Available online at: http://e-jurnal.lppmunsera.org/index.php/JSMI

Jurnal Sistem dan Manajemen Industri
(Journal System and Management of Industries)

ISSN (Print) 2580-2887 ISSN (Online) 2580-2895

Layout improvement design to reduce material handling cost by using the systematic layout planning method in the MSME industry

Inaki Maulida Hakim[1*], Durra Salsabila[1] , Keval Priapratama Prajadhiana[2]
[1]Department of Industrial Engineering, Universitas Indonesia, Jl. Ring Road, Pondok Cina, Depok City, West Java 16424, Indonesia
[2]School of Machine Engineering, Universiti Teknologi MARA, Jalan Ilmu 1/1, 40450 Shah Alam, Selangor, Malaysia

ARTICLE INFORMATION

Article history:

Received: August 8, 2024
Revised: June 20, 2025
Accepted: June 25, 2025

Keywords:

Layout
Material handling cost
MSMEs skin crackers
Systematic layout planning

*Corresponding Author

Inaki Maulida Hakim
E-mail: inakimhakim@eng.ui.ac.id

ABSTRACT

This research discusses layout improvements in MSMEs that produce skin crackers distributed in the Jabotabek area. Currently, the quantity of skin crackers produced is experiencing problems. One of the causes of problems is that material handling is still manual, poor layout settings, limited costs, unpredictable weather and lack of labor availability. Poor material handling causes long production duration, workers are less safe and comfortable, and material handling costs are high. Therefore, this research improved the layout by improving the material handling process. The research aims to analyze the existing layout problems, improve the layout, and compare the existing layout with the proposed layout. The method used to improve the layout is systematic layout planning (SLP). The results of the study are that material handling costs reduced by IDR 256,754.99 or 67.8%, increasing capacity by 17.77 kg per week can solve stock shortages, and the duration of material handling is reduced by 28.95 minutes per day or 69.19%.

1. INTRODUCTION

The research was conducted at MSMEs engaged in the snack food industry, especially skin crackers. Every month, the company produces around 1.5 to 2 tons. The factory area has a total area of 151.7731 m^2. The factory's first floor is 77 m^2 and the second floor is 74.8 m^2. The area includes nine workstations, a raw material warehouse, and a finished goods warehouse. However, the area does not include the oven, dining area, bathroom, and prayer room. The oven area was not included in this study because it is rarely used and is located in a different area or separate from the main area.

Currently, the quantity of skin crackers produced each week is sometimes not enough. Data from December 2023 to January 2024 shows that the average weekly stock shortage is 15.75 kg. Based on findings, the root causes of these problems, based on findings problems are manual material handling, poor layout arrangements, limited costs that cause the company to be unable to use the oven freely and cannot increase employee overtime hours, uncertain weather, and lack of labor availability. The root cause of the problem can be solved by improving the layout and material handling, which will reduce material handling costs (OMH). Reduced material handling costs can overcome the problem of unpredictable weather because the company can utilize the oven without concern for additional costs. Lack of labor availability is not the focus of this research because it is an external factor.

In the skin cracker production process, the

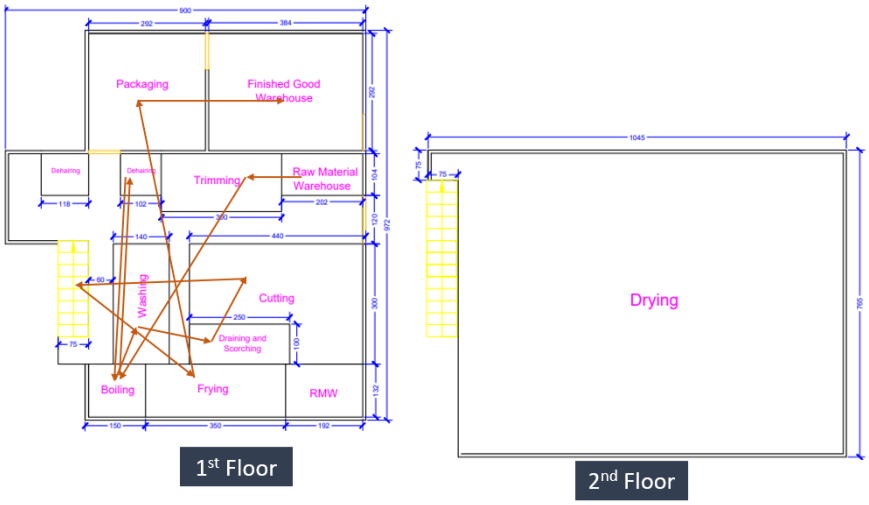

Fig. 1. Material flow of existing layout

materials carried by workers are heavy, ranging from 7 to 40 kg, and material handling is still manual, so the distance between material handling stations should be close to each other. However, the distance between workstations is still quite far because it must cross other workstations. In MSME Skin Crackers, in addition to the long distance of material handling with a daily distance of 1,322 m, the frequency per day is high, which is 192 times. In 6 hours of production duration per day, it takes 42 minutes to do material handling. According to Roy and Dangayach [1], the company's layout efficiency and interrelated productivity can affect the system's performance, quality, and productivity. Thus, it is necessary to reduce the distance of material handling and reduce the frequency of material handling so that the duration of the production process decreases.

Fig. 1 explains the flow of materials in the MSME production of skin crackers, where the layout is divided into 2 areas: the upper area and the lower area. Poor material handling, in addition to causing long production duration, also causes other problems. The first problem is that workers are not safe at work. The second problem is that workers are less comfortable at work. Long material handling distances with heavy material loads and high frequency make workers quickly tired at work. The last problem is the material handling cost, which is quite high, at IDR 378,237.65.

