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INCREASE OF EFFICIENCY OF WORKSTATION DESIGN THROUGH PRODUCTION SCHEDULING FOR MOSLEM CLOTHES IN SME "XYZ"

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ABSTRACT

Scheduling is time arrangement of some activity. Scheduling activities include allocating facilities, equipment or labor for an operation and to determine the order of an operation. The purpose is to minimize the waiting time, waiting services, inventory levels, and also the efficiency of facility, labor and equipment.
The aims of this study is to design a production schedule with improving the efficiency of every work stations. This study starts from the determination of standard time of each operation, labor scheduling, balancing the production line and simulated it with software Promodel 6 student version.
The measurement of working time using stop clock method then determines the standard time of each operations with Westinghouse approach. Then for labor scheduling using algorithm Lang method. Then for balancing production line using Rank Positional Weight (RPW) method, J-Wagon, Mirror, Moodie Young, Large Candidate Rule (LCR), and Region Approach then the result of those six methods are compared and which have the largest value of line efficiency and the smallest value of smoothing index and the smallest delay time will be selected.
From the data processing of this study showed that the standard time in producing Moslem clothing X-101 is equal to 28,31 minutes. The optimal method to balance this production line is using the Mirror method. By using this method, the value of line efficiency is 80,97% rise around 58,49% of the current production line condition, then the value of smoothing index become 3,97 and for the value of balance delay is 19,03%. And also the delay time become smaller 6,65 minutes decrease 90,96 minutes from the current production line condition.

***Keywords**: Production Scheduling, Standard Time, Algoritma Lang, Line Efficiency, Smoothing Index, DelayTime*

1. INTRODUCTION

One of SMEs (Small and Medium Scale Enterprise) that developed enough in Indonesia is SME in textiles and clothing (TPT). Stated by the Minister of Industry (2011), that the textile industry in 2011 to reach a positive growth rate, around 9,22%. Non–Oil and gas processing reached the second rank in growth of industry. Meanwhile, from the side of industrial role in the growth of Indonesian Economy, the textile industry ranks fourth, around 9,35% (Nurhasanah, 2013).
SME XYZ is one of SME whom produce textiles and clothing industries. This industry produces Moslem cloths. The outline, the process sequence of the Muslim cloth begins with cutting the cloth, then the clothes pieces sewing according to the model have been determined, and *pengobrasan* is done than the *penstickan* process which the aims is to made the stitching become stronger. Then process *nyamping* for unification of the body with sleeves to become clothing. Then the seam process on the bottom (camp), followed by labeling. Then do the inspection process, then the string must be cut off, ironing with steam, and the last is packing process before the delivered to the consumer.

The production schedule of this industry is not efficient because there is a lot of waiting time. This is indicates that there is an imbalance in the production line.

The imbalance of this production line is because the distribution of work load is improper, the delayed of raw material, poor layout, et cetera. A balance in production line is need in order to made the flow of the product run smoothly. With the line balanced can also improve the efficiency of the work station. Line balancing is a production scheduling which seeks to balance the workload at each work station, with resource allocation and distribution of resources with similar characteristic (Bedworth, 1987).

A good scheduling of production process can reduce idle time in the units of production and minimize items that are in process (Ginting, 2009).

According to the background, it is necessary to made a research about the scheduling of production in this industry. Production scheduling scheme which shall include the determination of standard time making Muslim clothing X-101, labor scheduling, and line balancing. Then the result of this line balancing will be simulated using the Promodel 6 Student Version software. With the design of a new production process shedulling would be expected that it can improve the efficiency of the station.

The focus of this problem is to find out how much standard time produce Muslim clothes per unit, if the labor resources that exist were optimal in the production process, what is the optimal method to balance the production line, and how the result of simulations using Promodel software on the current production line and production line proposed.

2. THEORETICAL BACKGROUND

Production Scheduling

Scheduling is the allocation of limited resources to work on a number of jobs. Production scheduling is one factor that plays an important role in the production of an industrial activity. Scheduling production processes that can either reduce idle or delay time in the units of production and minimize work in process. Scheduling can be defined as the process of allocating resources to select a set of tasks within a certain time period (Ginting, 2009).

Standard Time

Standard time is the time taken by a worker who had an average level of ability to complete a job. Standard time already includes adjustment factors and allowances (Wignjosoebroto, 1995).

Lang Algorithm

Lang Algorithm used to analyze the resource requirements in terms of the labor resources within the company. Phases in the execution of Lang Algorithm are:

a. Sort activities by Latest Start Time.
b. Where has the Latest Start Time equal, then sort by: allowances time the smallest, the longest duration of time, and the greatest resource needs (Bedworth, 1987).

