Facility Layout Improvement: Based on Safety and Health at Work and Standards of Food Production Facility

Asifa Fitriani, Galih Prakoso, and Anton Mulyono Azis

***Abstract*—**This study aims to improve the layout design of a Micro, Small and Medium Enterprises (SMEs) to minimize material handling and redesigning the layout of production facilities based on the safety and health and standards of food production facilities. Several layout problems of chip mushroom industry in Indonesia is cross movement between work stations; work accidents; and the standard of facilities that do not conform with the standards of the food industry. Improvement layout design using CORELAP and 5S method give recommendation and implementation of occupational health and safety standards of food production facilities. From the analysis, improved layout using CORELAP provide a smaller displacement distance is 155,84 meters from the initial displacement distance of 335,9 meters, and providing a shorter processing time than the original 112.726 seconds to 102.858 seconds. 5S method also recommended the completion of occupational health and safety issues as well as the standard means of food production by changing the better working environment.

***Keywords*—** CORELAP, Layout Design, 5S

I. Introduction

SMALL and medium enterprises (SMEs) is one of the selected alternative government in an effort to reduce unemployment and poverty. SMEs also take advantage of a variety of natural resource potential in an area that has not been processed commercially. This contributes to regional revenue and earnings of the Indonesian state. According to Jasra et al.[1] most of the foreign countries are realizing the fact that SMEs contribute a major portion of the country's GDP and economic activity and they hold an important place and get the similar effects when a business policy is laid by the government for larger businesses. One of unprocessed natural resources commercially in Bandung are mushrooms, there are some mushroom farmers areas, i.e. Ciparay, Banjaran, Soreang, and Ciwidey.

In the small and medium industries usually they do not have enough planning, both in terms of the application of occupational health and safety nor about plan the layout of production facilities, so that safety and hygiene standards are less unnoticed, also less work can be done effectively and efficiently. Fatoni *et al.* [2] plant the factory layouts that meet safety standards are needed in the industry, the problem of factory layout, facilities and production equipment is one factor that plays an important role in improving the productivity of the company.

Problems layout in the this mushroom chips is the cross movement between multiple workstations one cross movement of raw materials to finished goods, raw materials warehouse away with the processing station, and not maximal application of safety and health as well as the standard means of food production. Improvement plant layout carried by calculating the displacement moments and then searched the proposed new layout has a more minimal displacement moment. By minimizing the moment of transfer, then the material distance will be smaller.

Production facilities layout planning is an important issue, because the factory or industry will operate in the long term, then the error in the analysis and planning of the layout will cause production activities take place ineffective or inefficient. According to Vaidya *et al.*[3] plant layout design has become a fundamental basis of today's industrial plants which can influence parts of work efficiency.

II. Literature Study

According Heizer and Render[4] layout is an important decision that determines the efficiency of a long run operation. According Fatoni *et al.*[2] plant factory layouts that meet safety standards are needed in the industry, the problem of factory layout, facilities and production equipment is one factor that plays an important role in improving the productivity of the company. According Wiyaratn and Watanapa[5] plant layout design has become a fundamental basis of today's industrial plants roommates can influence parts of work efficiency. Ramtin[6] classical approaches to layout designing problems tend range to maximize the efficiency of layouts measured by the handling cost related to the interdepartmental flow and the distance Among the department.

Wignjosoebroto[7] outlines the purpose of the layout of the factory is set up work area and all production facilities as economical as possible for a safe and comfortable operation so as to raise the morale and performance of operators**.** Karyantina[8] stating the building and layout for the food industry should be designed to be easily cleaned and kept clean, room, tools and processes set to one direction and the entrance and exit of raw material so separated.

