Application of lean manufacturing concept for redesigning facilities layout in Indonesian home-food industry: A case study

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Application of lean manufacturing concept for redesigning facilities layout in Indonesian home-food industry

A case study

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Abstract

Purpose – The purpose of this paper is to redesign the layout of production floor by considering lean manufacturing in order to eliminate the waste and using Block Layout Overview with Layout Planning (BLOCPLAN) algorithm to attain new layout of facilities in Indonesian home-food industry.

Design/methodology/approach – The common problems that might be appearing in home-food industry, especially in the developing countries like Indonesia are unstandardized production process and unorganized work environment which could produce the waste. One of many solutions to handle this problem is improving the work area (work station) in production floor by rearranging and designing standard operating procedure (SOP) by using lean manufacturing concept. The initial data to minimize the waste is motion time study (data) to identify production standard time. The next step is identifying the common waste(s). Meanwhile, the production floor layout used in this research is designed by using BLOCPLAN algorithm.

Findings – The recommendation of shop floor facility layout is based on identified waste, which is excess transportation. Subsequently, standard operational procedure (SOP) is developed to support the recommended facility layout as the reference for cookie production process so it can minimize the waste.

Research limitations/implications – Lean concept is one of method that is widely implemented to reduce the occurrence of defective products and waste that do not provide added value. Based on previous researches, it was found that the concept of lean manufacturing can be applied in various types of service and manufacturing industries, both large companies and small and medium enterprises. Home-food industry competition nowadays is getting intense. This condition makes the stakeholders (of home-food industry, especially in Indonesia) need high performance and productivity to keep their business stable in winning the competition. The new layout can reduce the disadvantages of actual condition.

Practical implications – This research is useful for small- and medium-sized enterprises (SMEs) in Indonesia especially for home-food industry. The BLOCPLAN layout (as the recommendation) has displacement moment with reduction of 40 percent.

Social implications – This research believed that it can help SMEs improve their productivity in producing cake and cookies in terms of better layout which can reduce worker movement and standardized working procedure. The design of the production facility layout is a method used to rearrange the production process area so that the distance between processes can be minimized. SOPs was provided as the direction and supervision of workers to work according to standards.

Originality/value – SOP design can support recommended layout as the reference on making the cake (product) to eliminate wastes, which are motion/movement (alternating in production process flow) and long waiting time due to process delays.

Keywords Facility layout, Waste, Lean manufacturing, BLOCPLAN, Standard operational procedure

Paper type Research paper

Introduction

Lean manufacturing is emerging as one of the top manufacturing approaches in the early part of this millennium (Rishi *et al.*, 2012). Bhamu and Sangwan (2014) and AlManei *et al.* (2017) argued that the goal of lean manufacturing is to be highly responsive to customer

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demand by reducing waste and improving operating efficiency. Bhamu and Sangwan (2014) stated that lean manufacturing aims at producing products and services at the lowest cost and as fast as required by the customer. Globally, numerous manufacturing and service organizations are incorporating lean techniques to identify waste, eliminate non-value added (NVA) activities and increase efficiency. Some small- and medium-sized enterprises (SMEs) have also incorporated lean principles, yet others remain laggards (Deranek *et al.*, 2017; Rishi *et al.*, 2012; Sa'udah *et al.*, 2015; Antosz and Stadnicka, 2017; Sahoo and Yadav, 2018). Matt and Rauch (2013) argued that for many small enterprises between 10 and 49 employees the application of lean manufacturing could be one important step to increase the productivity and to be more competitive in the market. While Sahoo and Yadav (2018) investigated 121 SMEs across India which had implemented lean manufacturing in their firms, there are limited studies related to the application of lean manufacturing concepts in small and medium industries in developing countries such as Indonesia.

Lean management philosophy proposes a set of tools which can be used in companies' development (Antosz and Stadnicka, 2017; Olesen *et al.* 2015). Lean manufacturing is also made up of several tools and techniques, which are used together as continuous improvement devices to identify and eliminate waste while increasing flexibility (Mathur *et al.*, 2012). Some of these tools and techniques include value stream mapping, 5S workplace organization, total productive maintenance, set-up reduction, Kanban and pull production methods, cellular manufacturing, visual signals and process standardization (Sundar *et al.*, 2014; Zahraee *et al.*, 2014; Sahoo and Yadav, 2018). Lean tools, for example, 5S, quality circle, quality control, visual show and standardization are a low cost investment techniques which attainable to execute in SMEs (Rishi *et al.*, 2012).

