LAYOUT PLANNING FLOOR PRODUCTION BREAD FACTORY USING SYSTEMATIC LAYOUT PLANNING METHODS

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Abstract

Tight competition in the food industry, especially bread, does not diminish sales of bread produced by CV. Anni Bakery, but there are some problems that arise at this time, the limited production floor which is increasingly narrow due to increased production without adjusting existing capacity and irregular placement of production floor facilities. This background is used as a reference for companies to create new factories. The purpose of this study is to propose the layout of production floor facilities with the right facility layout so that the material costs are small. The climbing approach used is systematic layout planning (SLP). The results of the facility layout analysis obtained the best distance is the distance that has a total material transfer along 470.46 meters per day with details of sweet bread along 412.36 meters per day and white bread along 58.1 meters per day. In conclusion, this facility layout plan is declared feasible and can be continued as a reference material in making a new bread factory.

Keyword: facility layout; material handling; systematic layout planning;

INTRODUCTION

Factory layout is a procedure for regulating factory facilities to support the smooth production process (Wignjosoebroto, 1996). The regulation will try to utilize the area for the placement of machinery or other production support facilities and be arranged in such a way as to be able to support the efforts to achieve efficiency and effectiveness of the operations of production activities. Shubham B and Prasad D, (2016) Layout problems usually originate from long distances between several departments that are forced to travel long distances and impede material flow, causing higher costs.

Layout design includes setting layout of operating facilities by utilizing the area available to place machinery, equipment for operations and all equipment used in the operation process. One of the goals of designing the layout of production facilities is to use space more effectively. Use of space will be effective if machines or other plant facilities are arranged or arranged in such a way by taking into account the minimum distance between machines or production facilities, and the flow of material movement. Good layout of production facilities plays a very important role in the production process activities because it has a direct effect on the smooth running of the production process, so that it can increase production output, minimize the cost of moving materials, and can reduce bottlenecks (Wignjosoebroto S, 1996).

Tight competition in the food industry, especially bread does not shrink sales of bread produced by CV. Anni Bakery, this company produces two variants of bread and various flavors, these variants include; loaf breadand sweet bread with a production capacity of 170 kg / day and 35 kg / day, respectively. The consistency of the company in maintaining the quality of bread products with Brand Anniis able to survive and even trusted by consumers, by gaining the trust of consumers Anni Bread sales are concern in increased production. The number of production makes the company plan to expand its marketing area and create a new factory to anticipate the increasing production capacity. A systematic layout planning method is expected to provide a smooth process production, so it will increase production output, minimize material transfer costs, and be able to reduce the bottle neck, the facility now for the production floor area of 200 m^2 and there are a lot of flow or placement machines and facilities are not effective, including; the production process is divided into two production streams, namely the production of white and sweet bread. Irregular layout and narrow distances between parts for transportation or space for workers, making it difficult to move materials which caused high material removal costs. .

LITERATURE REVIEW

Planning Facility

Layout is the physical arrangement of production machinery and equipment, workstations, individuals, material areas of all arrangements and stages and material handling equipment (H. Radhwan et all, 2019). Meanwhile, according to Hadiguna, R A, and Setiawan H. (2018) the layout can be defined as the procedure for regulating factory facilities to support the smooth production process. The techniques that will be used in this study are mainly from the Systematic Layout Planning (SLP) and Graph based Theory (GBT) methods. Facility layout design is an influential factor in company performance to support efficient production processes (Bambang S. et all, 2019). Facing the new Industry 4.0 trend, manufacturing factories are required to have a more flexible structure to produce customized products in a limited time and at a reasonable cost. Although virtual factory technology is believed to help with plant layout planning and production planning, there is still a general lack of a framework and algorithm sbased simulation approach for designing optimized factory layouts and production processes (Zhinan Zhang et all, 2018) The final stage of design planning must be seen completely and clearly every part and rooms and facilities needed by the company starting from raw materials, production processes, administration and other supporting facilities to support production activities can run well and smoothly (Appel, James A. 1979).