Line Efficiency

Line Efficiency (LE), is the ratio of the total time work station divided by the number of cycles multiplied by the number of work stations or work station efficiency divided by the number of work stations. LE is one of the parameters used in determining the line balancing. LE used to calculate the following formula:

$$LE = \frac{\sum_{i=1}^{k} ST_i}{(K)(CT)} \times 100\% \quad (1)$$

Value of K is the number of work stations, CT is the cycle time and the STi is the greatest time in work station-i (Aribowo, -).

Smoothing Index

Smoothing Index (SI), is an index that shows the relative smoothness of a specific assembly line balancing. Good SI value is 0, which indicates that the current production is smoothly. SI is also used as a parameter that is used in determining the line balancing. SI is used to calculate the following formula:

$$SI = \sqrt{\sum_{i=1}^{k} \left(ST_{maks} - ST_i\right)^2} \quad (2)$$

Value of ST_{maks} is the maximum time at the work station, ST_i is the time at work stations-i (Aribowo, -)..

Delay Time

Where the operator or workers waiting to do the work process or the operation will be done is called waiting or delay time. Delay time (DT) is the excess between cycle time (CT) and station time. DT used to calculate the following formula:

$$DT = n.Ws - \sum_{i=1}^{n} Wi \quad (3)$$

Value n is the number of work stations, Ws is the greatest time work stations and Wi is the actual time at work station (Aribowo, -)..

3. RESEARCH METHOD

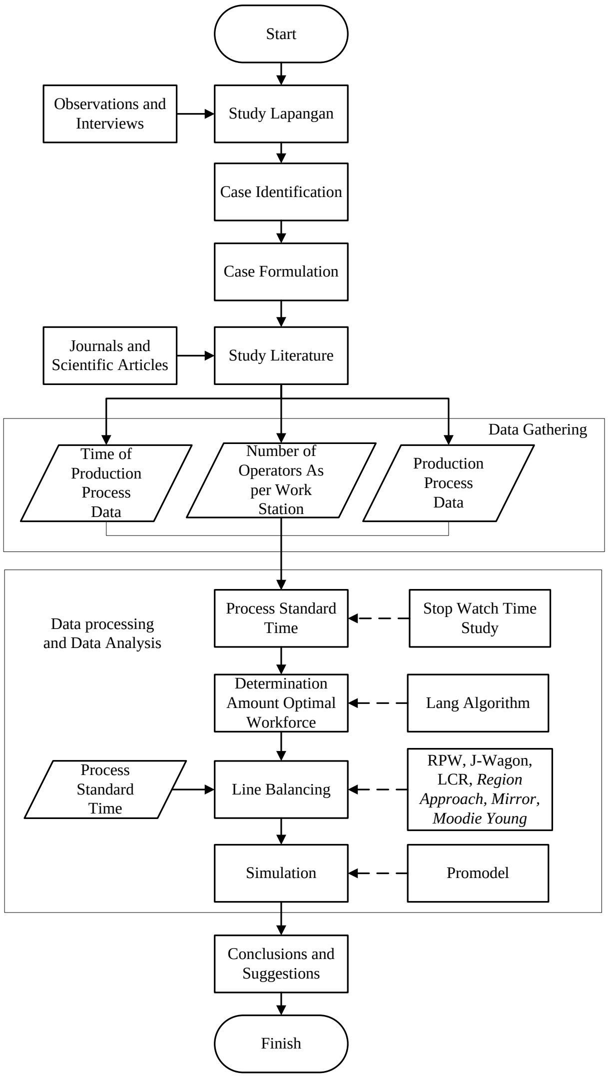

Figure 1. Research Method

4. RESULT

Production Process

There are 24 work element with 14 work stations to process moslem cloth with code X-101. Table 1 presents each of the elements are working in their respective work stations that exist in this industry.