Lean and factory layout

The focus of lean manufacturing approach is on reducing the NVA waste that impedes the flow of the product as it is being transformed in the value chain (Salleh and Zain, 2011). According to Liker (2004), waste on the shop floor is defined as everything that does not provide added value and disrupt the production processes. The majority of research studies on lean identify seven types of fundamental waste: correction, overproduction, motion, material movement, waiting, inventory and processing (Filho *et al.*, 2016).

A very significant change was felt by the company supporting the established main goal of lean production practices, starting with the reduction in engine set-up time, idle time, production lead time, employee overtime, inventory, defect reduction and cycle time, and thus saving production costs, increasing productivity, firms' profitability, and market position, as well as quality rate, machine availability, and overall equipment effectiveness (Narasimhan *et al.*, 2006; Kumar *et al.*, 2006; Hallgren and Olhager, 2009; Singh and Khanduja, 2010; Panizzolo *et al.*, 2012; Pullan *et al.*, 2013; Lyons *et al.*, 2013; Wong *et al.*, 2014; Saboo *et al.*, 2014; Jain *et al.*, 2015; Manfredsson, 2016; Thanki *et al.*, 2016; Karthik Bharathi *et al.* 2017). The concept of lean manufacturing can be developed with other method which depends on the problems that occur such as the improvement of factory layout, which is not in accordance with the rules of the good facilities layout can be improved by using the lean concept.

There are also many previous researches incorporating lean applications to design layout in industry (Heinavaara, 2010; Salleh and Zain, 2011; Mejia and Ramirez, 2012; Sa'udah *et al.*, 2015; Low *et al.*, 2015; Tarigan *et al.*, 2018). Salleh and Zain (2011) adopted lean manufacturing approaches in an automotive parts manufacturer in order to remain competitive in an increasingly global market. They selected APM Plastic Ltd for case study to implement lean layout in molding roof drip production line. They revealed that the implementation of lean concepts in designing layout in the production line has reduced the motion of the operator within the cell.

Mejia and Ramirez (2012) implemented lean manufacturing principles, specifically using Group Technology and Theory of Constraint, to redesign layout in a medium-sized machine shop located in Bogota, Colombia. They found that the new shop floor organization produced important benefits: the work environment markedly changed, and the workplace now looks roomier, neater, and cleaner. Sa'udah *et al.* (2015) conducted research which aimed to design facility layout in SME Food Industry using ARENA and Systematic Layout Planning (SLP) and also introduce a value stream that optimizes the flow of entire system distance between machines, frequency of material movement and capacity. Low *et al.* (2015) conducted study to examine how lean production principles (LPP) can be incorporated in the context of ramp-up factories to improve future ramp-up factory designs. They stated that the application of LPP to design facility in ramp-up factories can help them in reducing waste and achieving higher-quality products. They also revealed that the proposed LPP-driven facilities design especially can help ramp-up factories in improving tenants' operational needs after the building is occupied.

Hailemariam (2010) conducted research which focused on identifying and improving the inefficiencies related to logistic processes, developing improved layouts of the existing and new departments, and designing the material flow paths connecting the departments so that the handling and transportation efforts are minimized. Tarigan *et al.* (2018) applied lean service and market basket analysis method in Supermarket to simplify service process. Service process improvement is done by lean service method by identifying the root of problem using 5W + 1H concept.

Home-food Industry and the case company

Small and medium industries have an important and strategic role for the country's economic growth, both developing and developed countries. When the economic crisis took place in Indonesia in 1998, the ability of the SMEs to survive at this time verifies that this sector was part of a fairly strong business sector (Berry *et al.*, 2001). While Sulistyastuti (2004) argues that in developed countries and new industries, SMEs contribute to increasing exports and as subcontractors who provide various inputs for large-scale businesses as well as sources of innovation. The increasing growth of SMEs in Indonesia is dominated by the food and beverage industry. Over the last decade, the development of business in the food sector has experienced very significant growth. Based on Master Plan of National Industry Development Year 2015–2035, the growth of food and beverage SMEs which had the highest growth in 2017, which amounted to 9.23 percent, and then in 2018, the food industry became a priority subsector. The subsector is expected to be booster for achieving the growth target of the non-oil and gas industry in 2018, which was 5.67 percent. Moreover, this sector also increases investment realization. Indonesia's food industry sector contributes 34 percent to the non-oil industry's gross domestic product (GDP) in 2017 (Indonesian Ministry of Industry, 2017).