Systematic Layout Planning Method

This systematic methodology is very well organized to set strategies that enable people to identify, visualize, and assess the various activities, relationships, and alternatives involved in the project layout based on data input, material flow, relationship activities and relationship diagrams. This approach can increase the flow of material in product processing at the most minus the cost and lowest handling amount. The SLP method looks more attractive for designing factory layouts because it's a basic foundation and a fairly simple method, can be used in practice widely compared to the other procedures. Basically, the algorithm of the adjacency based graphical method, and the distance between departments is not considered. This method is not considered a specification of department dimensions because these must be determined separately and because of physical requirements or restrictions. According to Tamimi Z et all (2018) Systematic Layout Planning Method or SLP provides a suitable method for designing an efficient layout because it considers relationship value and material workflow precisely. According to Maina E. C., et all (2018) the Systematic Layout Planning Method (SLP) method is one of the methods that can spatial use and SLP are also proven procedural tools for designing new facility layouts, and can be used to improve existing productivity. Unfortunately, many companies, as found by not realizing it as a Technique. According to Suhardini (2017) the SLP technique can be applied to optimize the existing layout, and this application is expected to create the fastest material flow at the lowest cost and the lowest amount of material handling. This spatial planning system consists of four stages as follows:

Phase I : Determine the location where the facility will be built,
Phase II : Create an overall facility design
Phase III : Determine the detailed facility layout design (to be worked on in this paper)
Phase IV : Preparation and installation of design results

According to D. Suhardini et all (2017) Input data needed in Systematic Layout Planning there are five categories:

P (Products) : Types of products (goods / services) produced.
Q (Quantity) : Volume of each type of item / component produced.
R (Route) : Operating sequence for each product
S (Service) : Support services, such as changing rooms, monitoring stations, etc.
T (Timing) : At what time the type of product component is produced, what machine are needed.

Material Handling

According to Buchari (2018) in the production process sometimes the material flow path is not balanced. The imbalance of production is caused by differences in the cycle time of each work station. In addition, there is another problem, namely the existence of irregular material flow patterns that result in increased time and distance of displacement. High material handling costs can trigger inefficiencies in company productivity (I F Febriandini and Yuniaristanto, 2019). Material Handling The removal of this material will require a significant amount of costs, commonly known as material handling costs. Based on the formulation made by the American Material Handling Society (AHMS), the understanding of material handling is expressed as an art and science that includes handling, moving, packaging / packaging (storing, storing) as well as controlling / controlling (controlling)) from materials or materials in all its forms Material Handling Costs (OMH) are costs incurred as a result of material activity from one machine to another or from one other department of the ministry, the amount of which is determined to a certain extent. meter movement The purpose of moving materials is to increase capacity, improve working conditions, improve service to customers, increase the use of space and equipment and reduce costs Factors affecting the calculation of material handling costs include the distance from one work station to work station others and costs transportation per meter of movement. According to Syed A A N., et all (2016) Alternative layout can be proposed based on increased accessibility and efficiency criteria for material flow. According to Dede M (2018) one of the distance measurement systems that can be used is the Euclidean Distance method. Euclidean distance is the distance measured straight between the center of the facility and the center of the other facilities. Euclidean distance measurement systems are often used because they are easier to understand.

METHODS

According to Wignjosoebroto S., (2009) Method Systematic Layout Planning is a method that is often encountered in the process of planning the layout of the production facility. Besides being applied in the production section, but also applied in the transportation, warehousing, assembly and other office activities. The following is a flow diagram in solving the problem of the production floor facility layout:

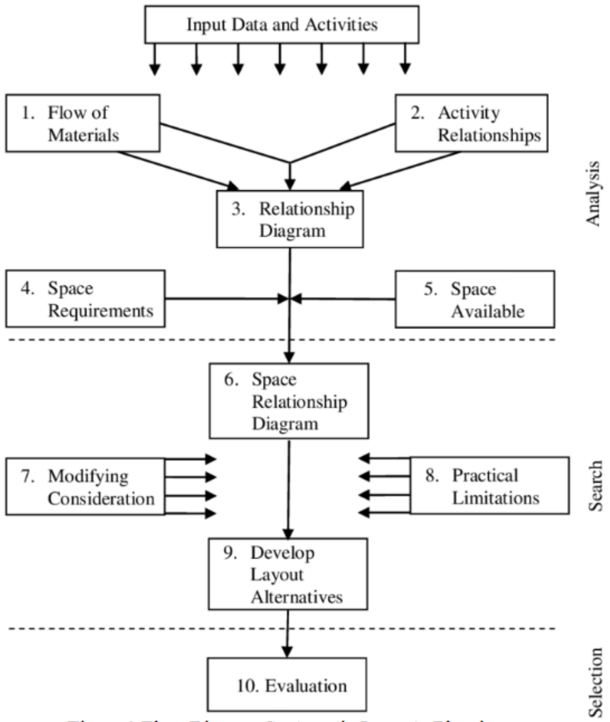

Figure 1 Flow Diagram Systematic Layoute Planning
Source : Wignjosoebroto S (2009)

According to Syed A A N., et all (2016) The steps undertaken in data processing are:

Step 1: PQRST analysis

Step 1 begins with PQRST analysis for the overall production activities. This includes P (product), Q (quantity), R (routing), S (supporting) and T (time).

