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Article

Designing the Production Facility Layout Using the BLOCPLAN Method (Case Study: PT Sehat Sejahtera Bersama, Jember)

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Abstract: PT Sehat Sejahtera Bersama is a business that produces soy beverages. There are currently no established guidelines for equipment arrangement at the PT Sehat Sejahtera Bersama facility. The flow of industrial processes is not considered by the machines used in it. As a result, there is less space for employees to move around, and time is wasted doing repetitive tasks, making the industrial process less effective and lowering output. The blocplan technique is the approach taken to overcome this problem. The facility layout problem at PT Sehat Sejahtera Bersama can be solved using this approach by considering the final layout, material transportation distance, degree of relationship closeness, and area requirements. The area at PT Sehat Sejahtera Bersama is 244.33 m², and the total space required is 647,1 m². In the suggested layout, which is the 17th layout out of 20 possible layouts, the choice of the blocplan method is based on the R-Score value, which is almost the same or close to 1.

Keywords: Layout Facility; Blocplan; Recommended Layout; Soy Milk Industry

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1. Introduction

Planning the layout of factory facilities is a method of managing the resources owned by the factory to streamline the production process [1]. At the level of Micro, Small, and Medium Enterprises, the layout of the factory production area is an important feature considered during the planning and business development processes [2]. According to [3], layout is a method of arranging manufacturing facilities to facilitate efficient output. The plan will utilize space to arrange equipment, facilities, staff, and other things that are temporary or permanent. Therefore, a good production facility layout is characterized by the absence of backtracking, minimal transfer frequency, and no excessive bottlenecks [4].

PT Sehat Sejahtera Bersama is a business that produces soy milk. This business markets its soy milk products throughout the city of Jember and its surroundings, such as Bondowoso and Situbondo. PT Sehat Sejahtera Bersama is located in Antirogo, Jember City, East Java Province. PT Sehat Sejahtera Bersama produces soy milk with a production capacity of 20,116 sachets per day. In the production of soybean milk, the equipment used includes a grinding machine (Disc mill), boiling tank, sealer machine, and freezer. Soy milk, which is the most produced product, has a facility layout design carried out on the production floor of PT Sehat Sejahtera. In addition, the process activities are more complex. The production process activities of soybean milk at PT Sehat Sejahtera Bersama begin with sorting, weighing, soaking, draining, grinding, filtering, cooking, filtering, and packaging. The number of workers at PT Sehat Sejahtera Bersama currently amounts to 20 people.

PT Sehat Sejahtera Bersama has a space area used as a production floor and warehouse of 246.33 m2. Currently, the layout of PT Sehat Sejahtera Bersama's facilities neglects the production process flow and does not adhere to the guidelines established regarding the placement of machines and equipment used in the process. As a result, workers have less space to move. Additionally, there is task repetition that causes time wastage and ineffective production methods, both of which reduce production productivity. Therefore, for the production process activities to run according to the process flow, PT Sehat Sejahtera Bersama must rebuild (relayout) the layout of its production facilities. The purpose of this research is to obtain an alternative design for a new layout based on the ARC method to determine the proximity relationship between departments using the blocplan algorithm [5].

The Activity Relationship Chart (ARC) method, or degree of relationship, is a technique for planning the interconnection between workstations based on the degree of activity relationship, which is expressed through an assessment using letters and numbers that indicate the reasons for the code [6]. The application of the blocplan algorithm (Bloc Layout Overview with Layout Planning) in layout design to obtain a new facility arrangement requires input from the Activity Relationship Chart (ARC) [7].

Activity Relationship Chart is a method of factory or department layout based on the degree of activity relationships, which are often expressed in qualitative assessments and tend to be based on subjective considerations from each facility or department [8]. Meanwhile, Blocplan is a facility layout design system developed by Donaghey and Pire at the Department of Industrial Engineering, University of Houston, in 1991. Blocplan is an algorithm for solving layout problems and handling both quantitative and qualitative data. The main elements embedded in Blocplan are improvement or exchange, and construction algorithms [9]. Both methods pay attention to the level of relationships between the parts/activities within a company. If the relationship between two departments has an A value, it must be closely aligned; if the relationship has an E value, it is very important to be closely aligned; if the relationship has an I value, it is important to be closely aligned; if the relationship has an O value, it is fairly essential to be closely aligned; if the relationship has a U value, it is not essential to be closely aligned; if the relationship has an X value, it should not be closely aligned.