Based on these problems, the company needs to make several improvements to reduce OMH. This can be done by improving layout and material handling. Based on previous research, by improving layout and material handling, the distance and frequency of material handling are reduced [2], the production process is faster [3], and workers are safe and comfortable while working [4]. Thus, it will impact material handling costs, and the company can increase capacity. According to Suhardi *et al.* [5], [6], rearranging the layout can reduce material flow and increase production. Therefore, this study aims to analyze the existing layout problems, get layout improvements to reduce material handling costs, and compare the existing layout conditions and proposed layouts by considering OMH/month, material handling duration/day, and production capacity/week. This study aims to investigate the cause and effect of material handling for improvements in MSMEs, specifically focusing on the research question: How can an ideal layout reduce material handling costs in MSME? The main contributions of this research are described as follows: First, from improvement this research improves the company's utilization and efficiency of the production process to minimize waste and maximize production targets so that production capacity can be achieved. Second, efforts to improve the layout of this research will be very beneficial in the long term, and the risk of work accidents will be greatly reduced. In this research, improvements to the layout were made, and recommendations for material handling tools were made. This aims to increase the efficiency of the production process, reduce the risk of injury due to incorrect working posture, and ensure that the products produced meet high standards of cleanliness and quality.

2. RELATED WORK

A good facility layout in accordance with company conditions is one of the main factors to optimize production duration and costs [7]. The plant is designed to meet quantity and quality requirements at the lowest cost [8]. The increase in capacity can occur because the efficiency rate will increase after improvement [9]. Improving production performance can reduce material handling costs and utilize the company's resources [10], especially for MSMEs. MSMEs make various efforts to improve the efficiency of their operations. Process and

http://dx.doi.org/10.30656/jsmi.v9i1.9212

Table 1. Literature review on systematic layout planning (SLP)

Author	Year	Method	Research scale			Aims
			Small	Medium	Large	
Shahin and Poormostafa [11]	2011	Simulation			√	Simulation and optimization for the integration of advanced quality and decision-making tools and techniques
Hossain *et al.* [12]	2014	SLP		√		Increasing productivity through facility layout improvement using systematic layout planning
Lin *et al*. [13]	2015	Optimization			√	Redesign and optimize the facility layout for the operating theatre in hospitals
Ali Naqvi *et al*. [3]	2016	SLP			√	Increase productivity and improve a manufacturing facility using systematic layout planning.
Barnwal and Dharmadhikari [10]	2016	SLP		√		Redesign the layout to get optimization the plant layout to increase production capacity on the new plant
Jain and Yadav [14]	2017	SLP			√	Improving the layout in the production area of processing mills to increase productivity
Gomez *et al*. [15]	2018	SLP			√	Replanning and redesigning the layout to reduce material handling costs
Febriandini and Yuniaristanto [16]	2019	SLP			√	Redesign Facility Layout using Systematic Layout Planning Method, Cosmeceutical Area
Gozali *et al*. [17]	2020	SLP			√	Replanning and redesigning the layout to increase capacity, reduce transportation time and increase movement efficiency
Suhardi *et al*. [6]	2021	SLP			√	Improving the layout can reduce the total cost of material transfer and the distance of material transfer from the initial facility layout.
Khasanah *et al*. [18]	2022	SLP		√		Improvement Using Systematic Layout Planning (SLP) to Reduce the Risk of Manual Handling.
Kumar and Malleswari [19]	2022	SLP		√		Evaluating the developed alternatives compared with the existing layout improves the flow of materials, utilizes space effectively, and is flexible.
Hu and Chuang [20]	2023	SLP and Optimization	√	√		Minimizing travel time and costs for warehouse workers while ensuring smooth product flow from storage to shipping.
Mao *et al*. [21]	2023	Simulation and SLP		√		Improving the traditional SLP layout method according to the actual situation and providing reasonable layout results by combining it with modern computer technology.
Salins *et al*. [7]	2024	SLP and Lean Manufacturing			√	Reducing material flow, efficient overall space and utilization improvement and reducing cost based on the principle of SLP and lean manufacturing rechnique.
This research		SLP	√	√		Minimizing the movement and transport of materials and reducing material handling costs in the production area.

product layouts that minimize the movement and transport of materials are important considerations in implementing material handling in the production area.

Table 1 explains the previous study to get a proposed layout improvement through literature studies in previous studies. Laurent *et al*. [4] explained that the SLP method is one method for improving layouts by reducing the risk of material handling, but there are some shortcomings which needs to be ascertained, including the distance and risks that will arise when the new layout is implemented. Therefore, risk mitigation is needed to reduce problems in material handling and work accidents. Suhardi *et al*. [6] also use the SLP method carried out in the manufacturing industry,

which has the same characteristics as the case study in this study. The SLP method was chosen to improve the proposed layout. In addition, this study also considers calculating material handling costs, which compares the selected layout proposals. Thus, the best layout is the one that produces the lowest material handling costs.

Systematic Layout Planning (SLP) is a planning procedure that makes it possible to identify, visualize, and assess the various activities, relationships, and alternatives involved in facility layout [14]. Material handling cost is the cost generated from the activity of moving materials from one machine to another or from one department to another that is required to arrive at a certain destination [22].

Several methods can be used to design and improve layouts, such as Systematic Layout Planning (SLP) [3], [4], [17], Automated Layout Design Program (ALDEP), and Computerized Relative Allocation of Facilities Techniques (CRAFT) [23], and Block Layout Overview with Layout Planning (BLOCPLAN) [24]. However, research on an MSME scale usually uses systematic layout planning, BLOCPLAN, or CRAFT [4], [8], [25], [26]. According to Qamar *et al*. [2], systematic layout planning (SLP) is better than BLOCPLAN and CRAFT. BLOCPLAN has the possibility of not being able to describe the initial layout accurately. Besides that, the algorithmic approach mainly focused on minimizing flow [9], [21], so it will be difficult to apply because there are many limitations in the MSMEs industry. Therefore, this study uses the SLP method to reduce material handling costs. In recent years, many studies have used SLP to improve layouts in different industries. Qamar *et al*. [A22] used SLP to evaluate and analyze the existing layout at Jordan Light Vehicle Manufacturing Company. Hu and Chuang [20] used SLP for e-commerce warehouse optimization to improve the efficiency of the sorting process. Febriandini and Yuniaristanto [16] imple-mented SLP in Biopro Cosmeceutical Sdn. Bhd. in Malaysia to reduce high material handling costs. Gomez *et al*. [15] used SLP for the wineries industry because efficient distribution of space in a winery contributes towards both economic and environmental sustainability.

Compared to the previous papers, a novelty of this paper is that it calculates the cost of improving layout and material handling. Most journals discussing layout and material handling improvements do not discuss the costs of applying the proposed layout. This is important to know, especially in the case of MSMEs, because MSMEs usually have limited costs. For example, research conducted by Hossain *et al*. [12] is not applicable because the changes are highly costly and time-consuming. In addition, this paper also adds recommendations for material handling systems that can be used and material handling methods so that material handling costs can be further reduced.