Step 2: activity relationships analysis

For determining activity relationship, outline process chart was constructed by observing the actual line for weeks in random shifts. Activity charts for individual departments (inside shop flow) were also investigated.

Step 3: flow of materials analysis

This step involves the analysis of flow of materials throughout the production. In this step from-to chart is constructed which represents the flow intensity and interaction between different production departments as explained in table from to chart The numbers in from-to chart matrix indicate flow intensity (trips) required for manufacturing one switch gear. From-to chart is also transformed in flow diagram as shown in figure from to chart

Step 4: relationship diagram

Relationship diagram establishes relative positioning decision among the functional areas. Even though from to chart acts as basis for department orientation but material flow is not necessarily the only reason. For this purpose mileage chart is constructed.

Step 5: space requirements/available analysis

These steps decide the amount of floor space assigned to each department. This decision is critical to design problem due to expensive floor space and plays vital role in future expansion. In step 5 respective function and area of each department is calculated. The switch gear facility is divided into five major departments. These departments work simultaneously and are dependent on each other. It is noted that this floor space area not only comprises the machinery and operation space but also includes the required support activities space such as maintenance, human–machine interaction and material handling equipment. Figure space relationship diagram depicts space relationship diagram through mapping each department size in accordance with material flow.

Steps 6: layout alternatives practical constraints

These steps convert the relationship chart into block layout. For switch gear facility following constraints are incorporated

Step 7: evaluation

Layout alternatives are evaluated as explained with distances between work stations can be determined by determining the center between work stations. Next is the calculation of the distance by using material Transfer Planning is a table used to calculate the amount of material transfer based on the material transfer equipment used.

From the calculation of the distance between work stations, it can be seen by adding up all the material movements that occur by considering the factors that influence the calculation of the cost of moving materials including: the distance from one work station to the work station another, the frequency of movement between work stations and the cost of transportation per meter of movement. The measurement of the mileage is adjusted to the conditions.

RESULT AND DISCUSSION

Annual Production

Capacity The highest annual production is the first year production, which is 437,067 units for sweet bread and 247,241 units for fresh bakery. Annual hourly production capacity for sweet bread = 437,067 / 3360 = 131 units per hour = 1310 units per day. Annual hourly production capacity for loaf bread= 247,241 / 3360 = 74 units per hour = 740 units per day.

Determination of Machine Capacity

With the production capacity that must be achieved every hour or per day, automatically to achieve it, it is necessary to know how many machines or production support devices needed to make sweet bread and white bread, following the calculation results :

Table 1. Needs for Machine Sweet Bread

Machine	Working time (clock)	Processing time (minute)	Result (pcs)	Working time each product (minute)	Down time each day (minute)	Setup (minute)	% Defect	Efficiency determination	Amount of product determantion	Theoretical machine needs	Actual machine needs
Large scale	10	1.02	30	0.03	0	5.63	0	0.99	1310	0.07	1
Small scale	10	0.45	30	0.02	0	1.08	0	1	1310	0.03	1
Measuring cup	10	0.28	30	0.01	0	0.42	0	1	1310	0.02	1
Mixer	10	30	30	1	0	0.53	0	1	1310	2.19	3
Fermentation rack 1	10	10	30	0.33	0	0.42	0	1	1310	0.73	1
Pressing	10	1.5	1080	0	0	6	0	0.99	1310	0	1
Working table 1	10	89.88	1080	0.08	0	3.8	0	0.99	1310	0.18	1
Fermentation rack 2	10	80	1080	0.07	0	3.72	0	0.99	1310	0.16	1
Working table 2	10	161.97	1080	0.15	0	3.9	0	0.99	1310	0.33	1
Stim	10	75	1080	0.07	0	3.8	0	0.99	1310	0.15	1
Oven	10	1440	1080	1.33	0	3.88	0	0.99	1310	2.93	3
Cooling rack	10	135	1080	0.13	0	3.73	0	0.99	1310	0.27	1
Packing	10	1.85	1080	0	0	3.73	0	0.99	1310	0	1