Because the food SMEs are now a priority subsector so that SMEs are required to be able to compete in terms of quality, costs and speeding up order fulfilment (delivery). Therefore, it is important for food SMEs to be able to apply this lean manufacturing layout concept in continuing sustainable improvements so that later products can be more competitive in terms of quality, cost and production time.

Common problems which exist in home-food industries are unstandardized production processes and unorganized work environments which could produce the waste. Proven in manufacturing, lean methods aimed at eliminating waste are being applied to increase efficiency, improve of quality and reduce costs (Grunden, 2008). In lean concept, standardization of procedure and continuous improvement become fundamental in the continuity of service process to improve the performance of a company (Tarigan *et al.*, 2018). At the beginning of the operations, the company should first identify the problems that can cause waste. These are seven elements in identifying waste, i.e. overproduction, inventory, transportation, waiting, motion, over-processing and correction (Jared, 2001).

CV Resti Jaya is one of the home-food industries that produce cookies in Padang, West Sumatra, Indonesia. The products produced vary and the equipment used to produce the cookies has also been numerous. This home-food industry applies make to order system, which is producing according to the order. Based on the field survey in the area of the cookie production process, it was found that the placement of the main and supporting materials to make the cookie was placed in empty areas. Placement of machinery and facilities for making cookies is also placed without considering the environment in the work area. In addition, the flow of production processes that occur in the production floor area also has workstations that are far apart so that the production process flows back and forth. The flow of this alternating production process also results in a waiting time between one workstation and another workstation, as well as the waiting time for the operator to work. Therefore, it can be concluded that the waste that often occurs on the production floor in this home-food industry is in terms of transportation, operator movement, and waiting time.

Based on that condition, this research aimed to redesign home-food industry facility in the case study company layout by using lean manufacturing concept to eliminate the waste in production floor. This research also designs standard operating procedure (SOP) in order to help home-food industry production floor stay sustainable in the future.

Redesigning production floor facility layout become important to eliminate commonly waste. Therefore, it hopefully can increase the productivity and make the production process become effective and efficient. Lean facility layout means to arrange the physical equipment within a shop floor to help the facility work in a productive way. A good layout scheme would contribute to the overall efficiency of operations. The research on facility layout of a production line has always been the key research area of industrial engineering domain (Diego-Mas *et al.*, 2009; Sahin and Türkbey, 2009; Raman *et al.*, 2009; Zhang *et al.*, 2009).

Meanwhile, the SOP design in this research has purpose to manage waste eliminating process. Through the SOP, stakeholders have clear working procedure. Therefore, problem formulation in this research is how to redesign production floor facility layout by using lean manufacturing concept to eliminate the waste. The objectives of this study are: designing standard operational procedure (SOP) for products (cookies): Saka (Brown sugar) Cookie; Skipi Cookie (Peanut butter choccochips cookies); Putu Cookie (green-colored steamed rice flour cookies) and giving the recommendation of production facility layout. These three kinds of cookies are the most ordered cookies by the customers.

Methodology

This research was conducted at one home-food Company in Padang, West Sumatra, Indonesia which produces various kinds of cookies such as Saka cookie, Skippi cookie, and Putu cookie. This home-food industry makes cookies based on orders from consumers. The problem found in this company was the arrangement of production facilities that are far apart between one workstations from the next workstation. This causes the production process flow back and forth. This condition has an impact on the waiting time between one workstation and another working station. The layout condition of production facilities, that it does not pay attention to the interrelationship between workstations results in long displacement times and high moments of displacement. Therefore this study aimed to redesign the production facility layout of this home-food company by calculating the moment of displacement that occurs in order to minimize the moment of displacement that occurs. Another problem faced by this industry was it does not have standard operational procedures for producing these cookies.

Lean manufacturing approach is used to determine and identify waste that occurs during the production process. The Block Layout Overview with Layout Planning (BLOCPLAN) algorithm is used to analyze the frequency of material displacement and the degree of proximity between workstations which are interconnected on the production floor.

The data collected in this study are: production process time; weighting of waste that occurs on the production floor; initial layout; size of facilities on the production floor; frequency of displacement that occurs on the production floor; and production activities that occur on the production floor. The stages carried out in this study are divided into three groups: eliminating waste; redesigning facility layout; and creating SOP.

