PLANT LAYOUT IMPROVEMENT OF SUPPLEMENTARY FOOD FACTORY USING SYSTEMATIC LAYOUT PLANNING TECHNIQUE IN THAILAND

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1. Introduction

Nowadays people around the world focus on beauty and health which stimulates demand for beauty and health-related products. Thailand is a country which is located in Southeast Asia. There are many different types of herbs in forests. Therefore, many traditional medicine or supplements are made of herbs in Thailand. Many Thai entrepreneurs are interested in this business sector. They need to increase their potentials in production and effectiveness. At the same time, the production process needs to be equipped with more or better equipment.

Management would like to improve their plant layout based on many reasons such as wasted times or delays in manufacturing, bad environment, increasing their productivity. According to these problems, researcher would like to analyze the problems and to find the way to improve the plant layout. A good layout is one which allows material flow rapidly.

However, Manufacturers of dietary supplements in Thailand have a legal obligation to comply with good manufacturing practices (Good Manufacturing Practice, GMP) for food products, such cleaning body area, locker room areas, etc. These activities may or may not exist in a company. Some facilities are also fixed. They are already existed in present layout. It takes costs to move to new locations. Therefore, a new plant layout must be considered these conditions in order to get a new plant layout.

2. Literature Review

The Systematic layout planning (SLP) is a tool used to arrange a workplace in a plant by locating two areas with high frequency and logical relationship close to each other. This technique is also organized way to layout planning. It involves of procedures, based on conventions for identifying, rating and visualizing the elements involved in plant (Patill and Kuber, 2014).

Plant layout embraces physical arrangement of industrial facilities i.e, operating equipment, personnel, materials and other services. Systematic layout Planning (SLP) is a plant layout technique that have been used by many academic and practitioners (Zhou, et al., (2010); Sutari and Rao U,2014). The SLP method is showed step-by-step of plant design from input data and activities to evaluation of plant layout (Shewale, et al., 2012).

The detailed procedures for SLP is shown in the figure 1.

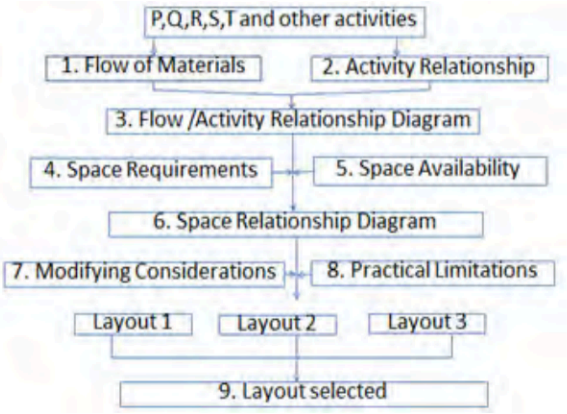


Figure 1 Systematic Layout Planning Processes

A supplementary food company is located in Chiang Mai province which is in northern region of Thailand. The company has its production line already. Area of present production process is 250 square meters. Production capacity of the plant is 1,350,000 bottles per year. Management would like to increase the capacity up to 3,000,000 bottles per year. At present a company is having a new process layout and getting some more new machines.

The company is produced four products. However, all products have the same production processes. These products contain with different ingredient and mixture ratios. The factory has a production period (batch) is producing products based on customer needs. A product which has the highest demand is selected to study.

3. Result

3.1 activity relationships

The production process of liquid supplementary food is started from washing glass bottle, disinfecting filling, sterilizing, labeling and packaging. Many machines and equipment are used in the production process. There are washing machine, disinfection incubator, filling machine, sterilizer oven and labeling machine. The operation process chart, flow of material and activity relationship chart have been used in analysis. A flow diagram of the manufacturing activities of the factory and activity relationship chart are shown in figure 2 and figure 3, respectively.

