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Systematic Layout Planning for Germinated Brown Rice Mill under GMP and ISO22000:2005 requirements

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Abstract—*This research aimed to study the effect of international standard for food safety to facility layout planning. Systematic layout planning was the procedure which be modified by integrated GMP and ISO22000 requirement into the initial phase of SLP. The result revealed that the integrated requirements help ensuring the safety and quality of food production process. In addition, three alternative layouts were developed and evaluated by using the materials handling distance as a criterion. The improved layouts could reduce the excessive transportation 76.66% to 81.21% and the selected layout can reduce distance from 47 meters to 8.83 meters.*

Keywords —*Systematic Layout Planning, Facility Planning, GMP, ISO22000, Rice Mill*

I. INTRODUCTION

Facility layout planning is an important activity for every manufacturing. A bad facility layout leads to excessive cost and ineffective production processes. So, an appropriate plant layout planning and design contributed to productivity of the factory and shorter lead time.[1]

In the food industry, a lot of requirements were forced the factory including GMP and HACCP. Some of those requirements had effects to facilities layout. Donk and Gaalman [2] were studied the food safety requirements and offered an approach that enables hygienic layout design of a food-processing plant that is particularly useful in production engineering and design for food processing companies. However, there is a little published papers concern about food hygienic in germinated brown rice mill which had specific processes. Therefore, this paper studied about facility planning and the effects of GMP and ISO22000 requirements on systematic plant layout for germinated brown rice mill in community enterprise.

II. LITERATURE REVIEW

Systematic layout planning or SLP is the facility layout design method which developed by Muther [3] in 1976. SLP methodology consisted of 11 steps including initial data investigation or PQRST analysis, flow analysis, activities relationship analysis, determining relationship diagram, space requirements calculation, space adjustment, determining space relationship diagram, modifying constraints, practical limitation, developing layout alternatives, and layout evaluation[4]. There are many academic papers studied the application of SLP in various industries. Kaewchua and Kiatnukul [5] used SLP to improve metal box plant in Thailand. The result of improvement could decrease material handling distance from 191.51 meters to 128.33 meter or 34% decreasing. Somsook et al.[6] had also applied SLP to wood furniture factory and reduced material handling distance 60.35%, material handling time 56.30% and production capacity increase 34.26%.

Good manufacturing practice or GMP was developed by CODEX, international food standard established by Food and Agriculture Organization of United Nation or FAO and World Health Organization or WHO, and was adopted by many countries worldwide. GMP is a manufacture and testing practice which helps

to ensure quality and safety of food and drug [7]. Many research papers studied about GMP in food manufacturing. Matyjek et al. [8] surveyed the situation of implementation Critical Control Point (HACCP) , Good Manufacture Practice (GMP) and Good Hygiene Practice (GHP) in food manufacturing plants. The survey revealed that 91% of the surveyed plants are familiar with GHP rules and 95% with HACCP. Amoa-Awua et al [9] studied about the effect of applying GMP and HACCP to traditional food processing at a semi-commercial kenkey production plant in Ghana. Their result showed that application of GMP and HACCP was effective as a quality management system for assuring the safety of kenkey in the traditional processing of maize into kenkey.

ISO22000 is an international standard for food safety management system developed by International Organization for Standardization. The ISO 22000 standard specified the requirements for a food safety management system that involves four element including interactive communication, system management, prerequisite programs and HACCP principles. ISO 22000 had been aligned with ISO 9001 in order to enhance the compatibility of the two standards and also integrated the principles of the HACCP system and application steps developed by the Codex Alimentarius Commission.[10]

III. METHODOLOGY

Methodology of germinated brown rice mill's facility planning followed Muther's SLP procedure. However, GMP and ISO22000 requirements were considered in the PQRST and relationship analysis session. Therefore, the modified SLP procedure was shown in Fig. 1.