3. RESEARCH METHODS

Research methodology in this research starts from data collection and data processing using the SLP Method, starting from evaluating existing, then analyzing based on material handling results from the proposed layout (Fig. 2). The OMH formula used in this study comes from Nasution *et al*. [27], and Tarigan *et al*. [28].

$$\text{OMH/m} = cost/\text{d} \quad (1)$$

where OMH/m = transportation cost (IDR/m); cost = operating cost/hour (IDR/hour) and d = distance/hour (m/hour)

After calculating the OMH/m of each material handling activity from one department to another, the material handling cost per month can be calculated using formulation 2.

$$OMH = (r)(f)(OMH/m) \quad (2)$$

where OMH = material handling cost; r = distance of displacement and f = displacement frequency

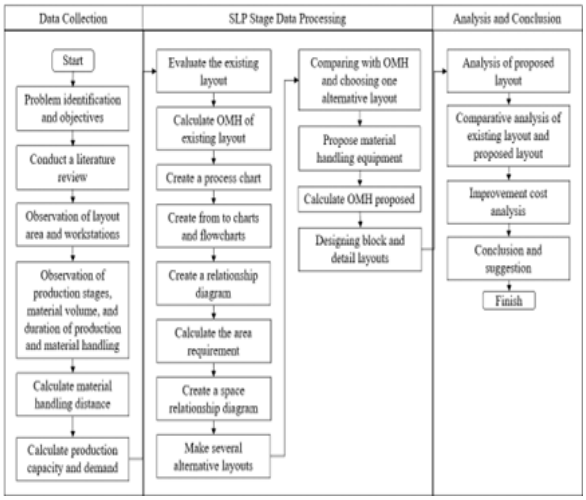

Fig. 2. Research framework

The initial stage carried out in this study is data collection. Data collection uses primary data and secondary data. Primary data is taken from interviews or discussions and direct observation. The interview stage was carried out several times with the supervisor, the owner, and one of the workers. Secondary data is collected through observations at the location. Table 2 is the list of data and the data sources.

4. RESULTS AND DISCUSSION

4.1. Case problem

This research has problems with manual material handling, poor layout arrangements, limited costs that cause the company to be unable to use the oven freely and cannot increase employee overtime hours, uncertain weather, and lack of labor availability. The root cause of the problem can be solved by improving the layout and material handling, which will reduce

http://dx.doi.org/10.30656/jsmi.v9i1.9212

Table 2. List of data and data sources

No	Data	Data sources
1	Detailed layout and workstation	Observations and interviews
2	Volume material	Observations for 5 days (Average volume of material brought by workers from each day workstation)
3	Production stages	Observations and interviews
4	Production duration	Observation for 7 days (From each batch done by workers, the duration is measured using a stopwatch)
5	Duration of material handling	Observation for 7 days (Stopwatch begins when the worker walks towards the workstation and stops at the next workstation)
6	Distance material handling	Distance from the center point of the workstation to the center point of the other workstations, as seen from the layout that has been drawn on Autocad
7	Production capacity and demand	Financial reports and proof of transfer

material handling costs (OMH). Reduced material handling costs can overcome the problem of unpredictable weather because the company can utilize the oven without concern for additional costs. Lack of labor availability is not the focus of this research because it is an external factor.

Table 3. Production Process

Workstation	Process
Trimming	Remove the remaining fat and meat
Boiling	Soak in hot water
Dehairing	Feather cleaning by scraping
Boiling	Boiled cowhide
Washing	Cowhide is washed and brushed with running water.
Draining and scorching	Drained
Draining and scorching	Burned to remove fine hair
Cutting	Cowhide cut into cubes.
Drying	Dry in the sun
Frying	Fry 7 times with medium oil temperature.
Raw material warehouse	Cowhide is left to sit overnight.
Frying	Half-fried and the result is called a lapuan
Frying	Fried in hot oil
Packaging	Crackers are packaged in plastic and in different sizes according to customer requests.

As a result of the calculation using the SLP method, the first thing that needs to be done is to evaluate or study the existing layout conditions. Table 3 explains the production process in the MSME skin cracker, starting from the Trimming Process, Boiling, Dehairing, Washing, Draining and Scorching for the drained, Draining and Scorching for burned to remove fine hair, next the Cutting process to cut cowhide into cubes, and then Drying. Drying Process: Drying in the sun. After the frying process, before keeping the raw material in the warehouse, there must be quality control to ensure the product's quality is good before the next process. The frying process is carried out twice to get optimal results, producing a good quality product. Frying is the most important stage in a series of production processes, because if you don't start the frying process properly, it will produce a defective product that cannot be packaged and will become waste. After ensuring that the product color and results are good with quality control, the product continues to the packaging process. It will then be stored in the finished goods warehouse and packaged in boxes according to the production batch before being given to consumers and retailers.

Several material handling distances are still quite far away. The order of the farthest is drying to frying (24.18 m), cutting to drying (23.45 m), frying to packaging (11.32 m), and shaving to drying (7.91 m). Currently, all material handling activities are manual. The highest material handling cost is in the material handling activities to and from drying. Material handling activities, from trimming to cutting, can be reduced by organizing the cowhide pieces. This research focuses on improving the layout to organize material handling in the process of making skin crackers.

4.2. Result

The calculation of OMH is obtained by calculating the frequency of material handling per day, length of track, operating cost/hour, distance/hour, calculating OMH/m, and calculating the material handling cost per month (Table 4).

After making the flow diagram, the area requirement needs to be calculated to make the proposed layout. In each workstation, the supervisor and one of the workers will determine the area requirements. Furthermore, a relationship diagram shows how much proximity is needed between workstations.

