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Design of the Effective Facility Layout in the Production Department of Healthy Drink

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Abstract: This study presents a study about a design of an effective and efficient facility layout of production department in the health drink industry to improve productivity. Because of the existing layout of facilities did not support the company to achieve the specified target. Repetition of processor and collision between operators when handling material causes problems on the shop floor. So, it is necessary to redesign the layout of production facilities. The Computerized Relationship Planning (CORELAP) algorithm is used to develop a new design. And computers simulation by using Flexim 6 and statistical analysis are conducted to test the hypothesis. The results of this study show that the proposed layout design is valid to reduce distance from 69 m into 48 m and material handling costs in the amount of 30%. Thus, the proposed design is more effective and efficient to improve productivity of production.

Key words: CORELAP, effective, layout, material handling, amount, Indonesia

INTRODUCTION

Basically, the layout of production facility is one of basic elements in design of work stations. The layout needs to be designed, so that the flow of production can proceed smoothly, effectively and efficiently (Bordoloi and Nath, 2014). This can be done by managing the facility layout in such by the proximity relation (Muther and Wheeler, 1994). Thus, it needs to rearrange the facility to simplify flow of production to increase productivity (Khan and Tidke, 2013; Bordoloi and Nath, 2014).

CV. XXX, is a manufacturer and distributor in the field of health drink of tea bags and brewed tea. Currently, the company wants to increase sales up to 10,000 bags each month but production in 2016 is still about 50% of target that is 5430 bags. It because of the flow production process and lead time are too long. Based on the preliminary study was found that flow process bring about backtracking and crowded such that the material handling cost is too high.

Material handling systems are not systematic become a big problem and disrupting the production process, so as affecting the system as a whole (Sule, 1994; Peer and Sharma, 2008). Well organized flow process is a major factor that affects the efficiency of production (Fitriani *et al*., 2015). So, a good layout of production process will eliminate some problem on material handling system (Lee and James, 1967; Peer and Sharma, 2008). Therefore, it is significant to be redesigned. The purpose of this study is to redesign the layout of health drink production facilities to improve productivity (Alex *et al*., 2010).

MATERIALS AND METHODS

Survey: Direct observation was conducted in the object of research. It is to identify the Initial layout of production department, flow process of production, direct labor cost, material handling tools.

Computerized Relationship Layout Planning (CORELAP) algorithm: CORELAP (Computerized Relationship Planning) algorithm was introduced by Lee and James (1967). This method develops a construction of layout. It works based on the product of Total Closeness Rating (TCR) that is a total of numeric values for relationship among departments (Alex *et al*., 2010). This algorithm requires initial data that consists of (Muther and Wheeler, 1994; Lee and James, 1967):

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- Activity Relationship Chart (ARC)
- Areas of each department
- The number of departments
- Closeness rating

As for procedures to use CORELAP algorithm is as follows:

Algorithm 1:

1. Calculate a TCR for each department (Khan and Tidke, 2013)
2. Select the highest TCR value of department for determining as fix location. If there are some departments having similar TCR then select a departement that has lots of absolute closeness
3. Subsquently, the next location of departement is determined refering to the second highest TCR
4. Repeat this process is started from step two until the entire department is located. If no department has A (absolute) or E (excellent) grade for closeness then proceed to I (Important) or O (Ordinary) or U (Unimportant) or X (unexpected) grade for closeness

Activity relationship chart: Activity Relationship Chart (ARC) is a method or technique for determaining degree of relationship between department (Muther and Wheeler, 1994). This degree consist of Absolute (A), Excellent (E), Important (I), Ordinary (O), Unimportant (U), undesireble (X) (Muther and Wheeler, 1994; Tompkins *et al*., 2010; LLC., 2003).

Total closeness rating: TCR is the calculation of the degree of proximity of each department or facility that is described in the Activity Relationship Chart (ARC) (Muther and Wheeler, 1994; Poor, 2010). This method refers to the degree of proximity between department that is a product of ARC. Result of TCR determine a priority for sequence location of department.

Simulation: Simulation is conducted by using Flexim 6 Software to model the initial model and the proposed model (Flexsim Archieves, 2009; Salman, 2014).