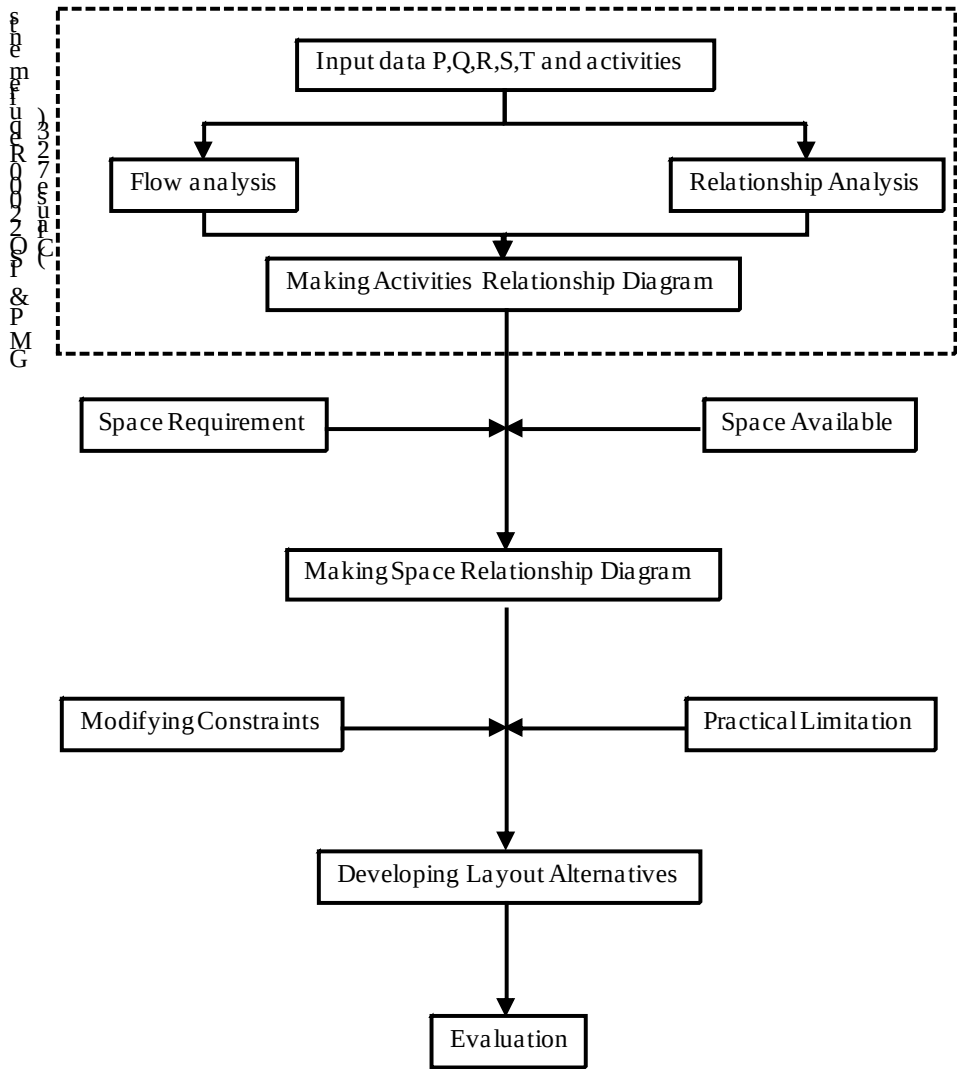


Figure 1 Systematic Layout Planning with GMP and ISO22000 requirements.

IV. RESULT AND DISCUSSION

4.1 Input data P, Q, R, S, T and activities

Input data was collected by interview, investigation and field survey. All necessary data was described in table 1.

Table 1 Data PQRST

Data	Details	Remarks
Product (P)	Germinated brown rice	
Quantity (Q)	100 kilograms per day	
Routing (R)	See Fig.1	
Support Service (S)	Dressing room	GMP and ISO22000 required dressing room before enter into production process.
Time (T)	Average demand 3,000 kilogram per month	

