Clearing station to be refined into semi-finished oil before being transferred to the storage tank. where the layout of the clearing station follows the previous layout
9. The Bunches of Ripe Fruits is stored in the Storage Tank before being transferred to the transport car.

5. CONCLUSION

Recommendations for the layout design of Palm Coconut Factories with the redesign of the layout of the oil palm mill were carried out with the results shown in Figure 3. Based on the proposed redesign of the layout of the oil palm mill, it can consider improving the placement of production that is not too far from production. Process to speed up the moveing process for 10 minutes with a reduced movement distance of 20 meters. then the management can consider increasing the area of the boil at the FLA station, with the aim of not using the area outside the station that is not needed when the boil is finished. In addition, to avoid waiting activities due to congestion, the thresher station layout can be considered not close to the tippler by increasing the distance between the thresher station and the tippler. last consideration, by extending the Crude Oil Chute (COG) which is a means of transport without having to change the layout of the previous station to provide a distance between the press area and the cleaning station, because of the very long pressing process that can lead to waiting activities.

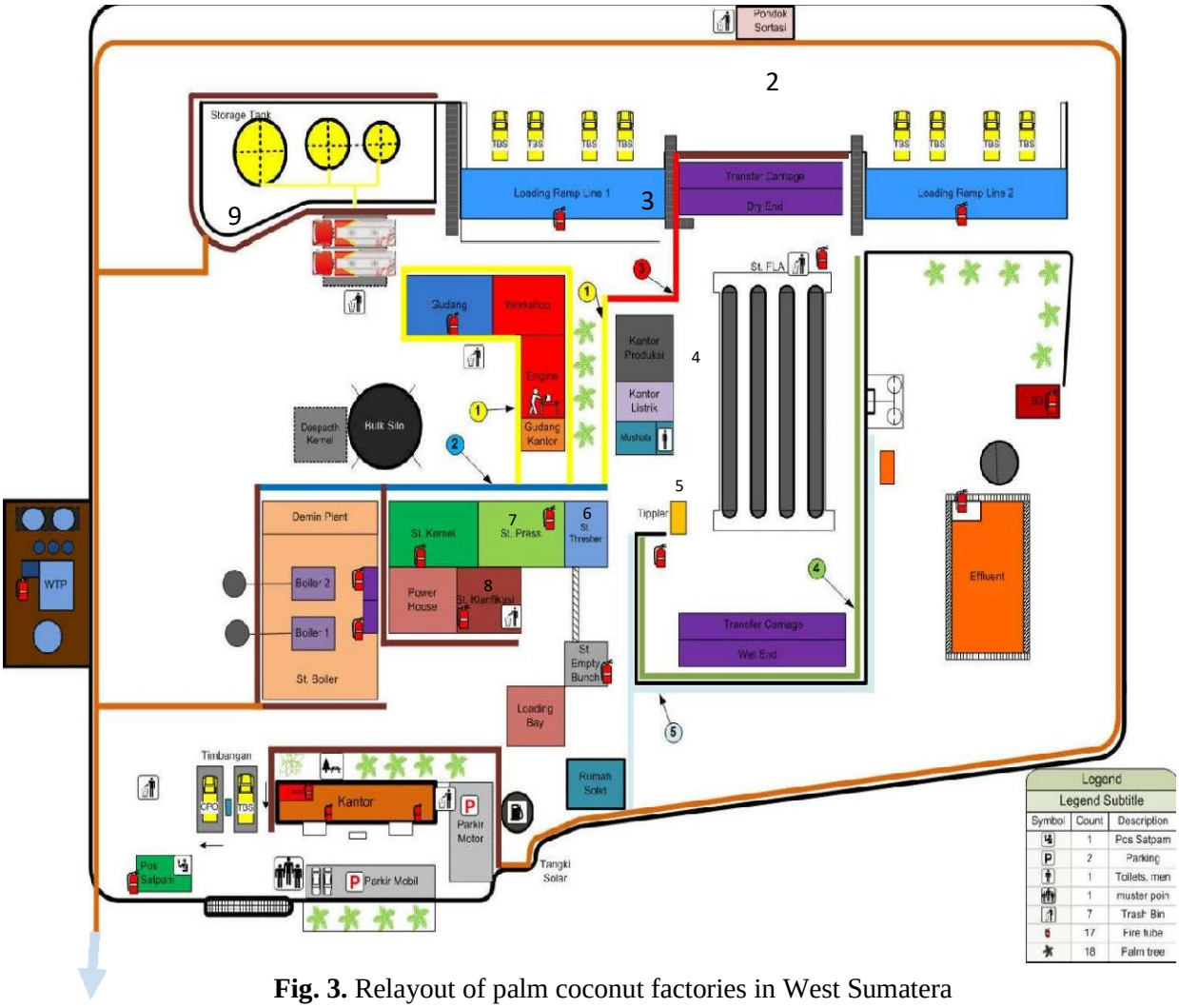

Fig. 3. Relayout of palm coconut factories in West Sumatera

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