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Productivity analysis to overcome the limited availability of production time in SME FBS

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Abstract. Good industrial development should pay attention to the human factor as the main driver. Condition of work procedures, work area, and environment can affect the production result because if not optimal, the production will run slowly. If the work system is less than optimal, the productivity will do so, the operator will work uncomfortably and be easy to undergo work fatigue, even it can cause work accidents. Thus, the optimal and ergonomic arrangement of the the overall work system mechanism and work environment design is required for workers to work well, regularly, safely and comfortably with the aim of improving work productivity. This research measures the performance in textile SME (Small and Medium Enterprise) located in Sukabumi which is SME FBS which produces children's clothing. This performance measurement is aimed at improving the competitiveness of the textile IKM so that it has the equal competitiveness with other SMEs or with textile industries that already have their name in market. Based on the method of hour standard time and TOC calculation at 2 FBS CMT (Cut-Make-Trim) in Sukabumi, which are the CMT Margaluyu Village and CMT Purabaya Village, the result is that the standard time of shirt work on CMT Margaluyu Village is less than that of CMT Desa Purabaya. It can be seen that more effective in SME FBS production is by process method.
Keywords: Standard Time, Theory of Constraint, Productivity.

1. Introduction

In this modern era, technological progress is growing. The development is in accordance with the increase of the various needs of human beings, both basic and additional needs. As consumptive beings, humans are never satisfied with what has been obtained, so they are constantly looking for something new to meet their needs. In the field of industry, it becomes a major factor to continue to innovate in order to meet the needs of consumers. With the help of better technological developments, the process can be done quickly and easily so as to maintain the trust of consumers.

In Indonesia itself, the level of intense competition occurs in various fields of industry, for example in the textile industry. The textile industry is one of the prioritized industries to be developed because it has a strategic role in the national economy that is as a contributor to the country's foreign exchange, absorbing labor in large quantities, and as a reliable industry. As one of the basic needs that must be used, the needs of clothing increase every year as the Indonesian population increases. In addition, the modern era is associated with the growing of the need in clothing. Therefore, textile companies in Indonesia are required to make innovations and improvements to meet those needs.

Time is the element to be considered in designing and improving the work system. Generally the determination of the systems and methods used in an industry depends heavily on its purpose, for example in a manufacturing industry is producing goods, a bank serves transactions with customers, sales of cow's milk from farms, and so on. Then, the industry needs approaches to increase its productivity with problem solving and so forth. The measurement of working time is intended to obtain the standard time. In the manufacturing system, this standard time is used as a basis for, among others, production scheduling, planning, financing, and productivity evaluation.

The previous research that used as reference is performance measurement at SME (Small and Medium Enterprise) textile industry located in Jakarta, that is SME VSH that produce women moslem clothes. Measurement of production scheduling performance is done by SCOR (Supply Chain Operation Reference) method with five indicators: reliability, responsiveness, agility, cost, and asset management. The problems that occur in the SME VSH are the emergence of defective products that affect the value of existing product assets in the warehouse. Judging from the worker factor, the problems that happened were the ability and experience of the less trained workers resulting in the resulting product not in accordance with the wishes and needs of consumers. Then look in terms of work environment, the emergence of defective products occur due to poor working environment, whether from noise levels, air temperature, working positions are not ergonomic and so forth. However, despite it all after analyzed using SCOR method performance measurement in production scheduling at SME VSH is 99% which means that the performance of SME VSH is good in production scheduling.[4]

CMT Margaluyu Village in the production process of the child shirt with each worker station has workers who do their respective duties (the sequent working process), so that the workers are not moving around. Meanwhile, in CMT Purabaya Village the workers are required to produce by method 1 person must complete 1 shirt, so that the worker should run from one work station to another work station until the shirt is finished. The reason is that CMT Margaluyu Village only has 4 workers and 2 sewing machines and 1 ham machine while CMT Purabaya Village has 8 workers with 4 sewing machines, 1 ham machine and 1 serger. The research team wanted to see what methods are suitable for the production of child shirts in SME FBS, whether by process method or by method 1 worker has to finish 1 shirt from start to finish.

2. Methods

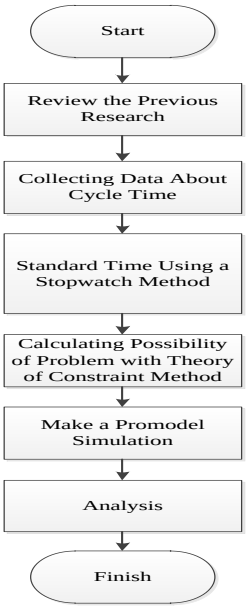


Figure 1. Flowchart

The first step taken in this research is to review the previous research with the similar theme. The research team conducted a review of the research by a graduate of Industrial Engineering Department of UAI who conducted research on SME VSH in 2016, that produce Women Moslem Clothes. Measurement of production scheduling performance is done by SCOR (Supply Chain Operation Reference) method with five indicators: reliability, responsiveness, agility, cost, and asset management [4]. After reviewing the previous research, the researcher conducts data collection on work stations in 2 CMT, CMT Margaluyu and CMT Purabaya which are both located in Sukabumi. Furthermore, the researcher calculates the cycle time with 30 times-observation of the workmanship using stopwatch then calculates the normal time and standard time of each work station. After obtaining each standard time from work stations in the 2 CMT location, the researcher calculates the Theory of Constraint, to find and see which work station has a constraint (in this case the constraint of working time on a work station against its available time). Therefore, the researcher analyzes what kind of method that is suitable for the child shirt production model in SME FBS in order to increase its production even with limited time, labour and machinery.