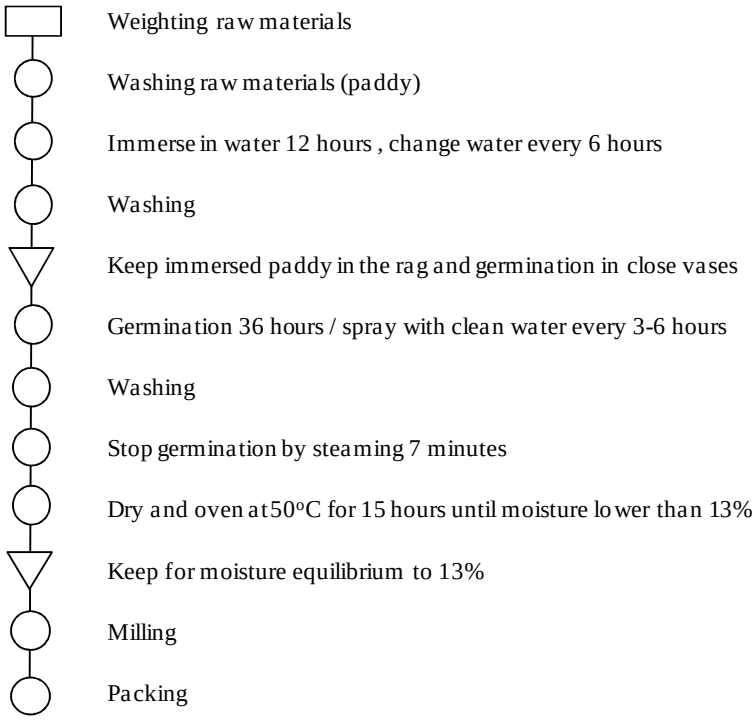


Figure 1 Production process of germinated brown rice.

4.2 Flow analysis

Flow process chart was selected to analyze the flow of material from the beginning to the end of process. The flow process chart of germinated brown rice production was shown in Table 2.

The material flow of germinated brown rice production could be categorized to five main activities including operation, transportation, inspection, delay and storage. There were 5 operation activities, 6 transportation activities, 1 inspection activity, and 1 storage activities. The distance of material handling in the traditional facility layout was 47 meters. There was excessive transportation between rice milling process and drying process because of separation of the machine.

Table 2 Flow Process Chart for flow analysis.

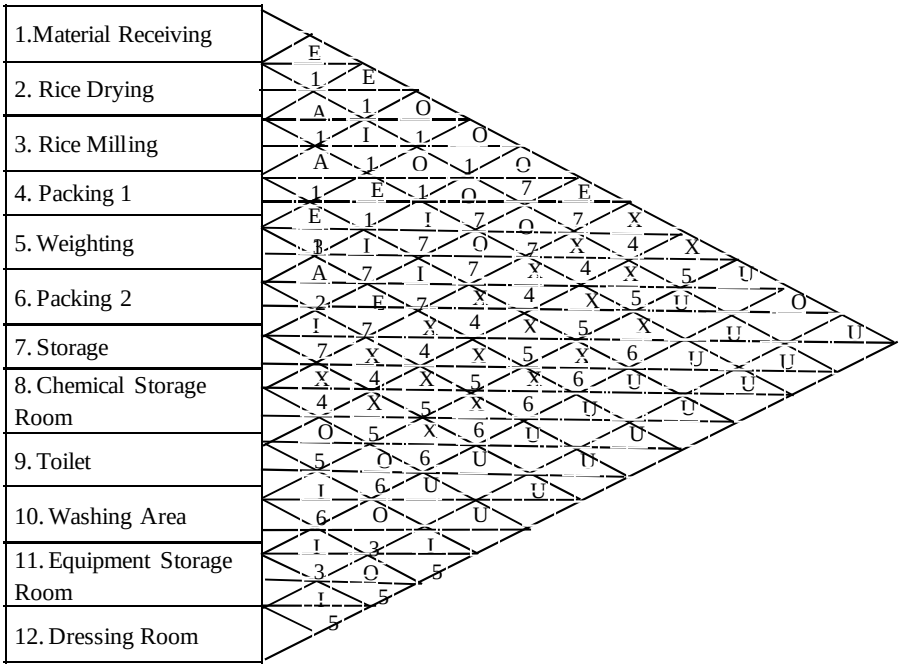
CHART NO. 1 SHEET NO.1	SUMMARY			
ACTIVITY: GERMINATED BROWN RICE PRODUCTION		PRESENT	PROPOSE	SAVING
LOCATION: UBON RATCHATHANI, THAILAND	OPERATION	5	-	-
PREPARED DATE: 16 JANUARY 2012	TRANSPORTATION	6	-	-
APPROVED DATE: 16 JANUARY 2012	INSPECTION	1	-	-
OPERATOR: KANOKWAN SUPAKDEE PAWINYADA BOONROM CHET SRIMAITREE SUPERVISOR: ASST.PROF.PEERASAK S.	DELAY	0	-	-
	STORAGE	1	-	-
	DISTANCE (METER)	47	-	-