Table 4. OMH/Month existing layout

OMH / Month						
From	**To**	**Frequency (1)**	**Distance (m) (2)**	**Length of track (m) (3) = (1) x (2)**	**OMH/m (IDR) (4)**	**OMH (IDR) (5) = (3) x (4)**
RMW	Trimming	168	2.51	421.68	29.78	12,559.05
Trimming	Boiling	672	7.91	5315.52	14.71	78,166.67
Boiling	Dehairing	672	5.98	4018.56	12.80	51,437.04
Dehairing	Boiling	672	5.98	4018.56	8.58	34,471.11
Boiling	Washing	672	3.31	2224.32	7.23	16,088.89
Washing	Draining and scorching	672	3.2	2150.4	12.73	27,377.78
Draining and scorching	Cutting	672	1.45	974.4	14.69	14,311.11
Cutting	Drying	378	23.45	8864.1	6.74	59,769.20
Drying	Frying	310.5	24.18	7507.89	7.71	57,890.09
Frying	Packaging	173.3	11.32	1962.13	6.07	11,912.21
Packaging	FGW	408	5.4	2203.2	6.39	14,085.71
Total						**378,068.86**

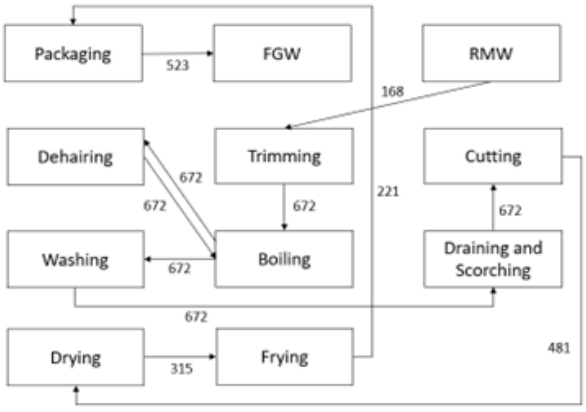

Fig. 3. Flow diagram

The next stage in data processing is the making of process charts. A process chart is a table containing steps in a process [29]. There are 17 production activities and 11 material handling activities from the entire series of production processes. Cycle time per kg of the production process is 11.4 minutes. Next, a from-to chart is made, and it is found that the highest frequency is the material handling activity from trimming to boiling, boiling to dehairing, boiling to washing, dehairing to boiling, washing to draining and scorching, and draining and scorching to cutting. This will be the focus in making alternative proposed layouts.

Based on the flow diagram (Fig. 3), it is known that boiling will be the focus in making the proposed layout because of the large number of material flows to and from boiling. Based on the area required and the relationship diagram (Fig. 4), a space relationship chart is created (Fig. 5). Based on the space relationship chart, several alternative layouts were made by making adjustments due to the limited area. In this research, two alternative layouts were made. The first alternative layout in Fig. 6 has significant changes compared to the existing layout.

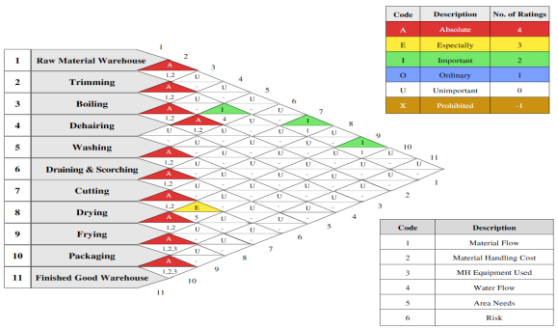

Fig. 4. Relationship diagram

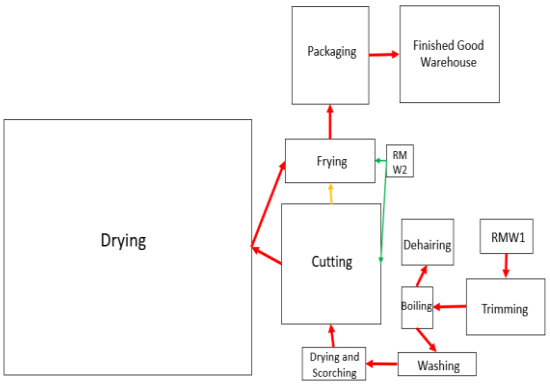

Fig. 5. Space relationship chart

In the second layout (Fig. 7), the changes from the existing layout are not too significant. Almost entirely the same, the biggest difference is in the boiling workstation's location and the washing workstation's size. Based on the results of discussions with the owner, only two possible alternative proposed layouts are due to limited space, and some workstations cannot be moved.

http://dx.doi.org/10.30656/jsmi.v9i1.9212

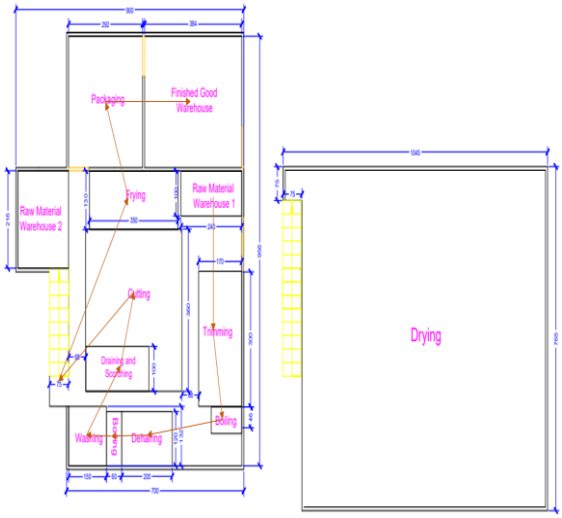

Fig. 6. Alternative layout 1

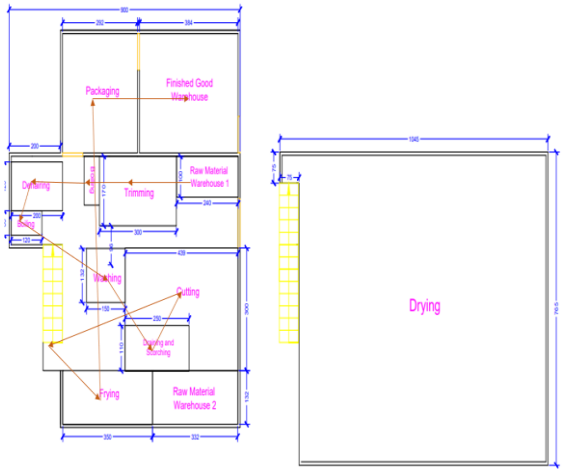

Fig. 7. Alternative layout 2

In this study, two alternative layouts are proposed based on OMH because if OMH is low, the duration of material handling will decrease, resulting in increased production capacity. The duration of material handling in alternative layouts is obtained by comparing the existing duration and distance with the alternative layout distance. This is in accordance with the Imanullah *et al*. [30] method regarding calculating the duration of the proposed layout. The total OMH/month of the first proposed layout alternative is IDR 233,392.13. Meanwhile, the total OMH/month of the second proposed layout alternative is IDR 236,573.53. The difference between the two alternatives is Rp3,181.41. The first proposed layout has a smaller OMH/month than the second proposed layout. However, the costs that need to be incurred for the first proposed layout will be much greater than the costs incurred for the second proposed layout. This is because there are many more changes in the first proposed layout than in the second proposed layout. Thus, implementing the second proposed layout will be better than the first proposed layout.