Material handling cost: The equation of material handling cost is used as follows:

$$OMH = r \times f \times OMH/m$$

OMH = The cost of material handling
r = The distance of displacement (m)
f = The frequency of removal

RESULTS AND DISCUSSION

Analysis of activity relationship among department: Figure 1 shows the result of ARC on closeness level between one department to another in production floor. It consists of ten departments namely receiving, raw material warehouse, grinding, weighing and mixing, tea bagging machine, oven, sealing, packing 1, 2 and finished goods warehouse.

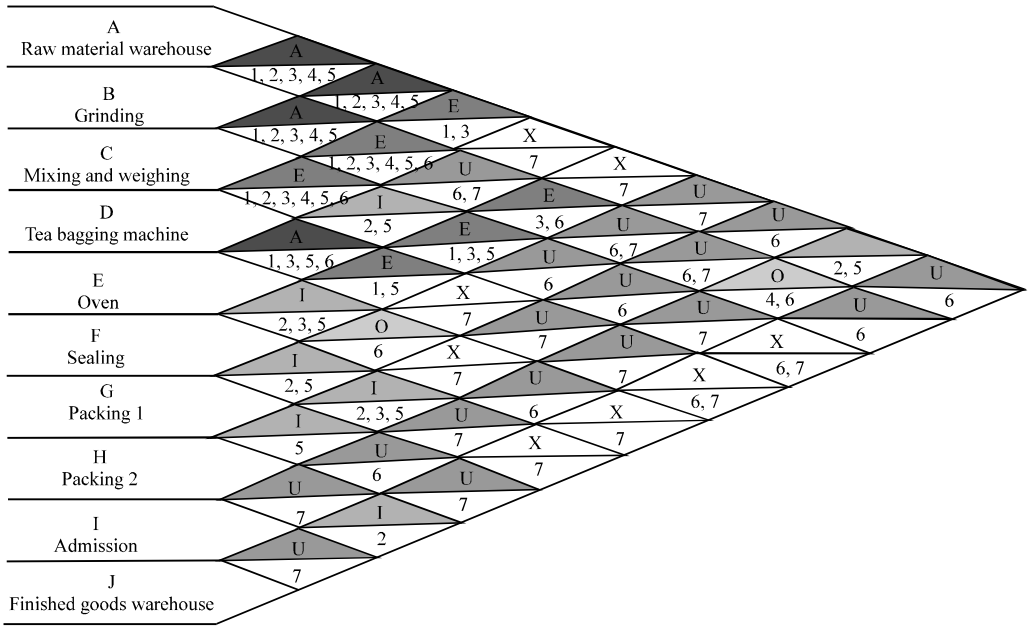

Fig. 1: Activity relationship chart; the reason: 1) Maintain sterility of raw materials; 2) Efiensi displacement; 3) Maintaining the quality of raw materials from outside the state; 4) Ease of monitoring; 5) Ease of haulage; 6) Protentially contaminated dust and 7) Annoying production process

Table 1: Total closeness rating

Facilities																		
Rating	1	2	3	4	5	6	7	8	9	10	A	E	I	O	U	X	SCO RE	TCR TCR
1	-	A	A	E	U	E	U	U	A	U	3	2	0	0	4	0	27	1
2	A	-	A	E	U	E	U	U	U	U	2	2	0	0	5	0	23	3
3	A	A	-	E	I	E	U	U	U	U	2	2	1	1	4	0	27	2
4	E	E	E	-	A	E	U	U	X	X	1	4	0	0	2	2	23	5
5	U	U	I	A	-	I	O	U	U	X	1	0	2	1	4	1	17	6
6	E	E	E	E	I	-	I	I	X	X	0	4	3	0	0	2	25	4
7	U	U	U	U	O	I	-	I	O	X	0	0	2	2	4	1	14	7
8	U	U	U	U	U	I	I	-	A	U	1	0	2	0	6	0	17	8
9	A	U	U	X	U	X	O	A	-	I	2	0	1	1	3	2	18	9
10	U	U	U	X	X	X	X	U	I	-	0	0	1	0	4	4	7	10

Raw material warehouse have Absolute closeness (A) with grinding department and mixing and weighing department and also grinding department with mixing and weighing department. While tea bagging machine departments are in absolute closeness with the oven department. That is because they should be close to each other to make efficient flow process as well as to maintain the raw material.