In addition, Blocplan generates and evaluates types of layouts. The connectivity map can be used as input data for the blocplan method, and the layout cost can be calculated using proximity and distance. This software determines how many rows are in the blocplan, which usually consists of 2 or 3 rows. The tool called blocplan was created to design facility layouts using a hybrid algorithm that combines refinement and constructive algorithms [10]. Reducing distance or increasing proximity between facilities is the main goal of blocplan. When designing the layout of a facility, the blocplan approach generates a number of alternative solutions that can be selected using three different criteria: product mobility, proximity score, and R-score [11]. By evaluating the layout selection based on the best R-score value and the suitability of the available area, the best design results are determined. It is hoped that the blocplan approach can solve the layout problems at PT Sehat Sejahtera Bersama, thereby increasing productivity at PT Sehat Sejahtera Bersama in the future.

2. Research Methods

The theoretical framework written contains several definitions of various supporting methods used in the research conducted. The function of this theoretical framework is to develop knowledge in explaining several variables present in this research.

Facility Layout

The process of arranging manufacturing facilities to facilitate efficient output is known as facility layout [12]. The facility layout is the method of arranging factory facilities to support the smoothness of the production process. The arrangement will utilize areas for the placement of machines or other production support facilities, the smooth movement of materials, the storage of materials both temporarily and permanently, worker personnel, and so on [12]. In designing the layout of manufacturing facilities or factory layouts, the physical elements that need to be considered are machines, equipment, operators, and materials. In general, the objective function is the minimum total transfer cost. This is achieved by arranging machines and equipment in such a way that they are not too far apart without violating ergonomic rules.

Activity relationship chart (ARC)

Activity relationship chart (ARC) is a very important layout design method, as it can be used by a designer to determine the proximity relationship of each activity group or department that usually exists in every company. In the Activity Relationship Chart, the distance, which is a determining variable, is replaced with letters or codes that are qualitative in nature [13]. Activity Relation Chart (ARC) is also mentioned as a method to provide new configurations in designing the layout of production facilities, thereby being used to improve productivity and production efficiency. Activity Relationship Chart (ARC) classifies the level of proximity relationships into 6 parts, which can be seen in Table 1 below:

Table 1: Classification of ARC Relationship Degrees

No	Symbol	Art	Color code
1	A	Absolute	Red
2	E	Very Important	Yellow
3	I	Important	Green
4	O	Normal	Blue
5	U	Not Important	Colorless
6	X	Not required	Chocolate

Source: Apple, 1990

The following are examples of reasons that can be used to strengthen the grouping of relationships above, according to Apple (1990:226), as follows:

Table 2: Example Reasons for ARC

No	Reason for Production Relevance
1	Workflow sequence
2	Using the same equipment
3	Using the same notes
4	Using the same space
5	Noise, dirt, dust, vibration, etc.
6	Facilitating the transfer of goods

Source: Apple, 1990

The process of making ARC can be seen in the example image 1. Below.

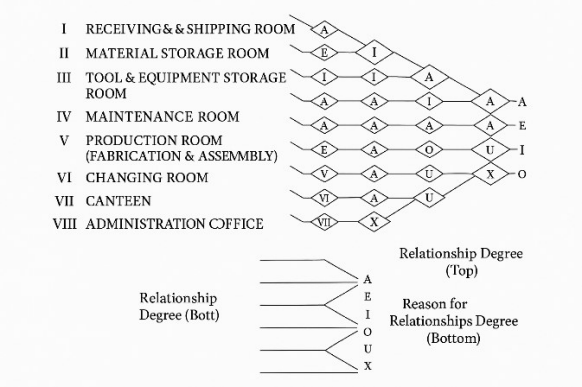


Figure 1. Example ARC

Planning Floor Area Requirements

The factor of facility area requirements is an important stage in the planning process. The calculation of floor space requirements is a factor that must be considered during the process of designing the facility layout. The process of calculating floor space requirements involves facilities that support the production process, ranging from materials and operator equipment to allowances. The calculation of the operator's allowance is 50% of the total area required (Purnomo, 2004). The proposed work area is calculated using the following formula:

Floor Area = (Machine Area × Number of Machines) × 150%

Blocplan

Blocplan is an algorithm for solving spatial layout problems and handling both quantitative and qualitative data. Blocplan prioritizes the integration of exchange and arrangement algorithms [14]. The main concept of the blocplan program is a redesigned layout to be more optimal. The blocplan program can create and analyze different types of layouts in response to input data. The blocplan algorithm is a hybrid algorithm that combines constructive algorithms and improvement algorithms for facility layout design. In this algorithm, an initial layout from a constructive algorithm is required and then developed with an improvement algorithm [1].