Table 2. Need for Machine Loaf Bread

Machine	Working time (clock)	Processing time (minute)	Result (pcs)	Working time each product (minute)	Down time each day (minute)	Setup (minute)	% Defect	Efficiency determination	Amount of product determantion	Theoretical machine needs	Actual machine needs
Large scale	10	1.02	30	0.03	0	5.63	0	0.99	740	0.04	1
Small scale	10	7,35	30	0.25	0	0.63	0	1	740	0.03	1
Measuring cup	10	0.22	30	0.01	0	0.25	0	1	740	0.01	1
Mixer	10	30	30	1	0	0.45	0	1	740	1.23	2
Fermentation rack 1	10	10	30	0.33	0	0.4	0	1	740	0.41	1
Pressing	10	3	60	0.05	0	6	0	0.99	740	0.06	1
Working table 1	10	8.12	60	0.14	0	0.48	0	1	740	0.17	1
Fermentation rack 2	10	10	60	0.17	0	1.02	0	1	740	0.21	1
Working table 2	10	25	60	0.42	0	1.07	0	1	740	0.51	1
Stim	10	120	60	2	0	1.05	0	1	740	2.47	3
Oven	10	45.23	60	0.75	0	1.05	0	1	740	0.93	1
Cooling rack	10	11.13	120	0.09	0	1.07	0	1	740	0.12	1
Packing	10	10.37	120	0.09	0	1.13	0	1	740	0.11	1

From to Chart

From To Chart (FTC) is a map used in analyzing the movement of material that occurs on the production floor. In this study, the type of FTC used is the distance of the FTC and the cost of the FTC. FTC distance is a graph that shows the distance between departments on the production floor. The distance is measured straight between the center of one facility and the center of another facility. The range of data is taken remotely using the rectilinear calculation formula. Based on table 3 and table 4 calculations. Obtained for total distance handling of 412.36 meters sweet bread production and total distance handling production loaf bread 58.10 meters.

Table 3. From To Chart Sweet Bread

From	To	Tools	Frekuency	Distance (m)	Total Distance (m)
Making batter	Pressing	Trolly	4	4.37	17.48
Pressing	Filling the bread	Trolly	16	4.65	74.40
Filling the bread	Steamer	Trolly	16	5.59	89.44
Steamer	Oven	Trolly	16	7.05	112.80
Oven	Finishing	Trolly	16	7.39	118.24
Total					**412.36**

Table 4. From To Chart Loaf Bread

From	To	Tools	Frekuency	Distance (m)	Total Distance (m)
Making batter	Pressing	Trolly	2	4.37	8.74
Pressing	Filling the bread	Trolly	2	4.65	9.30
Filling the bread	Steamer	Trolly	2	5.59	11.18
Steamer	Oven	Trolly	2	7.05	14.10
Oven	Finishing	Trolly	2	7.39	14.78
Total					**58.10**

Analysis of Activity Relationship

Analysis of material flow by drawing a variety of process maps, tends to look for the relationship of the activity of moving materials from a facility to a work with other facilities with quantitative aspects as a benchmark. There are also other qualitative factors which must be taken into consideration in planning the layout of facilities. Activity relationship charts are used for layout analysis based on qualitative considerations. ARC acquisition is obtained from interviews with production managers in CV. Anny Bakery. Sweet Bread and Loaf Bread are combined in one ARC because they have the same relationship in each department, only the machines used are different.

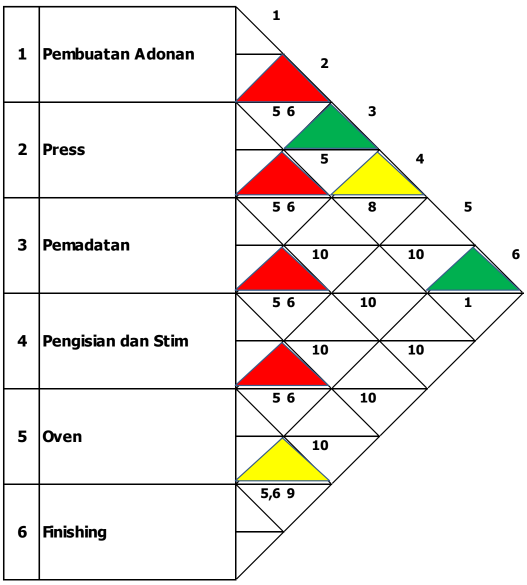

Figure 2. Activity relationship chart (ARC)