Table 1. Work Element on Each Work Station

Work Station	Work Element	Description
1	1	Work element of cutting cloths
2	2	Work elements of sewing part bottom cloth white with brown cloths on the sleeves
	3	Work elements of sewing a top white cloth with brown cloths on the sleeves
	4	Work elements of sewing brown cloths on sleeves
	5	Work elements of mounting rubber on the lower arm
3	8	Work element of sewing body parts wrinkle
	9	Work element of sewing body wrinkle parts with brown cloths below
	10	Work element of sewing body parts brown
	11	Work element of sewing lower body with the upper
	12	Work element of mounting strap
	14	Work element of sewing front and rear body
4	6	Work element of *pengobrasan* sleeves after sewing
	13	Work element of *pengobrasan* body after sewing
	15	Work element of *pengobrasan* after grafting
5	7	Work element of penstickan sleeves
6	16	Work element of penstickan body
7	18	Work element of nyamping
8	17	Work element of camp
9	20	Work element of pengobrasan afer camp
10	19	Work element of labeling
11	21	Work element of thread off
12	22	Work element of inspection
13	23	Work element of steam iron
14	24	Work element of packing

Standard Time

In order to use scheduling to determine the optimal workforce by Lang's Algorithm, standard time has to be found first. Table 2 shown the result.

Table 2. Standard Time Per Work Station

Work Station		Standard Time (minute)
1	Cutting cloth	0,60
2	Sewing sleeve	8,74
3	Sewing body	5,48
4	Pengobrasan	1,82
5	Penstickan sleeve	0,65
6	Penstickan body	0,46
7	Nyamping	1,89
8	Camp	0,69
9	Obras after camp	0,24
10	Labeling	0,41
11	Threads off	1,22
12	Inspection	3,51
13	Steam iron	1,07
14	Packing	1,53

Optimal Workforce

This scheduling method by Lang's Algorithm has possible to be built from the network production process workflow first. Network has made by categorized work element as in Table 3. Figure 2 shown the network, and Figure 3 shown the workforce scheduling.

Table 3. Scheduling to Optimized Workforce

Activities	LS	Time (minute)	Workforce
1-2	0,00	0,60	2
2-3	0,60	8,74	3
2-4	4,38	5,48	3
3-5	9,34	1,17	1
4-5	9,86	0,65	1
5-6	10,51	0,65	2
5-7	10,70	0,46	2
7-8	11,16	1,89	1
8-9	12,99	0,69	1
9-10	13,68	0,24	1
10-11	13,92	0,41	1
11-12	14,33	1,22	5
12-13	15,55	3,51	1
13-14	19,06	1,07	2
14-15	20,13	1,53	2

Designing Production Scheduling (Line Balancing)

On designing production scheduling performed with the aim of improving efficiency values work stations, reduce idle or delay time, and make a smoothly production flow.

The data used in the balancing line is Standard time data, after it made precedence diagram accordance network schedule at Lang algorithm as shown in Figure 2.

The method used to calculate line balancing is Rank Position Weight (RPW), J-Wagon, Large Candidate Rule (LCR), Moodie Young, Mirror, and Region Approach.

After the determined the method used, calculated value of LE, SI, BD, and DT then determined the optimal method. Table 9 presents the summary results of the calculation of LE, SI, BD, and DT with each method and current conditions. Table 10 presents the comparison of classification or grouping work station and efficiency per work station

From Table 4 shown that the optimal method in line balancing is Mirror. The value of LE is 80.97%, value of SI is 3,97. Value of DT is 6.65 min and value of BD is 19.03%.

Layout current condition, can be seen in Figure 4, while the layout of proposed condition can be seen in Figure 5.

Table 4. Recapitulation value DT, LE, SI, and BD

Method	DT (minute)	LE (%)	SI	BD (%)
RPW	15,39	64,78	9,58	35,22
J-Wagon	15,39	64,78	9,58	35,22
LCR	6,65	80,97	4,06	19,03
Region Approach	15,39	64,78	9,58	35,22
Mirror	6,65	80,97	3,97	19,03
Moodie Young	15,39	64,78	9,58	35,22
Current Condition	94,06	23,14	26,59	76,86

Table 5. Comparison of Grouping Work Station and Efficiency Per Work Station

Current Conditions		Conditions of Proposed	
Work Station	Efficiency Work Station	Work Station	Efficiency Work Station
1	7%	1	70%
2	100%		
3	63%	2	100%
4	21%	3	70%
5	7%		
6	5%		
7	22%		
8	8%		
9	3%		
10	5%		
11	14%	4	84%
12	40%		
13	12%		
14	18%		

Simulation With Software Promodel 6 Student Version

The assumptions used in making this simulation is:

a. Standard material warehouse capacity = 2.666,67 unit.
b. Arrival time of 2,55 min / unit.
c. Not considering the distance and resource.
d. Processing time using standard time, so it does not use distribution.
e. *Simulation run time* is 8,5 hours or 510 minute.