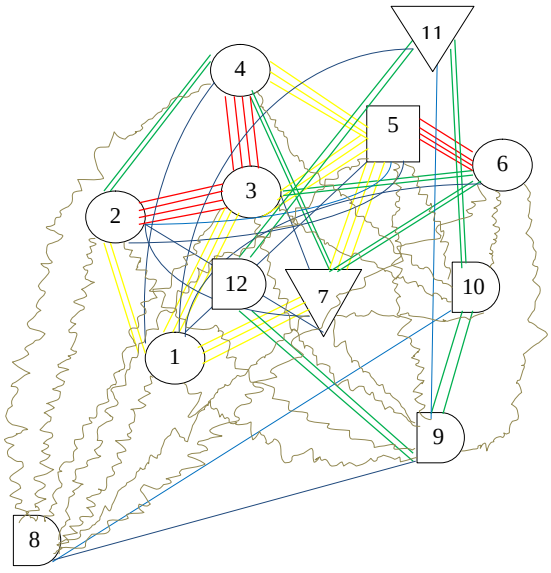
DISTANCE (m)	TIME (sec.)	SYMBOL	DESCRIPTION
-	N/A		Raw materials receiving (after germination process)
10	N/A		Move to drying process
-	N/A		Drying process
14	N/A		Move to rice milling process
-	N/A		Rice milling process
1	N/A		Move to packing area
-	N/A		Packing rice to plastic bag
3	N/A		Move to scale
-	N/A		Weight the finish product
16	N/A		Move to packing station 2
-	N/A		Packing station 2 (wrapping with brand's packaging)
3	N/A		Move to storage area
	N/A		Storage
47	N/A	5 6 1 0 1	Total

4.3 Relationship analysis and activity relation diagram

Activities in the germinated brown rice production process were arranged in 12 activities including material receiving, drying, rice milling, packing, weighting after pack, chemical storage, toilet, washing area, equipment storage, and dressing room. The arrangement of activities was based on GMP and ISO22000

requirements. All activities were analyzed their relationship by using activity relationship diagram as shown in Fig.3





Code	Score	Line Character	Relationship Level	Color
A	4		Absolutely Necessary	**Red**
E	3		Especially Important	**Yellow**
I	2		Important	**Green**
O	1		Ordinary Closeness OK	**Blue**
U	0		Unnecessary	No color
X	-1		Not Desirable	**Brown**
XX	-2, -3 -4, ?		Extremely Not Desirable	**Black**

Figure 3 Relationship diagram for germinated brown rice production.

Relationship diagram showed that chemical storage room (No.8) was extremely undesirable from other activities except toilet (No.9) and washing area (No.10). Similarly, toilet and washing areas were prohibited from production and packing process. This result revealed that a consideration of GMP & ISO22000 requirements in SLP procedure can help to ensure the safety and hygiene of food production.

4.4 Layout alternatives

After the consideration about space and other constraints we established three alternatives of germinated brown rice mill. The layout and flow diagram of each alternative were shown in Fig.4.