Safety and health at work is a program to keep workers avoid accidents and health problems caused by the working

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environment. Patten[9] 5S is a useful method for founding an organization and spread out a design and can improve communication and help employees to develop reviews their characteristic to decrease downtime, lead time, inventory, defect, injuries, and associated cost. Purpose safety according Fatoni *et al.*[2] is to protect the safety of workers in performing their duties, protect the safety of any person who is in the location of the workplace and to protect the security of equipment and production resources that can always be used efficiently.

CORELAP relationship stands for computerized planning layouts developed by Lee & Moore in 1967 where the use ranks close relationship expressed in TCR (total closeness rating) for the section of placement work stations. Burtonshaw-Gum[10] explains the term 5S workplace practices conducive to visual control with multiple stages. Activities of these stages are:

a. S1, namely seiri (Brief-segregation), separate the necessary items from items that are not needed, these items include tools, spare parts, materials, etc. Discard or save items that are not needed.
b. S2, namely Seiton (Neat-Setup), arrange them neatly items remaining to be more easily searchable at any time if necessary.
c. S3, namely Seiso (Rehearsal-Cleaning), items must be cleaned and washed. Employees are required to clean up the working environment, remove dirt and dust as well as keeping things in order to clean.
d. S4, namely Seiketsu (Consolidation), keeping the condition seiri, Seiton, and Seiso maintained.
e. S5, namely Shitsuke (Discipline), perform the previous four S with high discipline in which all employees practice good work habits in maintaining seiri conditions, Seiton, Seiso, and shiketsu.

III. Research Method

CORELAP calculation method can use software Blocplan 90 and Quantitative System 3.0. CORELAP using proximity relationship with letters (A, I, U, E, O, X) as input data based on the flow of goods and other factors. CORELAP calculate the activities of the busiest in the layout or who have the highest regard. The resulting layout design adjustments need to be done first because the location of the facility produced not in accordance with the conditions of the company. CORELAP can also be calculated manually. There are 4 main steps determine *the layout* in *CORELAP* namely:

1. Make ARC *(activity relationship chart).*
2. Finding the relationship between the departments represented on the relationship which important to that should not be adjacent.
3. Making TCR (*total closeness rating*)
4. Develop algorithms CORELAP
   a. Select one of the departments with a maximum TCR.
   b. Department allocated the second, choose departments that have a relationship with the selected department, if there is some relationship A then choose which has the largest TCR, if there are no ties A then choose a department that has a relation E (I, O, U) with a selected department.
   c. Repeat the process until all the departments allocated.
   d. First elected department allocated in the center of the diagram box, then use the method *western edge* (priority in the allocation of which is located on the west side) to determine the allocation of the next department.
   e. The numbers show the potential location facilities provided.
   f. Number 1 is always to candidates location on the west side of the departments that have been allocated.
   g. Box right next to the departments that have been allocated (horizontal / vertical) having a weight = 1
   h. Box right next to the departments that have been allocated in a diagonal direction has weight = 0.5
   i. Location value = weight x value relationship of the department that has been and will be allocated.

IV. Analysis Layout Planning

At the production site available land area of 4.75 meters x 7.75 meters.

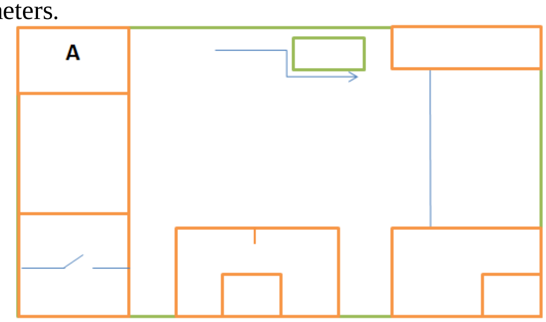

Fig. 1 First Floor Production Layout

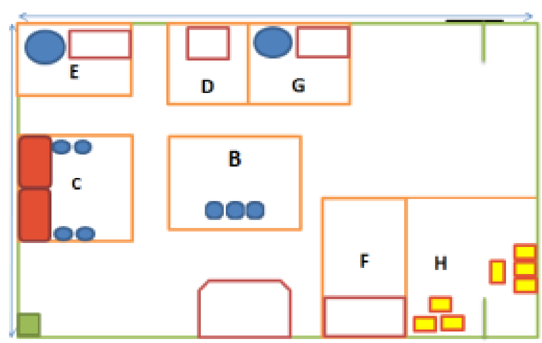

Fig. 2 Second Floor Production Layout

Specification:

A = Station Raw Materials
B = Processing Station
C = Boiling and Frying Station
D = Freezing Station
E = Cutting Station
F = Seasoning Station
G = Packing Station
H = Station Finished Product

Step 1. Calculate the Layout Early Production Facility Based on Time Allocation

TABLE I
ALLOCATION OF TIME BEFORE IMPROVEMENT

No	Station	Displacement time (sec)	Process Time (sec)	Allocation of Time (Seconds)
1	A – B	104	1920	2024
2	B – C	42	8410	8452
3	C – D	60	17100	17160
4	D – E	32	54000	54032
5	E – C	18	5410	5428
6	C – F	70	20800	20870
7	F – G	80	1800	1880
8	G – H	80	2800	2880
Total				**112.726**

- Total Time Displacement Materials = Total Materials X Time Displacement
- Production Time = Total Time Displacement Materials + Time Production Process

Step 2. Calculate the Layout Early Production Facility Based on Allocation Distance

TABLE II
DISTANCE DISPLACEMENT BEFORE IMPROVEMENT

No	Station	Distance Between Stations (cm)	Distance Displacement (cm)
1	A – B	1585	12680
2	B – C	190	2280
3	C – D	230	2760
4	D – E	205	1640
5	E – C	150	900
6	C – F	405	4050
7	F – G	280	4480
8	G – H	300	4800
Total			**33.590**

- Total Distance Displacement = Distance Between Stations X Displacement Materials
- Displacement Materials = (Total Expense Transport) / (Capacity)

Step 3. Make Activity Relationship Chart

With the degree of relationship:
A = Absolute need to be brought near(weighs the value of 6)
E = Very important approximated (weighted value of 5)
I = Important to approximated (weighted value of 4)
O = Pretty / regular (weighted value of 3)
U = Not important (weighted value of 2)
X = Not desired adjacent (weighted value of 1)

TABLE III
ACTIVITY RELATIONSHIP CHART

	A	B	C	D	E	F	G	H	TCR
A	-	6	2	2	2	4	2	1	19
B	6	-	6	3	3	4	2	1	25
C	2	6	-	6	6	5	2	1	28
D	2	3	6	-	6	3	2	2	24
E	2	3	6	6	-	2	2	2	23
F	4	4	5	3	2	-	6	2	26
G	2	2	2	2	2	6	-	6	22
H	1	1	1	2	2	2	6	-	15

Determining the location, selected station with maximum TCR. In this part or that the station has a maximum TCR is station **C** (boiling and frying station) with TCR is 28. The positioning of the biggest is the station that has a relationship with the station **C** (preset) that station **B** (station kneading), **D** (station freezing) and **E** (cutting station) with TCR each - respectively 25, 24 and 23. The selected station is a station that having the greatest TCR that station **B** (station kneading). The next placement is a station that has a relationship with the station **B** (station kneading), then its TCR compared with previous TCR, TCR select the largest, and so on until the O. relationship in order to get priority location is: **C, B, A, F , G, H, D, E**

Due to the location based on the *western edge* of priority, then the first location chosen was to part 1 for the rightmost and greatest worth. This algorithm continues in the determination of the other parts.

8	7	6
1	**C**	5
2	3	4

Fig. 3 First Iteration

If the work station B is allocated in:
Location 1, valuable: 6
Location 2, 4, 6, 8, valuable: (0.5 x 6) = 3
Location 3, 5, 7, valuable: 6
Then the chosen location is the location number 1 because it has the largest priority value and the smallest number of locations in the first iteration.