Eliminating waste

Calculating standard time. Standard time calculation starts with observing and retrieving data on the production process time. The processing time for each workstation collected consists of the process of transporting raw materials and the process of making cookies on the production floor by workers. Time measurement is done by the direct measurement method using stopwatch. The measurement of cookie production time is carried out for one week because the manufacturing time for each cookie varies every day. Saka cookies are produced three times a week, namely Monday, Wednesday and Friday, Skipi cookies are produced every day, while Putu cookies are made twice a week, Tuesday and Friday.

Creating process flow chart. Process flow chart was described based on the process of producing each cookie and elaborating the work done by workers. The standard time obtained in the previous stage was included in the chart.

Creating big picture mapping. Big picture mapping is aimed to provide an overview and understanding of the value stream in the production process as a whole and systematic. Information from big picture mapping is in the form of information flow, physical flow, and lead time needed. Identification of waste (NVA activity) is done by using the rating table regarding waste on shop floor. This table is filled by workers involved in the production process. It is useful for determining the weight of each waste found on the production floor, then choosing the right tool to identify, analyze and overcome these wastes.

Choosing value stream mapping tools. Waste that will be eliminated or minimized is waste that often occurs and is prioritized to be minimized on the production floor, then selecting the detailed mapping to analyze waste. The detailed mapping tool is done by using the value stream mapping tool table. The relationship between wastage and detailed mapping is divided into three, namely high correlation with weight 9, medium correlation with weight 3 and low correlation with weight 1. The detailed mapping chosen is the one that has the high correlation and prioritized to be minimized.

Redesigning facility layout

- Measuring production floor size.
- Determinating coordinate of workstations in original condition. The aim of this step is to determine the distances between workstations, the coordinate of each workstation is necessary to be calculated first.
- Determinating distances between workstations in original condition. Rectilinear distance formula are using to calculate distances between workstations.
- Determinating material handling frequency between workstations. Material handling frequency between departments per month can be identified from calculation of production volume per month divided by material handling capacity of each product.
- Calculating displacement moment at facility layout. This calculation is based on multiplication between displacement frequency and the distance.

- Establishing activity relationship chart (ARC). ARC designs factory facility layout that uses qualitative techniques. ARC shows the closeness of the relationship between a facility and other facilities. In assessing the level of relations between factory facilities, we need to pay attention to the factors that influence the level of relationships.
- Designing facility layout using BLOCPLAN algorithm. The design of facility layout uses BLOCPLAN Algorithm in this study was performed by using BLOCPLAN 90 Software. Afterwards, an evaluation of the new layout is carried out.

Creating SOP
Designing SOP is carried out after eliminating the occurrence of waste. The standard procedure for the manufacture of cookies is to ensure the cookies produced with high quality, on time, safe and without frequent movement of the operator.

Results

Waste elimination
Standard time tabulation. The steps to define standard time for each operation (done by cookies makers) are:

(1) Statistic trial for process time by using uniform test and sufficient test.
(2) Cycle time (Ws) tabulation by dividing total process time to the amount of processes.
(3) Normal time (Wn) tabulation: normal time (Wn) is the working time of an operator taking into account the adjustment factor (p). Normal time can be calculated by the following equation:

$$\mathrm{Wn} = \mathrm{Ws} \times p.$$

(4) Standard time (Wb) Tabulation: standard time (Wb) is the operator's working time by considering the allowance factor (l = allowance factor). Standard time can be calculated using the following equation:

$$\mathrm{Wb} = \mathrm{Wn} \times (1+l).$$

Process flow diagram. After standard time value for each product is identified, it is represented in process flow diagram which shows base activities in making cookies, including transporting, waiting and restoring.

Big picture mapping. Big picture mapping is a tool to describe the flow of the overall value that occurs in a system. The use of big picture mapping will facilitate the understanding of the system and identify the problems that occur. Big picture mapping shows the lead time and type of activity throughout the cookie production process at CV Resti Jaya. The standard time that has been obtained at the previous stage is also reflected in the big picture mapping of the cookie production process.

Selection of value stream mapping analysis tools (VALSAT). The next step is determining representative tools of the system by discovering the wastes in production process. This step uses waste weighting from questionnaire.

Waste identification. The purpose of this step is to identify the waste based on the real condition through the respondents' (who understand the real condition in production floor) assessment for scoring the waste. The interview process was conducted by equating perceptions about waste that might occur in the activity of making cookies on the production floor. Furthermore, respondents were asked to give weight to the types of waste from seven wastes that could be indicated. The waste scores from respondents' assessment are represented in Table I.