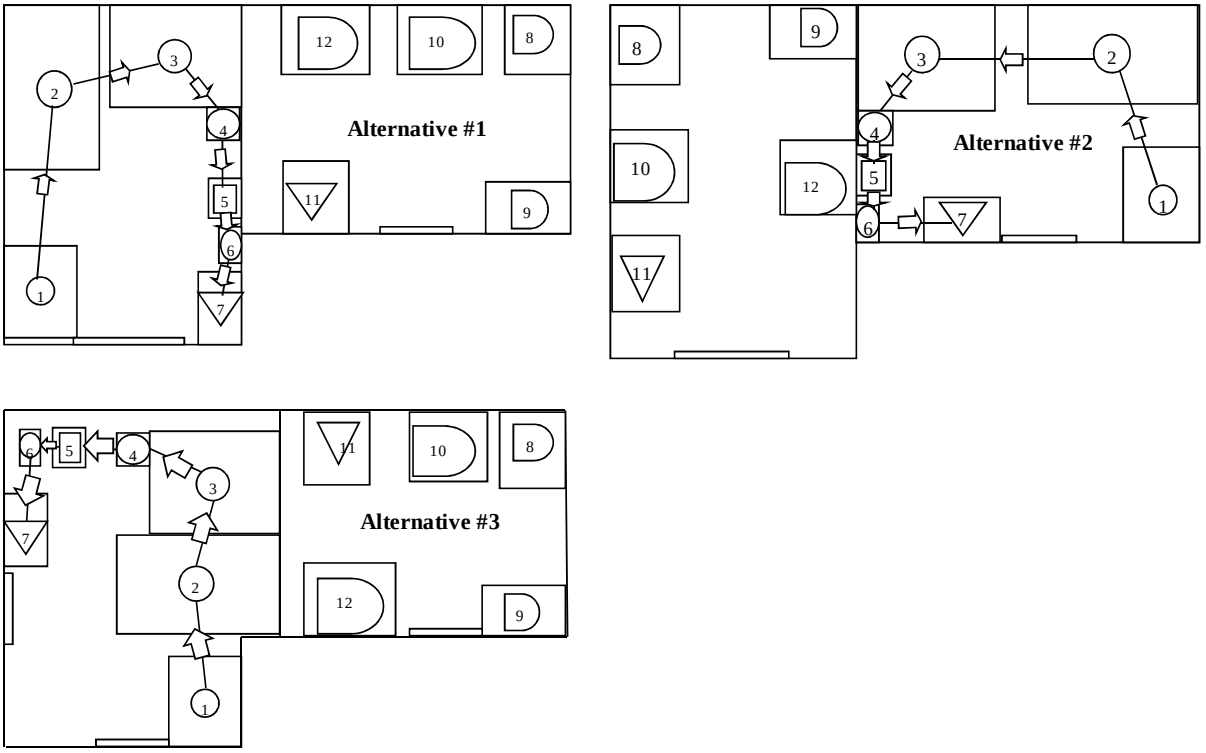


Figure 4 The alternative facility layout for germinate brown rice mill.

In an alternative layout number 1, all machines in production process were moved into the single room on the left hand side. This improvement could reduce the excessive transportation distance from 47 meters to 10.83 meters. The alternative layout number 2 was improved in the same manner, production processes were grouped and arrange in the single room. However, in an alternative layout number 2, space between each machine was different. Therefore, distance of material handling was reduced to 10.97 meters. The last alternative layout, number 3, was modified the structure of factory building to allow minimization of gap between drying machine and rice milling machine. This alternative layout could reduce material handling distance to 8.83 meters.

4.7 Evaluation

In this paper, an evaluation criterion for selecting the appropriate facility layout for germinated brown rice was material handling distance. So, the evaluation result was shown in table 3.

Table 3 Evaluation result

Facility Layout	Present	Alternative#1	Alternative#2	Alternative#3
Material handling distance (m)	47.00	10.83	10.97	8.83
% Reduction		76.96%	76.66%	81.21%

V. CONCLUSION

This research was studied about systematic layout planning for germinated brown rice mill in community enterprise under GMP and ISO22000 requirements. Three facilities layout were designed by using SLP procedure with food safety requirement consideration. The evaluation criterion in this paper was material handling distance. Therefore, the alternative layout number 3 was an appropriate facility layout which could reduce material handling distance from 47 meters to 8.83 meters or 81.21% reduction.

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