The results obtained of simulation with Promodel following:

1) Current Condition
Conditions currently consists of 14 work stations. With Promodel showed that there is no cloths that failed to enter the location of the raw materials warehouse. In addition, the state entity clothes X-101 in the system that are in operation is 32,12% of the total time in the system entities, and entities time in a system which exposed obstacle (blocked) because of queue are 12,11%.
2) Condition of Proposed
Proposed conditions, with optimal method which has been selected on the line balancing, that is Mirror method. Consists of 4 work stations. With Promodel showed that there is no cloth that failed to enter the location of the raw materials warehouse. In addition, the state entity clothes X-101 in the system that are in operation is 81,65% of the total time in the system entities, and entities time in a system which exposed obstacle (blocked) because of queue are 2,99%.

With proposed conditions, of entities clothes X-101 in the system that are in operating condition (in operation) up 46,71% of the current condition and time obstacle affected entities also decreased 29,95%.

5. CONCLUSION

1. Standard time that is need this industry in producing Muslim clothing X-101 was 8,74 minutes. This time already includes the standard time of adjustment factor and looseness.
2. The amount of labor in the industry is 26 people is not optimal. Because the *obras* activities 3-5, 4-5, and 9-10 only done by 1 labor. The industry should add 1 each for activities 4-5 and 9-10, so that the total labor force working in this industry is 28 people. In order to reduce the waiting time for the next process, which indirectly can make stacking of a half goods in production floor and can obstruct further processing.
3. The most optimal method is Mirror method of grouping the 14 work stations into 4 work stations.
4. With this method, IKM XYZ can increase the efficiency of line XYZ to 80.97%, and the current production to 3,97 to 6,65 minutes waiting time and line imbalances resulting from the unequal division of labor is also reduced to 19,03%.
5. The result of this simulations using Promodel 6 student version can be seen that the state entity shirt X-101 in the system that is in a state of operation (in operation) of 34,94% of the total time in the system entities, and entities affected by time constraints (blocked) in the system from a queue at 32,94%.
6. While the simulation result show that the proposed conditions of entities clothes circumstances X-101 in the system that are operating condition (in operation) amounted 81,65% of the total time in the system entities, and entities affected by time constraint (blocked) in a queuing system by 2,99%.
7. With the proposed conditions of entities clothes circumstances X-101 in the system that are in operating condition (in operation) up 46,71% of the current condition and overall time constraints affected entities also decreased 29,95%.

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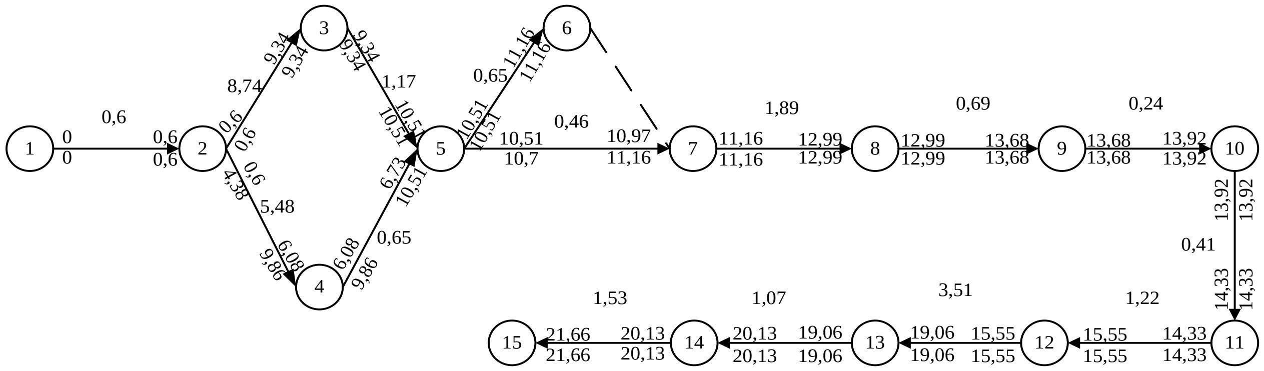