The average of waste weighting score is multiplied by matrix index of VALSAT selection. Waste weighting assessment is represented in Table II.

The selected VALSAT is obtained from the tool with the largest total weight of the seven tools available. The values found in Table II are the average value of the waste assessment score multiplied by the matrix index from the VALSAT selection. Total weight for tool process activity mapping (PAM) = 1 + 27 + 27 + 18 + 6 + +36 + 1 = 115.

The weights obtained from the seven tools are sorted from the largest to the smallest weights. The tool used as a detailed mapping is a tool with the greatest weight. Table II shows that the right tool for identifying waste in the value stream of cookie production is process activity mapping (PAM).

Process activity mapping. PAM is a tool to identify whole activity in a system. PAM consists of the information about physic flow or information, activity type, the distance, activity time and persons in the system. Stages of PAM are:

(1) Direct observation by identifying activities, processing time needed, distance of displacement, and tools used, as well as workers involved in making cookies at CV Resti Jaya.

(2) Group activities into five groups consisting of operations, transportation, storage, delay/waiting or inspection.

(3) Analyzing the type of activities into three types, namely value added, NVA or necessary but NVA.

No.	Waste	Score
1	Overproduction	0
2	Defective products	1
3	Unnecessary inventories	2
4	Inappropriate processing	2
5	Excessive transportation	3
6	Waiting	3
7	Unnecessary motion/movement	4

Table I. Waste weighting assessment

		Detailed value stream mapping						
No.	Waste	PAM	SC	PVF	QFM	DA	DP	PS
1	Overproduction	0	3		1	3	3	
2	Waiting	27	23	3		9	9	
3	Excess transportation	27						3
4	Inappropriate Processing	18		6	2		2	
5	Unnecessary Inventory	6	18	6		18	6	2
6	Unnecessary Motion	36	4					
7	Defects	1			9			
Total		115	52	15	12	30	20	5
Ranking		1	2	5	6	3	4	7

Notes: PAM, process activity mapping; SC, supply chain; PVF, production variety funnel; QFM, quality filter mapping; DA, demand amplification; DP, decision point; PS, physical structure

Table II. Waste weighting assessment

The comparison actual time among activities: operation, transportation, inspection, storage and delay in making cookies on CV Resti Jaya's production floor based on PAM can be seen in Table III.

Comparison between activities categorized as value added, NVA, and necessary but NVA in making cookies on the production floor can be seen in Table IV.

Based on this PAM, the waste that occurs during the production process at CV Resti Jaya can be identified as following:

(1) Excessive transportation or transportation occurs backtrack, and the distance becomes long and there are repetitive moments of displacement. This is due to inefficient movement of material, for example the transfer from the cookie printing workstation to the cake coloring station, because the distance is too far.

(2) Waiting, workers are waiting for the next process, including waiting for tools, supplies, unemployed components due to run out of raw materials, process delays and engine damage.

(3) Unnecessary motion, this movement is a movement that does not provide added value for products such as searching for, stacking components and equipment, walking, and so on. Examples of activities that do not provide added value at CV Resti Jaya are: walking outside the production area looking for baking pans, cookie printing devices and scales. This movement can actually be removed by doing an initial set-up before the cookie making process.

Redesigning facility layout

Production floor size. The production floor has 17 workstations to produce cookies. Every workstation consists of one or some work-elements. The data for each workstation is represented in Table V.

Coordinate determination of workstation in original condition

The aim of this step is to determine the distances between workstations, the coordinate of each work-station is necessary to be calculated first. Each work-station is represented in area allocating diagram (AAD) with original condition size. AAD for each work-station is in Figure 1

Table III. Actual time among activities: operation, transportation, inspection, storage, and delay

Activity	Actual time (second)	Percentage (%)	Category
Operation	8647.37	96.99	Value added
Inspection	6.08	0.07	Necessary non-value added
Transportation	228.60	2.56	Non-value added
Storage	33.28	0.37	Necessary non-value added
Delay	0.00	0.00	Non-value added

Table IV. Comparison among value added, non-value added, and necessary but non-value added

	Value added	Necessary non-value added	Non-value added
Total time (second)	8647.37	39.37	228.60
Percentage (%)	96.99	0.44	2.56