Next, place the other work stations using the same method as in the station B. Will eventually result in the design of the layout as follows:

B	**C**	**D**
A	**F**	**E**
H	**G**	

Fig.4 Last Iteration

From design layout is the result of the calculation of manual analysis, the author can design the layout of a new production facility for mushroom chips tune with the condition of the company. Following the initial layout comparison with the results of the preparation of the layout of the new facility:

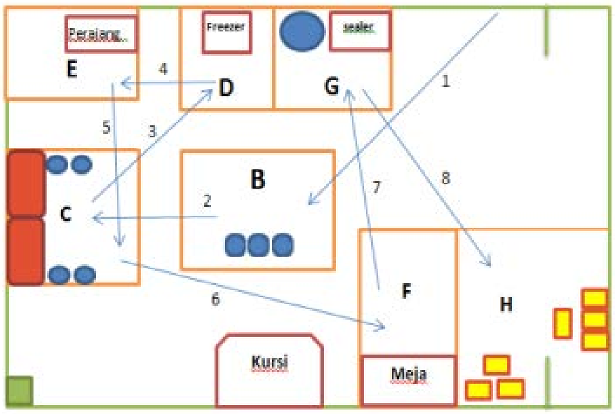

Fig. 5 Layout Before Improvement

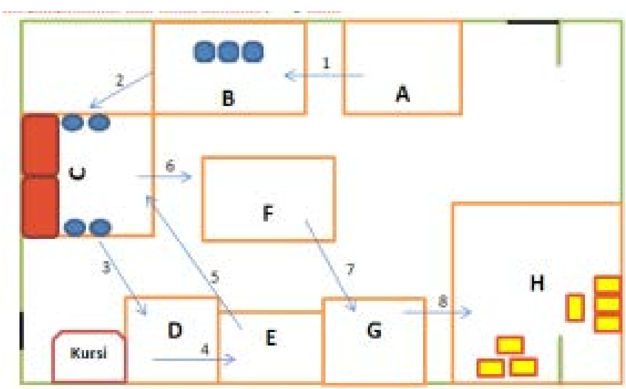

Fig. 6 Layout After Improvement

Step 4. Calculate the Proposed Layout Production Facilities Based on Time Allocation

TABLE IV
ALLOCATION OF TIME AFTER IMPROVEMENT

No	Station	Displacement time (sec)	Process Time (sec)	Allocation of Time (Seconds)
1	A - B	20	1920	1940
2	B - C	42	8410	8452
3	C - D	36	17100	17136
4	D - E	20	54000	54020
5	E - C	18	5410	5428
6	C - F	25	11200	11225
7	F - G	30	1800	1830
8	G - H	30	2800	2830
Total				**102.858**

Step 5. Calculate the Proposed Layout Production Facilities Based Allocation Distance

TABLE V
DISTANCE DISPLACEMENT AFTER IMPROVEMENT

No	Station	Distance Between Stations (cm)	Distance Displacement (cm)
1	A – B	200	1600
2	B – C	190	2280
3	C – D	192	2304
4	D – E	185	1480
5	E – C	150	900
6	C – F	240	2400
7	F – G	175	2100
8	G – H	210	2520
			15.284

Step 6. Comparing Layout Beginning With Proposed Layout Based Production Facilities Allocation Distance and Time

CORELAP calculation results can minimize the difference between the total distance of the displacement up to 180,06 meters of total displacement design layout are initially at 33.590 cm (335.9 meters) as calculated using methods CORELAP be smaller at 15.584 cm (155.84 meters). And of the total time, design layout calculation results using CORELAP is smaller 102.858 seconds. Compared with the total time of the initial layout design in the amount of 112.726 seconds, the design layout calculation result is smaller 9868 seconds or 2.74 hours.