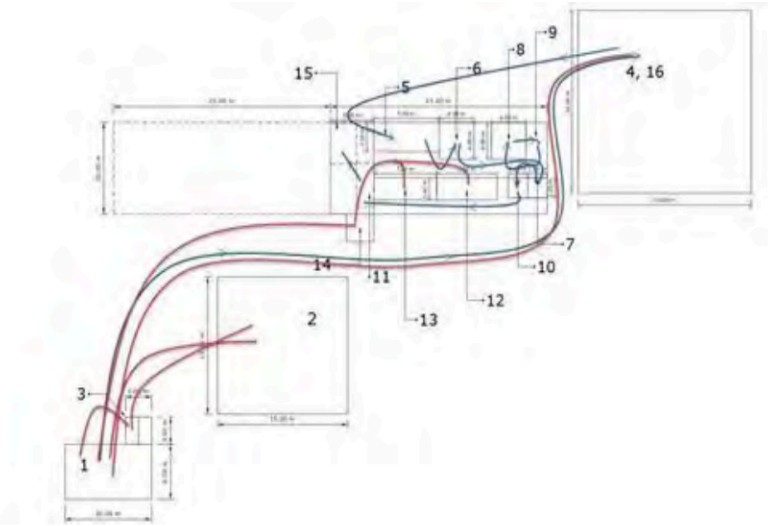


Figure 2 flow diagram of the present manufacturing activities

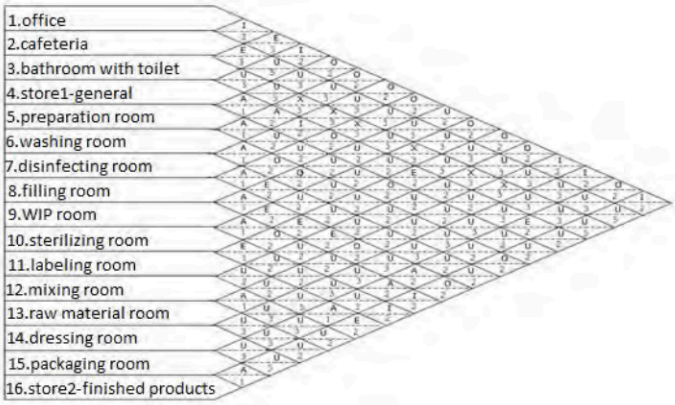


Figure 3 Activity relationship diagram of the present manufacturing activities

In order to calculate the overall score acquaintance (Total Closeness Rating: TCR), the score of all relationship levels were defined as follows: Class A = 10,000, E = 1,000, I = 100, O = 10, U = 0, X = -10,000 (Francis, et al., 1992). TCR is the sum of the value of the relationships with other departments. The highest score will be the first activity of the layout. The scoring is shown in table 1.

Activity	Process																Relationship						TCRs
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	A	E	I	O	U	X	
1	-	I	E	I	O	O	O	O	U	O	O	O	I	I	O	I	-	1	5	8	1	-	1580
2	I	-	E	U	U	U	U	U	U	U	U	U	U	U	U	U	-	1	1	-	13	-	1100
3	E	E	-	U	U	X	X	X	U	X	U	X	X	U	U	U	-	2	-	-	7	6	-58000
4	I	U	U	-	A	A	I	O	U	U	E	U	U	U	E	U	2	2	2	1	8	-	22210
5	O	U	U	A	-	A	U	U	U	U	O	U	U	U	U	U	2	-	-	2	11	-	20020
6	O	U	X	A	A	-	A	O	O	U	U	U	U	U	U	O	3	-	-	4	7	1	20040
7	O	U	X	I	U	A	-	A	E	U	U	U	U	U	U	U	2	1	1	1	9	1	11110
8	O	U	X	O	U	O	A	-	A	E	E	E	O	U	A	O	3	3	-	5	3	1	23050
9	U	U	U	U	U	O	E	A	-	A	O	U	U	U	A	I	3	1	1	2	8	-	31120
10	O	U	X	U	U	U	U	E	A	-	E	U	U	U	U	I	1	2	1	1	9	1	12110
11	O	U	U	E	U	U	U	E	O	E	-	U	U	U	A	E	1	4	-	2	8	-	14020
12	O	U	X	U	U	U	U	E	U	U	U	-	A	U	U	U	1	1	-	1	11	1	1010
13	I	U	X	U	U	U	U	O	U	U	U	A	-	U	U	U	1	-	1	1	11	1	110
14	I	U	U	U	A	U	U	U	U	U	U	U	U	-	U	U	-	-	1	-	14	-	10
15	O	U	U	E	U	U	U	A	A	U	A	U	U	U	-	A	4	1	-	1	9	-	41010
16	I	U	U	U	U	U	U	O	I	I	E	U	U	U	A	-	1	1	3	1	9	-	11310

Table 1 shows a summary of the overall ratings closely

The activity numbers 1, 2, 3, 4, and 16 activities are fixed locations. They are office, cafeteria, bathrooms and storage. Activity number 14 is an activity that must follow good practices (Good Manufacturing Practice, GMP). All production workers need to do this activity before enter to the plant. Therefore this activity must be done outside the plant. Thus there are only 10 activities left (activity 5, 6, 7, 8, 9, 10, 11, 12, 13, and 15).