Although making improvements to the layout can already reduce material handling costs, adding material handling equipment, material handling costs will decrease even more because the frequency of material handling will be reduced. The highest material handling cost is in the material handling activities to and from drying. Thus, tools are needed to increase the volume of tools. Material handling activities, from trimming to cutting, can be reduced by organizing the cowhide pieces. Previously, the cowhide was cut into four parts, but because the proposed layout minimizes the distance between workstations, the cowhide can be cut into two parts only. Between frying and packaging, and packaging to FGW (finished good warehouse), packaging to FGW has more material handling frequency. Therefore, from packaging to FGW is preferred to have material handling equipment.

In this research, it is proposed for tools to help the material handling process. Fig. 8 is a tool for material handling to facilitate the process of cutting, drying and frying. The previous tool was a tub with a capacity from cutting to drying of 7 kg and drying to frying of 8 kg. The proposal for material handling 1 is expected to increase production capacity through the process from cutting to drying by 17 kg and from drying to frying by 20 kg.

Fig. 8. Material handling equipment 1

Fig. 9. Material handling equipment 2

The second proposal in this study (Fig. 9) is to hold half-kilogram crackers. The skin crackers are carried from the packaging to the finished goods warehouse. Previously, leather crackers were carried by hand with a material handling capacity of 2.5 kg. If the material handling device 2 is used, the material handling capacity becomes 7.5 kg.

After adding material handling tools, the material handling cost in alternative layout 2 is calculated to get the material handling cost in the proposed layout. The calculation is the same as calculating material handling

cost on the existing layout; the difference is the addition of the volume of tools, and the material handling distance is shortened in calculating material handling cost in alternative layout 2. The results of the calculation of material handling cost per month on the proposed layout are IDR 121,482.66.

A proposed layout is obtained to reduce material handling costs. Fig. 10 explains the changes from the existing layout; the changes are only found on the first floor of the layout. The area of the equipment, operator room, and input/output room is based on the size of the area requirement. Fig. 11 explains the details of the proposed layout by explaining the flow of materials and has been validated through discussion.

The number of workers needed is obtained from discussions with the owner. The number of workers required is the same as the existing layout. That is because the number of equipment has not changed and the addition of production capacity is not too much, so current employees can still do it. In addition, there are no additional employees to reduce costs. The first stage of the production process is trimming, first boiling, dehairing, second boiling, and washing. These activities can be done for the first time when new workers arrive at the workplace. The same person does the first trimming and boiling because the boiling can be left behind. While the cowhide is boiling, the worker can do other processes at the same time. Just like the second boiling process, workers can leave the cowhides boiling and continue dehairing the skins. After all the skins have been washed, two workers can drain and scorch the skin, and two can go straight to cutting. The two workers can join the cutting workstation when the scorching is complete. Drying can be done if the volume of the material handling tool or bag is full. The first frying can be done while doing other work. Meanwhile, the second and third frying can be done by two workers, and the other two workers do the packaging process. Thus, the total number of operators required is four workers.