No.	Workstations	H(m)	W(m)	Total area (m^2)
1	Saka and Putu storage	4	7.5	30
2	Skipi storage	2	1	2
3	Saka stirring	2	2.5	5
4	Skipi stirring	2	2	4
5	Putu stirring	1.5	1.7	2.55
6	Saka milling	1.5	4.5	6.75
7	Saka stamping	8	2.5	20
8	Skipi stamping	4	1.5	6
9	Putu stamping and packaging	4.5	1.5	6.7
10	Frying	5.5	3	16.5
11	Cooling	2	1,5	3
12	Sugaring	2.5	1,5	3.75
13	Coloring	2.75	2,5	6.88
14	Baking	2.5	3	7.5
15	Saka packaging	6	3	18
16	Skipi packaging	2.5	2	5
17	Warehouse	10	2.75	27.5

Table V.
Data and size of workstation

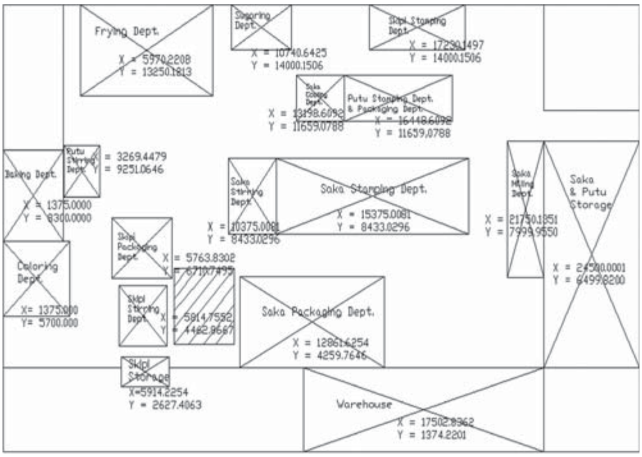

Figure 1.
Production floor AAD in original condition

Distances determination between workstations in original condition

Distances between workstation are calculated using rectilinear distance formula. The researchers use the symbol for each workstation, such as: Saka and Putu Storage, Skipi Storage, Saka Stirring, Skipi Stirring, Putu Stirring, Saka Milling (G) Saka Stamping, Skipi Stamping, Putu Stamping and Packaging, Frying, Cooling, Sugaring, Coloring, Baking, Saka Packaging, Skipi Packaging and Warehouse.

Material handling frequency determination between workstations

Material handling frequency between departments per month can be identified from calculation of production volume per month divided by material handling capacity of each product. Material handling frequency per month is represented in Table VI.

Table VI.
Total material handling frequency between department per month

No.	Start stations	Destination stations	Movement frequency/month (times/month)
1	A	C	24
2	C	G	98
3	G	F	684
4	F	G	684
5	G	J	684
6	J	K	684
7	K	L	684
8	L	K	684
9	K	O	684
10	O	Q	342
11	B	D	104
12	D	H	1,162
13	H	M	1,162
14	M	N	1,162
15	N	P	1,162
16	P	Q	897
17	A	E	8
18	E	I	32
19	I	Q	272

Tabulation of total displacement moment at facility layout

Displacement moment tabulation is formulated on:

$$Z_{A-B} = f_{A-B} \times d_{A-B}.$$

This tabulation is based on multiplication between displacement frequency and the distance. Total displacement moment at original layout is 122,037.84 meter/month. After evaluating the original layout from the production floor, there were several conditions that need to be improved. The recommended layout is designed to overcome the weaknesses found in the original layout. The results from evaluation of the actual layout for the Saka, Skipi and Putu cookies production floors can be seen in Table VII.

Activity relationship chart

ARC is a design from close relationship between workstations in production floor. ARC is based on the workstations which have qualitative criteria for close relationship between theirs. ARC is used as BLOCPLAN input. The relationship reasons to eliminate the waste are:

(1) Process flow sequence;

(2) Easy for material displacement;

Table VII.
Evaluation results from actual layout

No.	Problems occur waste	Improvement needed	Improvement purpose
1	Production flow has backtrack	Transfer of workstations adjacent to the process of each cookie types	Material flow becomes continuous
2	The distance of material handling is relatively far away	Move workstations according to the level of proximity based on activity relationship chart (ARC)	Minimize the total displacement distance between workstations
3	Working area with irregular flow patterns	Designing layout that is tailored to flow patterns based on the product and process	Production flow based on product type and process

(3) Easy for inspection;

(4) No process linkage; and

(5) Disturbing the activity (work).

Algorithm BLOCPLAN using Software BLOCPLAN 90

(1) Determine workstation's specification.

(2) Input data of workstation close relationship between workstation.

(3) 20 times iteration using Automatic Layout. Iteration output is in Figure 2.