3.2 Space

The numbers of machine or equipment are also analyzed in order to meet the management's requirement. According to the type of plant layout, which is a product layout, numbers of machine is calculated. The following equation is used.

$$M_{ij} = \frac{P_{ij} \cdot T_{ij}}{t_{ij}}$$

where

Mij = j kinds of machinery products i

Pij = production rate of the machine type i j

Tij = Time of manufacturing equipment type i by j

t ij = All production of products using Mascus i j

The results of the calculations are detailed in Table 2.

Types of machine	Before improvement		After improvement	
	amount (machine)	Area (sq.m.)	amount (machine)	Area (sq.m.)
1. Bottle washer	1	6	1	6
2. Disinfection incubator	1	5.5	2	11
3. Containing machine	1	8	2	16
4. Sterilized incubator	1	5.28	1	5.28
5. Labeling machine	1	3.6	3	10.8

Table 2 Number of machines and their areas before and after improvement

3.3 Adjustments

Position of each activity is developed by using the TCR (table 1). The following step is carried out to select placement sequence of departments:

1. Select the highest TCR value deployed first.

2. Look at the relationship by considering the relationship between A and then followed by E, I, O, U, respectively. If there are two A of the relationship, it is considered that the A which has more value than another. It will be first deployed.

3. The position is held by an anti-clockwise to add to the channel with the lowest number first

A development of placement sequence of departments is shown in Figure 4.

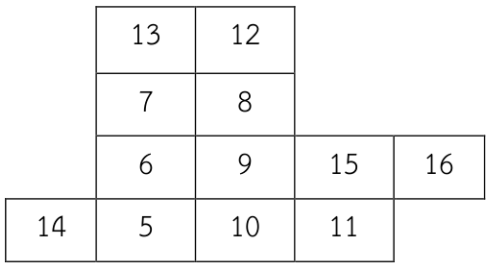
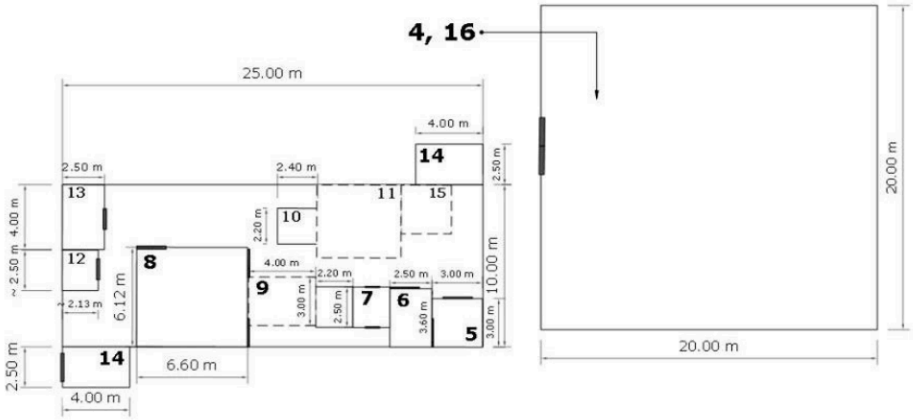
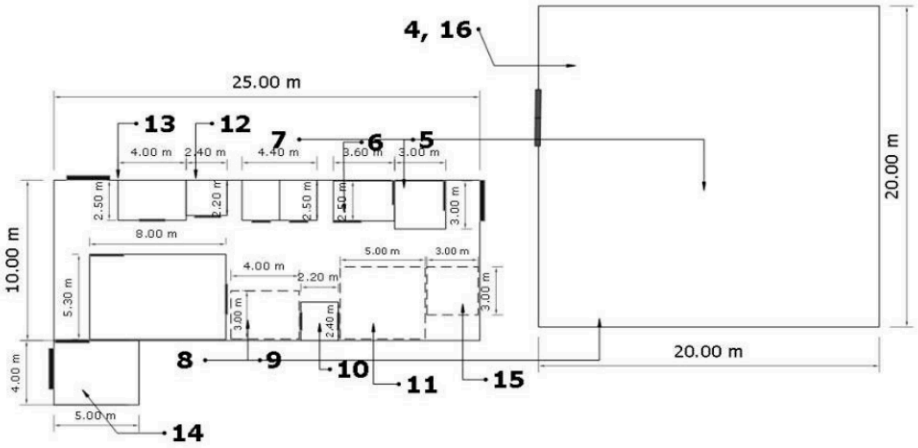


Figure 4 the placement of departments using TCRs.