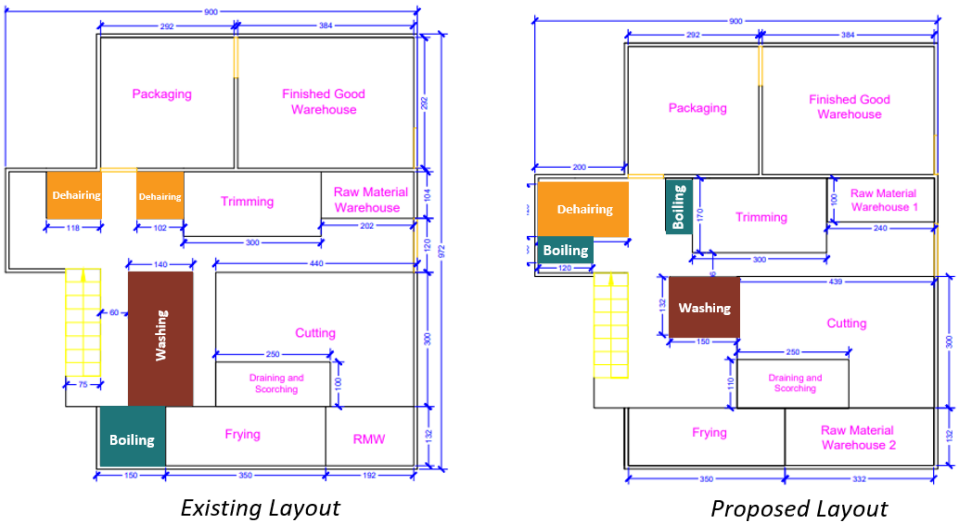

Fig. 10. Exiting vs proposed layout

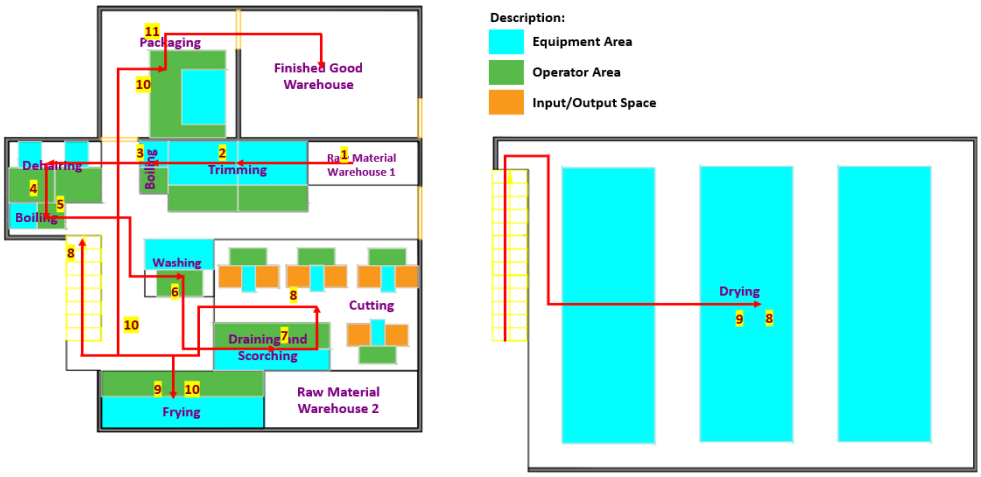

Fig. 11. Detailed proposed layout with material flow

http://dx.doi.org/10.30656/jsmi.v9i1.9212

Table 5 and Table 6 compare OMH/month and duration of material handling/day. Of all the decreases, the material handling activity with the largest decrease in OMH/month is from dehairing to boiling, with a decrease of 89.1%. Trimming to boiling and boiling to dehairing also have a decrease in OMH/month of more than 80%. Thus, the change in the position of the boiling workstation and the change in material handling volume greatly affect the decrease in OMH/month.

Table 5. Comparison of OMH/Month

From	To	OMH/Month	
		Existing (IDR)	Propose (IDR)
RMW	Trimming	12,559.05	14,260.28
Trimming	Boiling	78,166.67	9,640.96
Boiling	Dehairing	51,437.04	8,998.48
Dehairing	Boiling	34,471.11	3,751.37
Boiling	Washing	16,088.89	11,769.80
Washing	Draining & scorching	27,377.78	13,354.76
Draining & scorching	Cutting	14,311.11	12,148.83
Cutting	Drying	59,769.20	15,450.22
Drying	Frying	57,890.09	16,061.59
Frying	Packaging	11,912.21	11,415.11
Packaging	FGW	14,085.71	4,631.28

Table 6. Comparison of the duration of material handling/day

From	To	Duration of material handling/day	
		Existing (s)	Propose (s)
RMW	Trimming	75	86
Trimming	Boiling	469	58
Boiling	Dehairing	309	54
Dehairing	Boiling	207	23
Boiling	Washing	97	71
Washing	Draining & scorching	164	80
Draining & scorching	Cutting	86	73
Cutting	Drying	445	93
Drying	Frying	428	96
Frying	Packaging	107	103
Packaging	FGW	127	42

4.3. Discussion

The addition of material handling equipment greatly affects the decrease in OMH/month. Using material handling equipment 1 to and from drying decreased the OMH/month by more than 70%. In addition, using material handling equipment from packaging to FGW caused OMH/month to decrease by 67.1%. The overall material handling cost was reduced by 67.8%, from IDR 378,237.65 per month to IDR 121,482.66 per month. The reduced material handling cost can be allocated to gas costs for the oven and workers' overtime salaries. Overall, the duration of material handling is reduced by 28.95 minutes per day or 69.19%. With the decreased material handling duration, the company will have additional time to produce more goods to meet the expected production quantity.

The production capacity value per week from the existing layout is obtained from the average production in December 2023 - January 2024. While the production capacity/week of the proposed layout without material handling equipment is obtained from the duration of material handling/day of the existing layout minus the proposed layout without material handling, then multiplied by seven to get in one week. The difference in material handling duration/week is divided by 11.4 minutes because the cycle time of 1 kg of leather crackers is 11.4 minutes. In the proposed layout without material handling equipment, the additional capacity per week is 10.44 kg. While in the proposed layout with material handling equipment, the additional capacity per week is 17.77 kg.

By reducing the duration of material handling costs, the company can increase production by 17.77 kg per week. The additional production capacity of 17.77 kg per week can fulfil the stock shortage because the stock shortage in the existing condition is 15.75 kg. The increase in production capacity per week from 346.5 kg to 364.27 kg has a percentage increase of 5.11%. The cost required to change from the existing layout to the proposed layout is Rp3,760,451. According to [3], the average rate of non-foreman laborers per day in DKI Jakarta Province is IDR 150,420. Meanwhile, the calculation of construction materials based on the [9] price per m^2 is IDR 261,870.29.

From the increase in production per week, amounting to 17.77 kg, and the reduction in OMH/month of IDR 256,754.99, the improvement cost will be returned after five weeks. Based on discussions with the owner, with these costs and a payback after five weeks, the company has no objection to implementing it. The increase in production capacity will be even greater because the company can use the oven more freely and pay employees overtime. The material handling equipment consists of two material handling equipment 1 or bags and one material handling equipment 2 or trolley. Material costs are incurred to build:

a. Washing making (1.5 m x 0.7 m x 0.4 m)
b. Boiling making (0.6 m x 0.6 m x 0.6 m): 2 tools
c. Frying making (0.8 m x 0.8 m x 0.8 m): 2 tools

4.4. Managerial Implications

This research has managerial implications: a better layout and more efficient workflow. Goods, raw materials and equipment can be arranged to minimize the time and effort required to move or search, helping Managers focus on reducing production time and operational costs, while increasing workforce productivity. In addition, it helps managers evaluate

storage needs, work areas and space for customer interaction, so that everything is utilized efficiently and helps reduce the risk of work accidents, improve employee safety and create a comfortable work environment. This research provides solutions to the MSME industry using SLP, which considers material handling a problem for the skin cracker MSME industry, to make it easier to produce skin crackers. In addition, the proposed tools can help reduce the workload for workers, so that the production process can run smoothly and meet production capacity.

Beside that, this research has theoretical implications that emphasizes the importance of layout design that can optimize the flow of goods and raw materials, minimize waiting time, and reduce waste of resources. In the context of MSME, an efficient layout can reduce travel distances between processes, speed up production cycles, and increase space usage. Integration with previous research regarding layout improvements in MSMEs helps provide a stronger framework for thinking, supports recommendations, and shows relevance. In the context of MSMEs, this research is relevant for rearranging workflow and placement of tools or materials to reduce unproductive working time. MSME that carry out mass production can take advantage of this approach to improve the layout of the production floor and reduce bottlenecks. MSMEs with small warehouses can redesign their layout to improve inventory management efficiency. MSMEs can use this research to design layouts that separate pedestrian paths and production machines to improve safety.