Table 5. Activity Relationship Level

No		Code	Color

	Level of Importance		
1.	Absolute importance	A	Red
2.	Specific Important	E	Yellow
3.	Urgent	I	Green
4.	Ordinary	O	Blue
5.	Not important	U	White
6.	Undesirable	X	Chocolate

The reasons for states the level of importance is as follows:

1. Using the same note.
2. Using the same personnel.
3. Using the same space.
4. Level of personnel relations.
5. The level of paperwork relationships.
6. Work paper flow order.
7. Do the same work flow.
8. Using the same equipment and facilities.
9. Noise, dirty, vibration, dust, etc.
10. Not in sequential workflow

Requirements The Area

The company has land for a new factory covering an area of 12x28 336 m2. In the needs of the engine area is determined by the number of machines, tolerance and allowance of 300% are used and 100% is an assumption to anticipate layout incompatibility with circumstances that are not taken into account. Here are the results of the calculations:

Table 6. Size of Machine Need of Sweet Bread

No	Departement	Machine/tools	Amount of	Machine P (m)	Machine L (m)	Machine large /	Sub. Total	Tolerance (%)	Tolerance large (M2)	Allowance (%)	Large alloance	Large total each operation (m2)
1	Making batter	Large scale	1	0.4	0.3	0.12	0.12	300	0.36	100	0.12	0.60
		Small scale	1	0.24	0.24	0.06	0.06	300	0.17	100	0.06	0.29
		Measuring cup	1	0.2	0.2	0.04	0.04	300	0.12	100	0.04	0.20
		Mixer	3	1.3	0.8	1.04	3.12	300	9.36	100	3.12	13.52
											Total	**14.61**
2	Pressing	Fermentation rack 1	1	0.68	0.8	0.54	0.54	300	1.63	100	0.54	2.72
		Pressing	1	0.8	0.8	0.64	0.64	300	1.92	100	0.64	3.20
											Total	**5.92**
		Working table 1	1	2.4	1.2	2.88	2.88	300	8.64	100	2.88	14.40
		Fermentation rack 2	1	0.68	0.8	0.54	0.54	300	1.63	100	0.54	2.72
											Total	**17.12**
3	Filling the bread	Working table 2	1	2.4	1.2	2.88	2.88	300	8.64	100	2.88	14.40
											Total	**14.40**
4	Steamer	Steamer	1	1.4	1	1.40	1.40	300	4.20	100	1.40	7.00
											Total	**7.00**
5	Oven	Oven	3	1.5	1	1.50	4.50	300	13.50	100	4.50	19.50
		Cooling rack	1	4	0.8	3.20	3.20	300	9.60	100	3.20	16.00
											Total	**35.50**
6	Finishing	Packing	1	2.4	1.2	2.88	2.88	300	8.64	100	2.88	14.40
											Total	**14.40**
											Total	**108.95**

Table 7. Size of Machine Need of Loaf Bread

No	Departement	Machine/tools	Amount of	Machine P (m)	Machine L (m)	Machine large /	Sub. Total	Tolerance (%)	Tolerance large (M2)	Allowance (%)	Large alloance	Large total each operation (m2)
1	Making batter	Large scale	1	0.4	0.3	0.12	0.12	300	0.36	100	0.12	0.60
		Small scale	1	0.24	0.24	0.06	0.06	300	0.17	100	0.06	0.29
		Measuring cup	1	0.2	0.2	0.04	0.04	300	0.12	100	0.04	0.20
		Mixer	2	1.3	0.8	1.04	2.08	300	6.24	100	2.08	10.40
											Total	**11.49**
2	Pressing	Fermentation rack 1	1	0.68	0.8	0.54	0.54	300	1.63	100	0.54	2.72
		Pressing	1	0.8	0.8	0.64	0.64	300	1.92	100	0.64	3.20
											Total	**5.92**
3	Filling the bread	Working table 1	1	2.4	1.2	2.88	2.88	300	8.64	100	2.88	14.40
		Fermentation rack 2	1	0.68	0.8	0.54	0.54	300	1.63	100	0.54	2.72
											Total	**17.12**
4	Steamer	Steamer	1	1.4	1	1.40	1.40	300	4.20	100	1.40	7.00
											Total	**7.00**
5	Oven	Oven	3	1.5	1	1.50	4.50	300	13.50	100	4.50	22.50
		Cooling rack	1	4	0.8	3.20	3.20	300	9.60	100	3.20	16.00
											Total	**38.50**
6	Finishing	Cutting	1	1.2	1.2	1.44	1.44	300	4.32	100	1.44	7.20
		Packing	1	2.4	1.2	2.88	2.88	300	8.64	100	2.88	14.40
											Total	**21.60**
											Total	**101.63**