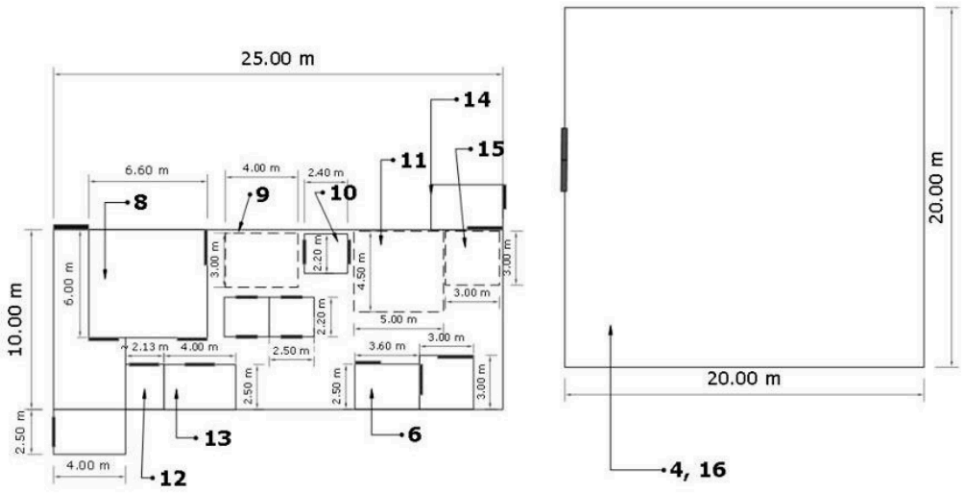
We discussed with management, supervisors, and workers about the placement of departments. Based on adjustment concept and practical limitations, a numbers of layout were developed. There are three different proposed plant layouts as shown in Figure 5.



a. Proposed plant layout no. 1



b. Proposed plant layout no. 2



c. Proposed plant layout no. 3

Figure 5 Three proposed plant layout

3.4 Assessment

Two Assessment methods are used to evaluate the proposed plant layout. There are 1) to evaluate distance-based scoring method and 2) to assess the satisfaction method.

The distance-based-scoring method is a method that needs two different data. The first data is distance data. The distance of each department is measured from the center of department (centroid) to the next department by using the computer program Sketchup. The second data is frequency of each activity. The frequencies of each activity are observed and recorded for 5 days.

The following equation is used to evaluate the activity : for m.

$$S = \sum_{i=1}^{m-1} \sum_{j=i+1}^{m} f_{ij} D_{ij}$$

where

Dij is the distance between activities or departments i and j.

fij is often - out of each department per unit distance moves between departments or between departments i and j, j, i.

The second assessment is to assess the satisfaction of those who involved. A questionnaire is developed. There are seven topics which have different weight. Each topic has four levels of satisfaction levels. Satisfaction levels were defined as follow: 4 = most, 3 = moderately satisfied, 2 = satisfy, and 1 = least. Manager, supervisors and workers were asked. The results of both assessment methods are shown in Table 3 below.

Type of Layout	distance-based scoring method	satisfaction method
Present layout	961.72	-
Layout no. 1	874.62	560
Layout no. 2	808.78	485
Layout no. 3	808.55	515

Table 3 Results of assessment methods using distance-based scoring method and satisfaction method

As results in table 3, we have found that different assessment provides different solution. Management and workers discussed and made a decision. Finally, they have chosen a proposed plant layout no. 1. Their reasons mainly are they did not want to move their dressing rooms and they familiar with its original location.

4. Discussion

Dressing room is a specific activity to comply with good manufacturing practices (GMP). This activity must be done before get in the plant. In this study, we have tried to set its TCR value up to 50,000 (the actual value equals 10). Thus, a dressing room should be the first activity in the plant layout. However, the dressing room should be located outside the plant. Since the present plant layout already has this activity. Therefore, the location of a dressing is in the same.

Frequency data may not enough. Some studies used costs per unit of distance data instead of frequency data. But in this study, the plant is quite small and it is labor intensive investment. Cost per unit of distance data may not appropriate.

Assessment of plant layouts provides different results. It is an interesting issue, which occurs in practice. Although analyst has quantitative data such as distance and frequency data, which are reliable data. However, when the data was analyzed, the result may not acceptable. Because the data has limitations.

The decision making using the satisfaction of the people involved could be quite inappropriate. Generally, people prefer what they familiar with rather than what they have to change. It is possible that they will satisfy with the familiar one rather than the others.

5. Conclusion

A new plant layout of supplementary food plant is developed using systematic layout planning (SLP). Ten activities are relocated within 250 square meters. Some more chines are needed such as filling machine, labeling machine and disinfection oven. The capacity of the new plant can produce 3,000, 000 bottles per year. The total distance of the new plant layout is decreased 9.05% when compare with the distance of the present layout.

6. References

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