5. CONCLUSION

This research aims to improve MSMEs capacity for production through layout improvement. The systematic layout planning (SLP) method improves the layout to reduce material handling costs. Unlike the others, a novelty of this paper is that it calculates the cost of improving layout and material handling. Most journals discussing layout and material handling improvements do not discuss the costs of applying the proposed layout. The proposed layout used is alternative layout 2 because it is better than alternative layout 1 in terms of cost. Material handling improvements include tools from cutting to drying, drying to frying, and packaging to the finished goods warehouse. In addition, the previously divided cowhide by four in the trimming is simply divided by two. This can reduce the frequency of material handling.

This result from the calculation material handling cost is reduced by IDR 256,754.99 or 67.8%. In addition to the reduction in OMH, the increase in capacity by 17.77 kg per week or an increase of 5.11% can meet the needs of stock shortages. The increase in capacity can occur because the duration of material handling is reduced by 28.95 minutes per day, or reduced by 69.19%. The results of the calculations for reducing material handling costs have been discussed with the owner, who agreed to the proposals suggested in this research.

The limitation of this research is that the scope of the study was conducted on MSMEs, where the production process and material handling activities are still very simple and use manual equipment. In addition, this research focuses on technical and efficiency aspects, such as reducing the distance travelled by materials and increasing production flow to reduce material handling activities and costs. This study did not consider non-technical factors, such as employee needs, safety, and work environment, which could be added to this study.

The future scope for further research related to layout improvement is that further research can include worker productivity parameters, not just material handling costs, material handling duration, and production capacity. It is because worker productivity is also one of the impacts of changes in layout and material handling. Worker productivity will increase if layout and material handling improve. This research suggests using technology with software for a simulation plan layout after improvement. Simulation can be used to see more clearly the production flow and see if there are activities that collide with other activities. In addition, simulation can also be used to clearly measure the increase in production capacity and material handling duration. In this research, layout improvement only uses systematic layout planning, but for further research, it can combine systematic layout planning with an algorithmic approach. In future research at MSME skin cracker, researchers need to consider increasing production capacity not only based on current stock shortages, but also from possible future market demand increases. And for the future, AI application techniques must be addressed. Future work must also be incorporated to analyze and identify future workers who do not use manual methods but use AI to speed up work.

ACKNOWLEDGMENT

This work became possible with the help and support of UMKM skin crackers owner, supervisor, and workers, who gave access to facilities, datasets, and were willing to be interviewed, and the Department of Industrial Engineering, Universitas Indonesia, for financial support.

REFERENCES

[1] R. Roy and G. S. Dangayach, “Measuring productivity and material handling cost reduction,” *Int. J. Bus. Syst. Res.*, vol. 9, no. 3, p. 214, 2015, doi: 10.1504/IJBSR.2015.071820.

[2] A. M. Qamar, O. T. Meanazel, A. H. Alalawin, and H. A. Almomani, “Optimization of Plant Layout in Jordan Light Vehicle Manufacturing

http://dx.doi.org/10.30656/jsmi.v9i1.9212

Company," *J. Inst. Eng. Ser. C*, vol. 101, no. 4, pp. 721–728, Aug. 2020, doi: 10.1007/s40032-020-00576-5.

[3] S. A. Ali Naqvi, M. Fahad, M. Atir, M. Zubair, and M. M. Shehzad, "Productivity improvement of a manufacturing facility using systematic layout planning," *Cogent Eng.*, vol. 3, no. 1, p. 1207296, Dec. 2016, doi: 10.1080/23311916.2016.1207296.

[4] J. Laurent, L. Gozali, R. Farrel, and C. O. Doaly, "Production Layout Replanning Using Systematical Layout Planning with Shared Storage Method Analysis and Flexsim Simulation in Garment and Textile Company," in *Proceedings of the International Conference on Industrial Engineering and Operations Management*, Michigan, USA: IEOM Society International, 2022, pp. 2159–2171. doi: 10.46254/AN12.20220377.

[5] B. Suhardi, E. Juwita, and R. D. Astuti, "Facility layout improvement in sewing department with Systematic Layout planning and ergonomics approach," *Cogent Eng.*, vol. 6, no. 1, p. 1597412, Jan. 2019, doi: 10.1080/23311916.2019.1597412.

[6] B. Suhardi, L. Elvira, and R. D. Astuti, "Facility Layout Redesign Using Systematic Layout Planning Method in PT. Pilar Kekar Plasindo," *J. Technol. Oper. Manag.*, vol. 16, no. 1, pp. 57–68, Jul. 2021, doi: 10.32890/jtom2021.16.1.5.

[7] S. S. Salins, S. A. R. Zaidi, D. Deepak, and H. K. Sachidananda, "Design of an improved layout for a steel processing facility using SLP and lean Manufacturing techniques," *Int. J. Interact. Des. Manuf.*, vol. 18, no. 6, pp. 3827–3848, Aug. 2024, doi: 10.1007/s12008-024-01828-9.

[8] Y. Ojaghi, A. Khademi, N. M. Yusof, N. G. Renani, and S. A. H. bin S. Hassan, "Production Layout Optimization for Small and Medium Scale Food Industry," *Procedia CIRP*, vol. 26, pp. 247–251, 2015, doi: 10.1016/j.procir.2014.07.050.

[9] A. Nabila, M. I. H. Umam, A. Suherman, V. Devani, and M. R. Nazaruddin, "Layout Redesign Using Compiterized Relative Allocation of Facilities Techniques (CRAFT) Algorithm Method (Case Study: PCL Company)," in *Proceedings of the International Conference on Industrial Engineering and Operations Management*, Michigan, USA: IEOM Society International, 2022, pp. 1580–1590. doi: 10.46254/SA03.20220320.

[10] S. Barnwal and P. Dharmadhikari, "Optimization of plant layout using SLP method," *Int. J. Innov. Res. Sci. Eng. Technol.*, vol. 5, no. 3, 2016, [Online]. Available: https://www.ijirset.com/upload/2016/march/46_Optimization.pdf

[11] A. Shahin and M. Poormostafa, "Facility Layout Simulation and Optimization: an Integration of Advanced Quality and Decision Making tools and Techniques," *Mod. Appl. Sci.*, vol. 5, no. 4, p. 95, Aug. 2011, doi: 10.5539/mas.v5n4p95.