(4) The optimum layout is indexed by highest R-Score. However, if there is same value of R-Score, the lowest REL-DIST SCORE needs to be found from the highest R-Score. The lowest REL-DIST SCORE describes the close workstations distance should be low. The result shows the highest R-Score belongs to the 4th iteration with R-Score is 0.64.The BLOCPLAN 90 layout is represented in Figure 3.

(5) Determination workstation coordinates for recommended production floor layout.

(6) Tabulation of distance between workstation using rectilinear formula.

(7) Tabulation of total displacement moment for recommended facility layout. The result of displacement moment for recommended layout is 73.711 meter displacement/month.

The comparison result shows the recommended facility layout has the lowest material displacement moment. After obtaining the selected layout using BLOCPLAN90 software, each workstation or department is described in the form of AAD. The proposed AAD is useful for determining the distance between new departments by first calculating the coordinates of each department. The recommended layout using BLOCPLAN increases material flow efficiency up until 39.6 percent. The final layout is represented in Figure 4.

There are several changes in distance that occur in the proposed layout, for example: the location of the department that most contributed to the small moment of displacement is in the Saka Stamping Department (G) to the Frying Department (J), with an initial displacement distance of 14.22 to 4.99 m. The transfer of Skipi Stirring Department (D) to

LAYOUT	ADJ. SCORE	REL-DIST SCORES		PROD MOVEMENT
1	0.59 - 5	0.73 - 4	674 - 6	0 - 1
2	0.49 -20	0.69 -12	719 -10	0 - 1
3	0.59 - 6	0.72 - 8	686 - 8	0 - 1
4	0.64 - 1	0.75 - 1	578 - 2	0 - 1
5	0.53 -12	0.70 - 9	732 -11	0 - 1
6	0.53 -15	0.68 -13	795 -12	0 - 1
7	0.61 - 2	0.72 - 7	684 - 7	0 - 1
8	0.60 - 4	0.73 - 3	662 - 5	0 - 1
9	0.55 - 8	0.75 - 2	535 - 1	0 - 1
10	0.55 - 8	0.70 -10	695 - 9	0 - 1
11	0.56 - 7	0.65 -17	802 -13	0 - 1
12	0.53 -12	0.64 -19	878 -17	0 - 1
13	0.51 -18	0.63 -20	939 -20	0 - 1
14	0.61 - 2	0.73 - 6	642 - 4	0 - 1
15	0.52 -16	0.73 - 5	606 - 3	0 - 1
16	0.51 -18	0.66 -15	887 -19	0 - 1
17	0.53 -12	0.65 -16	849 -16	0 - 1
18	0.54 -11	0.69 -11	808 -14	0 - 1
19	0.52 -16	0.65 -18	882 -18	0 - 1
20	0.55 - 8	0.68 -14	830 -15	0 - 1

TIME PER LAYOUT 33.41

DO YOU WANT TO DELETE SAVED LAYOUT (Y/N) ?