Figure 2. Network Schedule

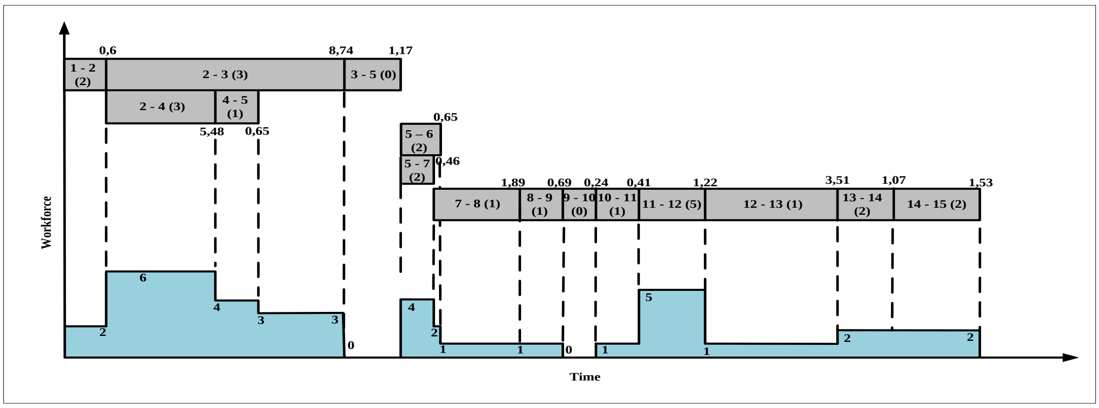

Figure 3. Gantt Chart Scheduling Workforce Current Conditions

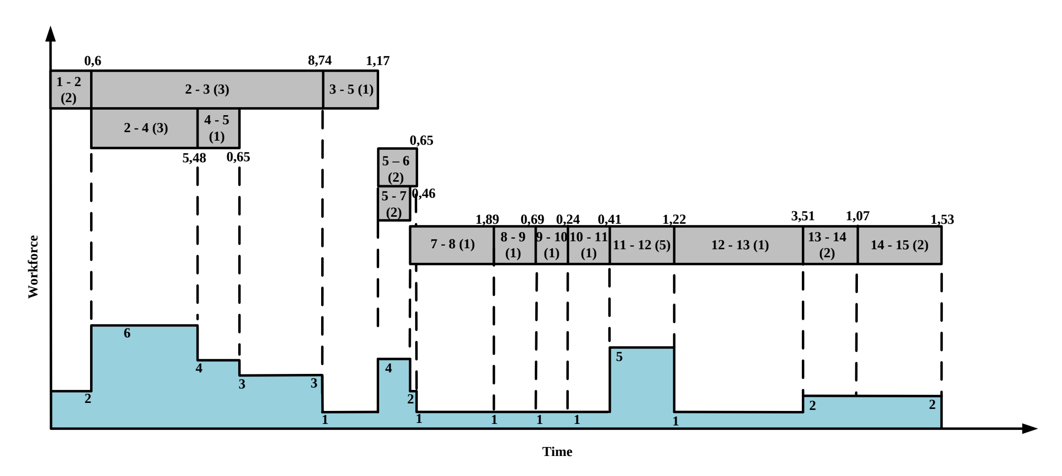

Figure 4. Gantt Chart Proposed Scheduling Workforce

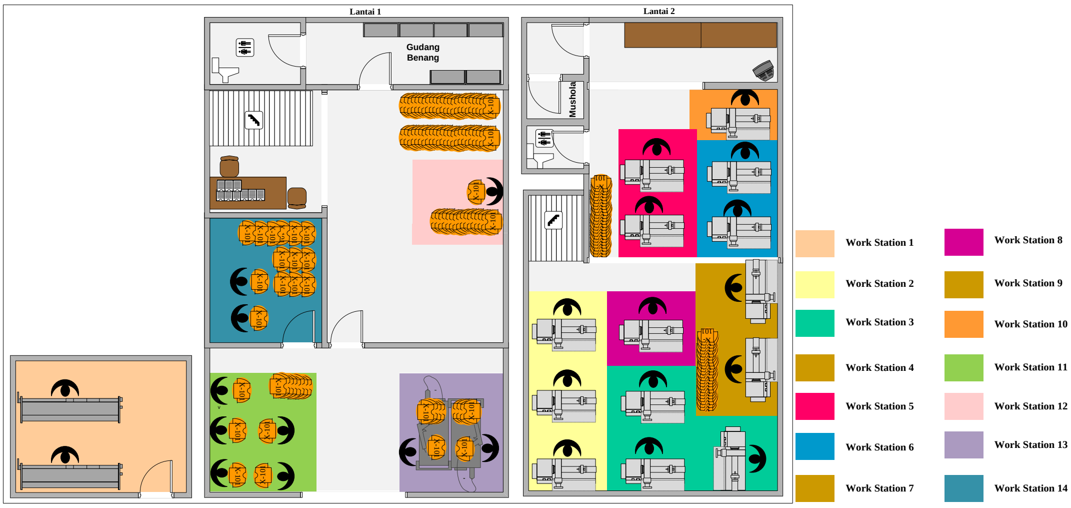

Figure 5. Layout