Analysis of Space Relationships

The following form of analysis for space relationships (Activity relationship diagrams) of the relationship analysis map (Activity relationships chart) for more appropriate alternative layout:

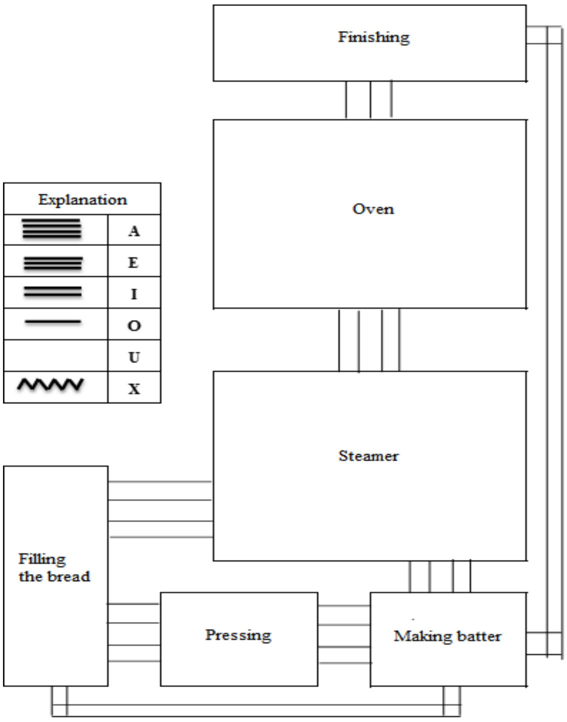

Figure 3. Activity relationship diagram (ARD)

The Proposed Layout

The following figure is an overview (Block plan) layout of the proposed facilities based on the Space relationship diagram of the previous proposal.

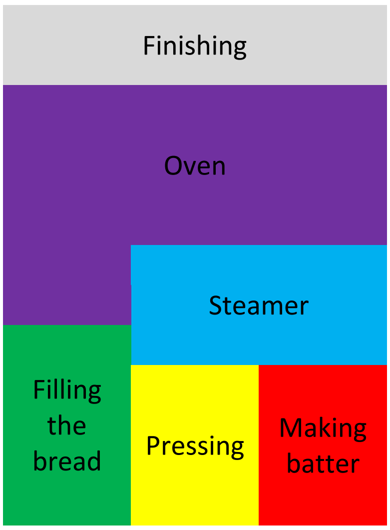

Figure 4. Block plan proposals

Evaluation results taken da r analysis of the relationship of activities and maps of the operation process (material flow). This results in the distance of moving material from the dough-making department to the press department is 4.37 meters for sweet bread 4 times and white bread 2 times, the press department to the compaction department is 4.65 meters with the frequency of material transfer for sweet bread 16 times and white bread 2 times, the compaction department to the filling and stim department is 5.59 meters with the frequency of transferring ingredients for sweet bread 16 times and white bread 2 times, the filling and stim department to the oven department is 7.05 meters with the transfer frequency the ingredients for sweet bread are 16 times and white bread 2 times, and the oven department to the finishing department is 7.39 meters with the frequency of transferring ingredients for sweet bread 16 times andbread 2 times, then the total distance of material transfer is white 470.46 meters (sweet bread along 412.36 meters and white bread along 58.1 meters).

CONCLUSION

Based on the results of the most appropriate layout analysis with the Systematic Layout Planning (SLP) Method is a layout that has a material transfer distance of 470.46 meters (sweet bread along 412.36 meters and white bread along 58.1 meters).. This consideration is based on the analysis and discussion in the previous section, where the results achieved are the shortest distance chosen. While the capacity, area and other facilities have been adjusted to the area needs for the next few years. So the facility layout plan is appropriate to be proposed to companies that plan to build new factories.

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