Figure 2. Twenty times iteration process

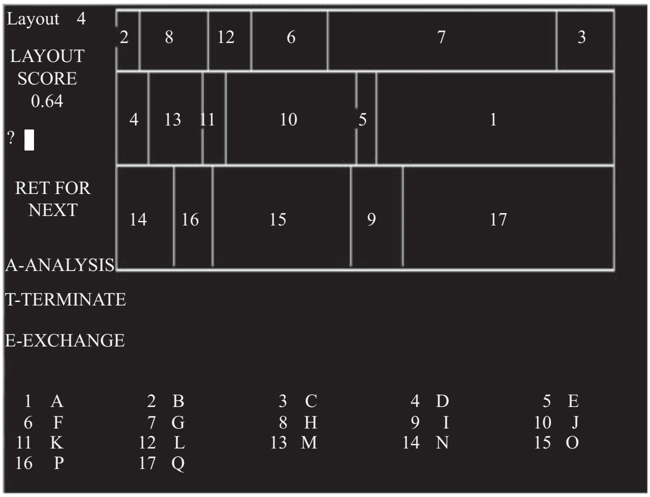

Figure 3.
Output BLOCPLAN

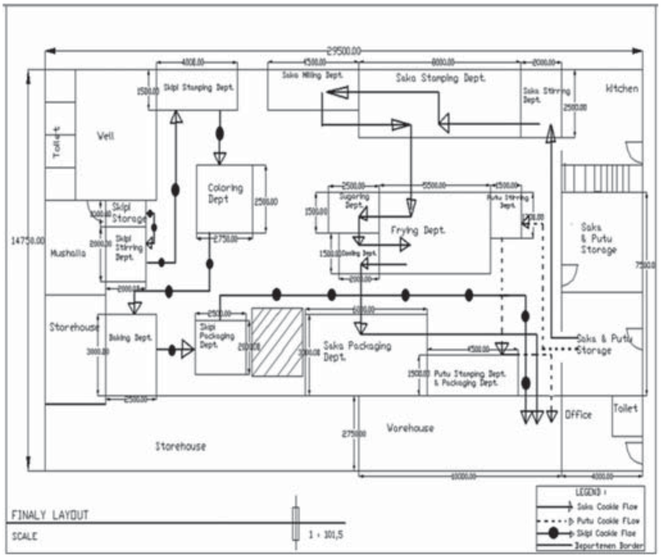

Figure 4.
Final layout

Skipi Stamping Department (H) can eliminate distance of 11.4 m from the actual layout. Skipi Stamping Department (H) transferred to the Coloring Department (M) can eliminate the distance of 18.77 m from the actual layout. Saka and Putu Storage Department (A) transferred to Putu Stirring Department (E) can eliminate distances of 16.34 m.

Standard operational procedure

SOP design is made as the lean manufacturing concept implementation based on actual production process. Through the SOP, it is expected that standardized work can be created to eliminate working variance in process since it is the key to make consistency of work performance. Some adjustments to conditions of the proposed layout are included in SOP designed which is mainly related to the sequence of production processes and standard time for each process.

The design of SOP is aimed to make all production activities work according to working guidelines. If production activities have been carried out in accordance with the designed SOP and overtime can be reduced, or even eliminated. The standard time obtained is also used as a reference for director to assess operator performance, as well as the operator's responsibility for their respective work becomes clear. Documented SOPs can facilitate various parties to understand the process of making cookies such as Saka cookie, Skipi cookie, and Putu cookie. In other words, this SOP will later serve as a guideline to train new workers if additional worker is needed later along with increasing production capacity and increasing demand for cookies produced by CV Resti Jaya.

Conclusion and further research directions

This study provides a recommended facility layout which is developed according to identified waste, which is excess transportation. Therefore, redesigning of production floor is aimed to minimize material displacement transporting distance. Then, SOP is created to support the recommended facility layout as the reference for cake production process so it can minimize the waste. The new layout design and SOP based on the workstation layout can provide several benefits for CV Resti Jaya, namely:

(1) The optimal layout can increase output with lower production costs. This is because employee working hours and machine working hours are lower. SOPs designed with reference to the new layout can increase production targets per day. This is due to the shortened transportation time, so that it can increase the amount of production due to minimized transportation time and consumer demand can be fulfilled as well.

(2) The new layout obtained can shorten total production time and minimize material transfer costs.

(3) The layout of the workstation for the production of the three cakes can shorten the production time due to the shorter transfer distance between workstations. With the existence of an SOP designed based on a new layout, overtime can be eliminate and the company can meet consumer demand that increases every week or in other words the production target per day is achieved without having to work overtime.

(4) The layout of the new workstation can reduce the distance of moving goods or raw materials for the manufacture of the three cakes starting from the initial process until the cake products are stored in the warehouse. Therefore, the short distance between production processes can shorten the third production process time of the cake.

Therefore, the new layout and standardized work procedures can shorten the manufacturing time for the three cakes and in the end the daily production target can be achieved. This paper has presented the results of a study on implementation of Lean Manufacturing concept incorporating with redesigning shop floor layout in Home-Food industry. SOP design can support recommended layout as the reference on making the cake (product) to eliminate wastes, which are Motion/Movement and Waiting. According to the layout improvement, the recommendation can reduce the disadvantages of original condition. The BLOCPLAN layout (as the recommendation) has displacement moment with amount 73, 711 meter displacement/month, while the original condition has displacement moment of 122,037.84 meter displacement/month The recommended layout from this study reduces waste by lowering original displacement levels with reduction of

40 percent. One of the limitations is the fact the study is only a single-firm case study. This makes the results/outcomes more difficult to be generalized throughout the home-food industry.

Future research could employ lean concepts in improving facility layout and eliminating NVA activities in SMEs by developing SOP as standard guidelines for their production process. Finally, it is expected that the results can be useful to continuously improve SMEs' productivity with new facility layout and standardized working procedure.

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