In terms of departmental organization, blocplan and CRAFT can be compared. The difference is that CRAFT only uses form to chart, whereas the blocplan approach can use links as input data. Both proximity and distance can be used to calculate the cost of layout size. The software determines how many rows are in the block plan, which usually consists of two or three rows [14].

Blocplan has a disadvantage, which is that it will not replicate the original layout precisely. The only way to develop a layout is by making adjustments or swapping the locations of departments [15]. According to [16], the blocplan sometimes uses a from-to chart map as additional input data besides the relationship map, but only one of the two inputs is used to evaluate the plan. The relationship map and flow data cannot be combined to evaluate the plan. The steps of the blocplan method for creating a layout are:

Entering data is the initial step in running the blocplan application. The number of departments, names, and locations of each department are some of the details required to operate Blocplan. The interrelationship data for each department is another important piece of information. The Systematic Layout Planning (SLP) symbol from Muther is a connecting code or symbol used in the blocplan [16].

In reality, each blocplan user determines the value of each department relationship symbol. For example, the user believes that symbol A is three times more important than

symbol E in an application. However, in another context, this comparison may differ, for example, symbol A is only considered twice as important as symbol E. The system usually displays the values for these symbols, which will later be adjusted according to the user's needs. Symbol A has a value of 10 points, as shown in Figure 2, then symbol E is worth 5 points, symbol 1 is worth 2 points, symbol O is worth 1 point, symbol U is worth zero, and symbol X has a value of -10 points. If the user wants, they can change the value of these connecting symbols.

Blocplan will create and display the score for each department for the aforementioned issue based on the relationship map and the total value of all relationship symbol values. The sum of all symbolic relationship values is the department score [16].

Blocplan will display five options for the length-to-width ratio of the intended layout: 1.35:1 for the first option, 2:1 for the second option, 1:1 for the third option, 1:2 for the fourth option, 1:2 for the fifth option, and 1:2 for the fifth option.

Blocplan can be selected based on user preferences. Blocplan will generate a maximum of 20 layout options. Departments will be randomly arranged in specific sections of the plan. A specific scale will be used to illustrate layout options, and scores will be given to each option. to be able to choose the optimal layout option. Starting with option 1 and continuing to the last option, you can choose it. blocplan will display the layout options and their scores one by one. The best option can be suggested as the option with the highest score.

3. Results and Discussion

Activity Relationship Chart

ARC is created based on considerations of the frequency of material transfer flows between each station, the frequency of operator/labor transfer, the similarity of material handling equipment used, and also factors regarding comfort while working [17].

An easy method for arranging the layout of departments or facilities according to the level of activity relationships is the Activity Relationship Chart (ARC) [18]. According to [19], the purpose of using the Activity Relationship Chart (ARC) method is to provide layout improvement suggestions so that the performance of the export process is not disrupted. The relationship between the material flow pattern and the location of each supporting department about the production department will essentially be explained by this chart [20]. Except for qualitative analysis, this ARC can be compared to the From to Chart. If the From To Chart analysis is conducted with both factors, the ARC will replace the numerical codes that indicate the level of qualitative activity relationships and the letter codes that explain the reasons for selecting letter codes for weight or volume numbers and the distance of material transfer from one department to another [20]. The result of the redesign of the soybean milk production facility layout at PT Sehat Sejahtera Bersama began with the creation of an ARC, which can be seen in the following Figure 2:

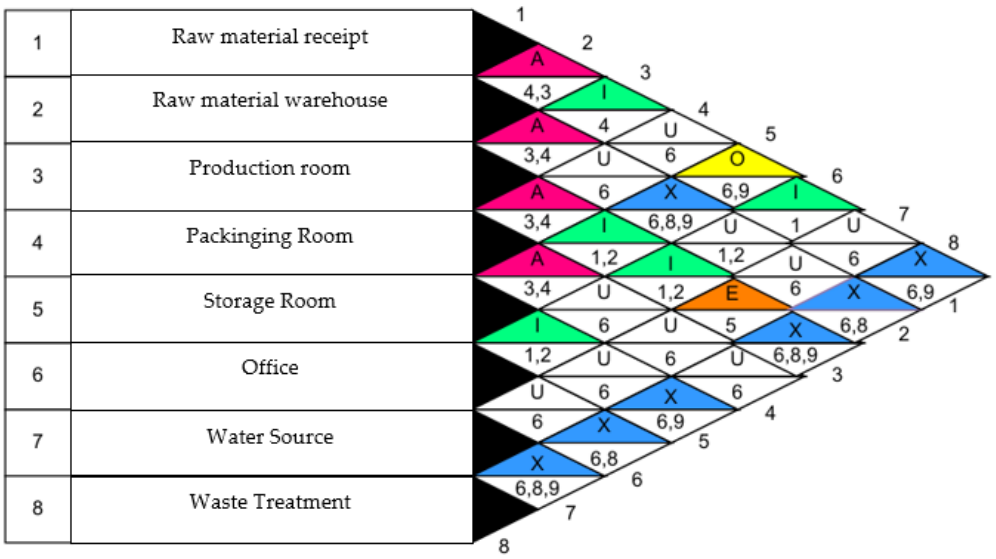


Figure 2. ARC Production PT Sehat Sejahtera Bersama

Based on the image above, it can be seen that several departments must be closely located, such as the raw material receiving department and the raw material warehouse, the raw material warehouse and the production area, and the production area to the packaging area.

Determination of Floor Area Requirements

The calculation for floor space requirements is meticulously considered by identifying the number of departments, taking into account the size and number of machines, the materials processed, and the equipment used. The calculation of space requirements for each department also takes into account tolerances/allowances for machines and operators. The results of determining the space requirements for each department are as follows:

Table 3. Space Requirements

Department	Machines/Work Equipment, etc.	Jml	Size		area (m^2)	Total area (m^2)	Luas total (m^2) × *allowrance*	Keb. Ruang (m^2)
			P	L				
Raw Material Receipt (PBB)	Truck	1	7	2	14	14	14	28
	Total							**28**
Raw Material Warehouse (GBB)	Keranjang BAL	2	0.80	0.60	0.48	0.96	0.48	1.44
	Karung Bahan Kedelai	60	0.90	0.56	0.50	30.24	15.12	45.36
	Keranjang Kemasan	2	0.80	0.60	0.48	0.96	0.48	1.44
	Total							**48**
Production room (RP)	Pekerja Produksi	7	2	1	2	14	7	21
	Sortasi	1	1.60	0.80	1.28	1.28	0.64	1.92
	Timbangan	1	0.6	0.4	0.29	0.29	0.14	0.43
	Bak Perendaman	1	1.88	0.90	1.69	1.69	0.84	2.53
	Mesin Penggiling (*Disc Mill*)	2	0.33	0.33	0.10	0.21	0.10	0.31
	Tangki Rebus	2	0.78	0.98	0.76	1.52	0.76	2.28
	Total							**29**
Packanging Room (RPE)	Pekerja Dan Material	4	2	1	2	8	4	12
	Mesin Sealer	3	0.80	0.40	0.32	0.96	0.48	1.44
	Trolley	2	0.90	0.60	0.54	1.08	0.54	1.62
	Total							**15**
Storage Room (RPN)	Kemasan Plastik Ukuran 150 ml	1000	0.08	0.19	0.015	15.2	7.6	22.8
	Freezer	1	1.70	0.63	1.07	1.07	0.53	1.60
	Total							**24**
Office	Direktur	1	2	2	4	4	1.2	5.2
	Manajer/ Pengadaan Bahan	2	2	2	4	8	2.4	5.2
	Tata Usaha	1	2	2	4	4	1.2	5.2
	Pengawas Produksi	1	2	2	4	4	1.2	5.2
	Musholla	1	2	2	4	4	1.2	5.2
	Toilet	2	2	2	4	8	2.4	10.4
	Officer Boy	1	2	2	4	4	1.2	5.2
	Total							**41**
Water Source (SA)	Tandon Air	2	3.46	2.9	10.03	20.06	10.03	30
	Total							**30**
Waste Treatment (PL)	Kolam Aerasi	1	5	5	25	25	10	35
	Total							**35**

Designing Alternative Proposals Using the Blocplan Algorithm

The process of redesigning the layout was carried out using the help of the Blocplan software (Bplan 90). The proposed layout design process requires input data in the form of ARC and the area of each department. ARC data input is used as the basis for determining the degree of proximity between facilities. The blocplan algorithm is capable of generating up to 20 alternative layouts. The results can be seen in the image below:

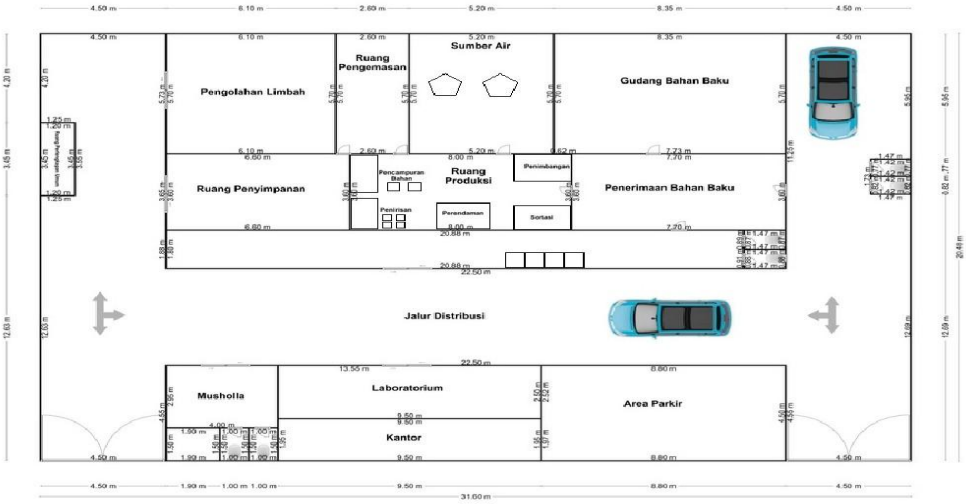


Figure 3. Proposed blocplan layout results

Based on data analysis, Layout 18 was chosen because it showed the highest R-Score value (0.80) and a Distance score value (486), making the layout have the highest R-Score or nearly 1 based on the data processing results at the PT Sehat Sejahtera Bersama production facility. Compared to the initial concept, this new proposed layout includes additional rooms in the center and a location that can be used for storing finished goods.

Based on the total available area and the calculation of the production area requirements at PT Sehat Sejahtera Bersama for machines and a 50% allowance, the total production area requirement is 246.33. Thus, the area needed for the production facilities at PT Sehat Sejahtera Bersama has been met/available, as the total area available is 600 m2.

The layout of PT Sehat Sejahtera Bersama includes several additional features/facilities, such as an office. With the office facilities, PT Sehat Sejahtera Bersama has a dedicated space for administrative support and also a reception area for customers who wish to purchase soybean drink products at PT Sehat Sejahtera Bersama. The results of the selected layout can be seen in the following image:

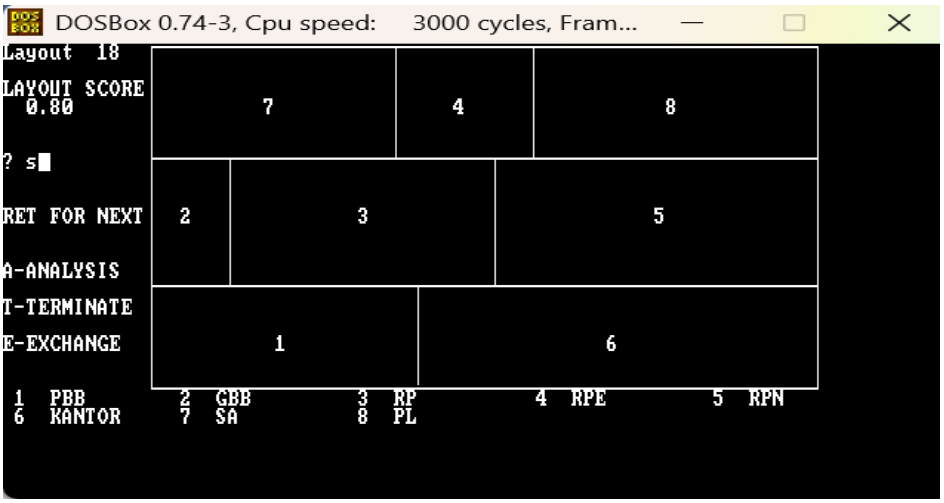


Figure 4. Illustration of Layout Results

4. Conclusions

Based on the research conducted at PT Sehat Sejahtera Bersama for machines and a 50% allowance, the required production area was found to be 246.33. Thus, the area needed for the production facilities at PT Sehat Sejahtera Bersama has been met/available, as the total available area is 647.1 m^2.

There is enough space needed for eight departments or work facilities. The BLOCPLAN technique suggests 20 different layouts; the configuration with the greatest material handling distance savings, layout 17, was selected based on the R-Score value, which is close to 1.

To determine the ideal transfer distance and to calculate the material transfer cost, it is recommended that further research discuss reducing the material transfer distance using additional techniques such as OMH (Material Handling Cost).

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