While tea bagging machine with mixing and weighing, grinding, a raw material warehouse department and sealing department have Excellent closeness (E). It because to maintain quality of raw materials. And oven department with weighing and mixing and sealer department then sealer deaprtment with packing 1 and 2 department then packing 1 and 2 department with the finished goods warehouse then admissionwith the raw material warehouse has an Important closeness (I) level. It because to move easily.

An oven department with packing 1 department and tea grinder department with admission deaprtment have Ordinary closeness (O) level. It because of easiness to monitor. The other department has Unimportant closeness (U) level. This means no critical link.

Analysis of total closeness rating: Table 1 describes result of TCR that is a closeness rating for each department based on result of ARC. Department 1 and 3 have the highest TCR that is 27. It means that these departments should be located in the first position. Because these departments are most critical to start a production process. And other departments is placed to next location refers to the next higher TCR.

Validation: From the initial layout validation results using statistical tests on Flexim 6, the layout has been considered valid. It because of the equality test that is two averages calculated H_0 and Z is accepted for entry within limits. Calculated H_0 and F on two variance equality test is also included in the limit as well as the chi H_0 if the calculated $\chi^2<\chi^2$ Table and the simulation results show the value 12.78333333<9.487729037. So that, in other words, simulation data results were in accordance with data of with the real system.

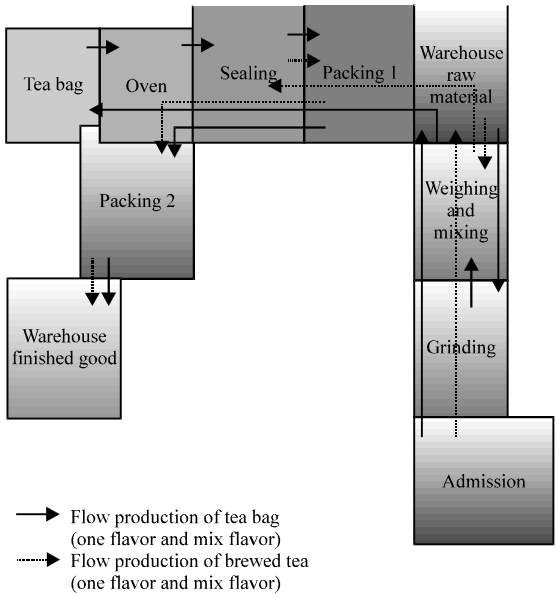

Fig. 2: The initial layout

Analysis of proposed layout design: Figure 2 is the initial layout design and Fig. 3 shows the simulation on Flexim 6 of initial layout. Figure 4 is the the results of the final iteration of CORELAP and (Fig. 5) shows the proposed layout from iteration. That describes the proposed layout design of shop floor.

The proposed design has a change in the position of department which producing a shorter of total distance from 6-48 m. So, it can reduce total of material handling cost in the amount of rupiah (30%). As well as the flow process is also more efficient and effective.