Step 7. Analyze the initial 5S Conditions

TABLE VI
5S CONDITIONS

Sub Variable	Indicator	Result
1. Safety and Health		
a. The availability of personal protective	Complete / Incomplete	Incomplete
b. Procedure the operation of the machine	Yes/No	No
c. Water	Clean/Unclean	Clean
d. Waste channel	Open/Closed	Open
e. Vector-borne diseases	tail/*fly grill/plate*	0 tail/*fly grill/plate*
2. The standard facilities of food production		
a. High-field work	Centimeter (cm)	1 cm
b. Number of washing tub	Unit	2 unit
c. Number of toilets employee	Unit	1 unit
d. The amount of trash	Unit	2 unit
e. High ceilings	Meter (m)	3 meter

Step 8. Recommend methods 5S

A. Applying Stage *Seiri* (Brief - Sorting)
Seiri is the first stage of the 5S concept, the first stage is done by sorting the goods are still needed and that is not necessary. With the segregation of this there will be no accumulation of goods in the warehouse and production

areas. At this stage of the process can be done in a way to classify the existing tools on the production site mushroom chips based on frequency of use.

B. Applying Stage *Seiton* (Neat - Setup)

Seiton is the second stage of the 5S concept, in this stage is done is compile existing equipment with neat to be easily searched, can be reached quickly when needed and decrease workplace accidents such as tripping over stuff scattered. Steps should be applied:

1. Establish an area or place that will be used to store each piece of equipment in accordance with the role.
2. Save and procedures in accordance with a neatly defined previously.
3. Please tick (written) on the storage devices.

C. Applying Stage *Seiso* (Rehearsal - Cleaning)

Seiso is the third stage of the 5S concept, at this stage of impurities such as dust, remnants of oil production and marked on the floor cleaned and disposed of to prevent illness and accidents such as slipping liquids production scrap. The cleaning process is done before and after the production process. The steps that must be done at this stage:

1. Clean the dust, dirt, cobwebs, the remnants of production, the edges of the stove and oil spots on the floor.
2. Wash clean production facilities such as basins, blenders, knives, Pan, etc.
3. Organizing and cleaning up back where raw materials upon completion of production.
4. Clean all floors swept and mopped production.

D. Applying Stage *Seiketsu* (Care - Stabilization)

This stage is an activity that is carried out to maintain the conditions that have been achieved after implementing the three previous stages. *Seiketsu* stage is important to be implemented, because if not three previous stage will not last long. At this stage the awareness of employees and managers who determine the success or failure of *Seiketsu* applied aspects. The role of the owner is very influential on employee work attitudes 5S that is important to do, especially food factory hygiene must be number one. Owners should regularly provide guidance to all employees and remind employees to always apply the 5S method.

E. Applying Stage *Shitsuke* (Diligent - Discipline)

Shitsuke is the last stage of the 5S method, at this stage the employee should be able to get used to implement 5S. Familiarize yourself with the existing rules, such as the discipline will be the use of PPE. This stage can be maintained continuity with the appeal of the owner of the factory and affirmation to all employees that anyone who does not perform will be sanctioned at the discretion of the owner. With this, the layout of the production facility mushroom chips will continue to be clean, well maintained and looked neat so that consumers do not hesitate to consume the product.

V. Finding and Discussion

The results of calculations CORELAP can minimize the difference between the total distance of the displacement up to 180,06 meters of total displacement design layout mushroom chips are initially at 33.590 cm (335.9 meters) as calculated using methods CORELAP be smaller at 15.584 cm (155.84 meters). And of the total time, design layout calculation results using CORELAP is smaller 102.858 seconds. Compared with the total time of the initial layout design in the amount of 112.726 seconds, the design layout calculation result is smaller 9868 seconds or 2.74 hours.

VI. Conclusion And Future Recommendation

The conclusion of this study is CORELAP method can be used to make improvements layout of the facility, by minimizing the distance moved and processing time. And 5S method can be use as an attitude of the company's work to create a better working environment.

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