[12] M. R. Hossain, M. K. Rasel, and S. Talapatra, "Increasing productivity through facility layout improvement using systematic layout planning pattern theory," *Glob. J. Res. Eng.*, vol. 14, no. 7, pp. 71–76, 2014, [Online]. Available: https://engineeringresearch.org/index.php/GJRE/article/view/1269

[13] Q.-L. Lin, H.-C. Liu, D.-J. Wang, and L. Liu, "Integrating systematic layout planning with fuzzy constraint theory to design and optimize the facility layout for operating theatre in hospitals," *J. Intell. Manuf.*, vol. 26, no. 1, pp. 87–95, Feb. 2015, doi: 10.1007/s10845-013-0764-8.

[14] S. Jain and T. K. Yadav, "Systematic layout planning: A review of improvement in approach to pulse processing mills," *Int. Res. J. Eng. Technol.*, vol. 4, no. 5, pp. 503–507, 2017, [Online]. Available: https://www.irjet.net/archives/V4/i5/IRJET-V4I599.pdf

[15] J. Gómez, A. Tascón, and F. Ayuga, "Systematic layout planning of wineries: the case of Rioja region (Spain)," *J. Agric. Eng.*, vol. 49, no. 1, pp. 34–41, Apr. 2018, doi: 10.4081/jae.2018.778.

[16] I. F. Febriandini and Yuniaristanto, "Re-design Facility Layout using Systematic Layout Planning Method: A Case Study : Biopro Cosmeceutical Sdn. Bhd.," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 495, no. 1, p. 012027, Jun. 2019, doi: 10.1088/1757-899X/495/1/012027.

[17] L. Gozali, L. Widodo, S. R. Nasution, and N. Lim, "Planning the New Factory Layout of PT Hartekprima Listrindo using Systematic Layout Planning (SLP) Method," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 847, no. 1, p. 012001, Apr. 2020, doi: 10.1088/1757-899X/847/1/012001.

[18] U. Khasanah, A. P. Sutarto, and N. Izzah, "Work Facilities Improvement Using Systematic Layout Planning to Reduce the Risk of Manual Handling," *J. Nov. Eng. Sci. Technol.*, vol. 1, no. 01, pp. 15–23, Aug. 2022, doi: 10.56741/jnest.v1i01.56.

[19] V. Kumar and V. N. Malleswari,

"Improvement of facility layout design using Systematic Layout planning methodology," *J. Phys. Conf. Ser.*, vol. 2312, no. 1, p. 012089, Aug. 2022, doi: 10.1088/1742-6596/2312/1/012089.

[20] X. Hu and Y.-F. Chuang, "E-commerce warehouse layout optimization: systematic layout planning using a genetic algorithm," *Electron. Commer. Res.*, vol. 23, no. 1, pp. 97–114, Mar. 2023, doi: 10.1007/s10660-021-09521-9.

[21] J. Mao, J. Cheng, X. Li, H. Zhao, and D. Yu, "Simulation of Low Carbon Layout Optimization of Disassembly Line Based on SLP Method," *Sustainability*, vol. 15, no. 6, p. 5241, Mar. 2023, doi: 10.3390/su15065241.

[22] R. Muther and L. Hales, *Systematic Layout Planning*. United States of America: Management & Industrial Research Publications, 2015. [Online]. Available: https://richardmuther.com/wp-content/uploads/2016/07/Systematic-Layout-Planning-SLP-4th-edition-soft-copy.pdf

[23] V. Deshpande, N. D. Patil, V. Baviskar, and J. Gandhi, "Plant layout optimization using CRAFT and ALDEP methodology," *Product. J. by Natl. Product. Counc.*, vol. 57, no. 1, pp. 32–42, 2016, [Online]. Available: https://www.researchgate.net/publication/318743771

[24] C. Mgbemena, I. N. Okafor, and B. U. Oreko, "Improving Capacity Utilisation in Bread Processing Factories Using the BLOCPLAN Algorithm," *Int. J. Ind. Prod. Eng.*, vol. 2, no. 2, pp. 1–16, 2024, [Online]. Available: https://journals.unizik.edu.ng/ijipe/article/view/3551

[25] M. Faishal and M. A. Pratama, "Reducing Waste of Material Transport in Manufacturing Facility using Systematic Layout Planning and Simulation Approach," *ASM Sci. J*, vol. 16, pp. 134–142, 2021, [Online]. Available: https://www.akademisains.gov.my/asmsj/?mdocs-file=6696

[26] P. Mallick, K. Muduli, J. N. Biswal, J. Pumwa, and P. Oyekola, "Development of a Suitable Plant Layout using Computerised Relative Allocation of Facility Techniques," *Int. J. Recent Technol. Eng.*, vol. 8, no. 2, pp. 4956–4961, Jul. 2019, doi: 10.35940/ijrte.B1070.078219.

[27] H. Nasution, I. Budiman, and A. Salim, "The cost analysis of material handling in Chinese traditional praying paper production plant," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 309, no. 1, p. 012044, Feb. 2018, doi: 10.1088/1757-899X/309/1/012044.

[28] U. Tarigan, A. Ishak, N. A. Fabiola, N. Sembiring, K. Syahputri, and U. P. P. Tarigan, "Proposed improvement of production floor layout using urban algorithm in minimizing the cost of material handling (Case study of rubber wood processing factory)," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1122, no. 1, p. 012062, Mar. 2021, doi: 10.1088/1757-899X/1122/1/012062.

[29] J. M. Apple, *Plant layout and material handling*. United States of America: John Wiley & Sons, Inc., 1963. [Online]. Available: https://books.google.co.id/books?id=VQJUAAAAMAAJ&q

[30] H. Imanullah, H. Heryani, and A. Nugroho, "Analysis of Bread Production Facilities Layout using BLOCPLAN Algorithm," *Ind. J. Teknol. dan Manaj. Agroindustri*, vol. 10, no. 2, pp. 172–181, Aug. 2021, doi: 10.21776/ub.industria.2021.010.02.8.

http://dx.doi.org/10.30656/jsmi.v9i1.9212