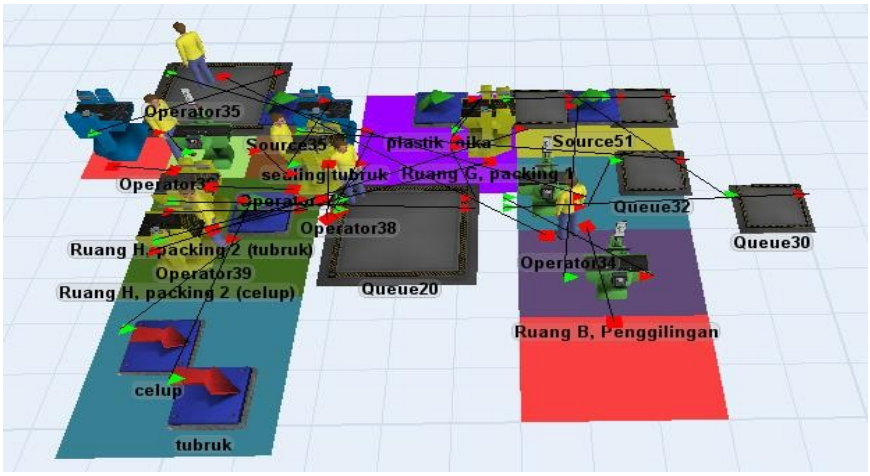

Fig. 3: The simulation of initial layout

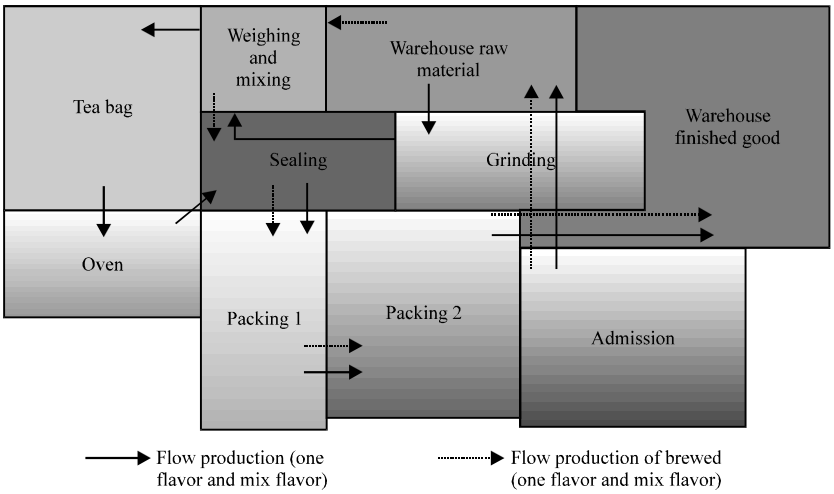

Fig. 4: The proposed layout

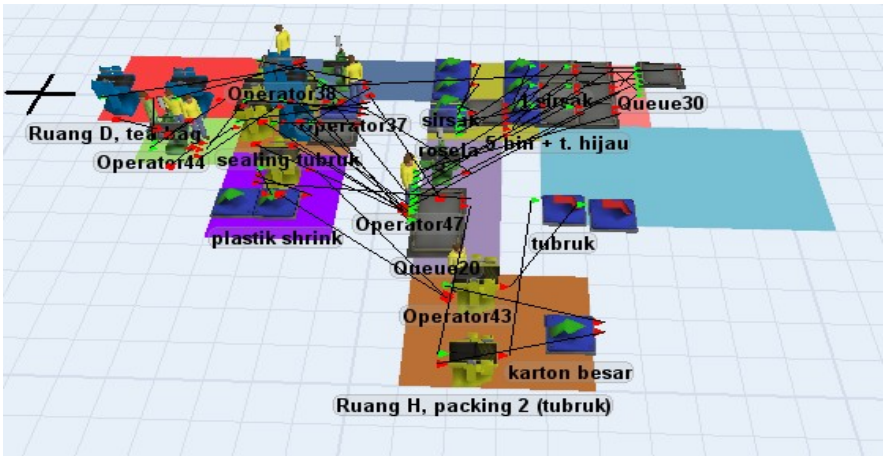

Fig. 5: The simulation of proposed layout

CONCLUSION

It was concluded as follows: the proposed design has a change in the position of department which a raw material warehouse is a department in the first location. Subsequently, a mixing and weighing department is in the second location. And grinding department is in the next location. In the 4th location is sealing department. Tea bagging machine department is in the fifth location. For the sixth location is department of oven and for the seventh location is packing 1. Department of Packing 2, Department of Admission and Department of Finished Goods Warehouse is location for the 8th-10th.

The proposed design produces a shorter of total distance from 69 m into 48 m, so that, it can reduce 30% of total of material handling cost. Computerized layout planning is one of an effective method to redesign the facilities. So that, the proposed layout design of facilities in production department is more effective and more efficient to save manufacturing cost and continuity of a process of tea bag and brewed tea production.

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