3. Result and Discussion

3.1 Working Methods

CMT Margaluyu Village in the production process of the child shirt with each worker station has workers who do their respective duties (the sequent working process), so that the workers are not moving around. Meanwhile, in CMT Purabaya Village the workers are required to produce by method 1 person must complete 1 shirt, so that the worker should run from one work station to another work station until the shirt is finished. The reason is that CMT Margaluyu Village only has 4 workers and 2 sewing machines and 1 ham machine while CMT Purabaya Village has 8 workers with 4 sewing machines, 1 ham machine and 1 serger. We need to know which method that has more effectiveness in the production of sewing shirts in SME FBS.

3.2 Cycle Time

The way to get raw data from the collected data is as follows[2]:

$$Ws = \frac{\sum x}{N} \quad (1)$$

Explanation:
Ws : Cycle Time
∑x : Sub-Group Average Price
N : Number of Performed Observations.
We didn't used the "data adequacy test" after we get cycle time in each activities in 2 CMT. Because according to [1] it said that the use of the calculation model is used for population N which has been determined whose value must be greater than the value of the sample n sought from the calculation. This means that the data taken should be always enough. Therefore, we recommend that the term 'test adequacy data' be avoided and replaced by the term 'the number of samples should be' or any other meaningful terms.

3.2.1 Normal Time Calculation. This is the formulation to get the normal time[2]:

$$Wn = Ws\ x\ p \quad (2)$$

Explanation:
P : adjustment factor of 1 normal average cycle, p1 for too slowly working or vice versa.

3.2.2 Standard Time Calculation. And this is how we get the standard time for each process[2]:

$$Wb = Wn + (Wn\ x\ \%\ Allowance) \quad (3)$$

Allowance is the factors given to the worker to complete his work besides the normal time.

Table 1. Cycle Time and Calculation of Normal Time in CMT Margaluyu Village

Number	Work Elements	Skill			Effort			Consistency			Condition			Total	Rating Factor	Cycle Time (Second)	Normal Time (Second)
		Explanation		Score	Explanation		Score	Explanation		Score	Explanation		Score				
1	Reach Fabric	Excellent	B1	0,11	Excellent	B2	0,08	Excellent	B	0,03	Good	C	0,02	0,24	1,24	5,48	6,79
2	Assembly Pocket	Good	C2	0,03	Good	C2	0,02	Excellent	B	0,03	Good	C	0,02	0,1	1,1	151,15	166,27
3	Sew the Body Shirt	Good	C1	0,06	Good	C1	0,05	Average	D	0	Good	C	0,02	0,13	1,13	126,33	142,75
4	Sew using Serger	Excellent	B1	0,11	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,19	1,19	101,01	120,21
5	Trim	Good	C1	0,06	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,14	1,14	75,70	86,30
6	Sew Shirt Sleeve	Good	C2	0,03	Average	D	0	Good	C	0,01	Good	C	0,02	0,06	1,06	311,99	330,71
7	Sew Cuff	Good	C2	0,03	Good	C1	0,05	Excellent	B	0,03	Good	C	0,02	0,13	1,13	355,82	402,08
8	Sew using Serger	Good	C1	0,06	Good	C2	0,02	Excellent	B	0,03	Good	C	0,02	0,13	1,13	79,17	89,46
9	Trim	Good	C1	0,06	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,14	1,14	64,23	73,22
10	Assembly Shirt Sleeve to Body Shirt	Good	C1	0,06	Excellent	B2	0,08	Good	C	0,01	Good	C	0,02	0,17	1,17	129,52	151,54
11	Assembly Collar	Good	C2	0,03	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,11	1,11	146,90	163,06
12	Assembly Label	Excellent	B1	0,11	Good	C2	0,02	Good	C	0,01	Good	C	0,02	0,16	1,16	23,07	26,76
13	Sum	Good	C1	0,06	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,14	1,14	129,97	148,17
14	Put the Finished Shirt	Excellent	B1	0,11	Excellent	B2	0,08	Excellent	B	0,03	Good	C	0,02	0,24	1,24	8,13	10,09

Table 2. Cycle Time and Calculation of Normal Time in CMT Purabaya Village

Number	Work Elements	Skill			Effort			Consistency			Condition			Total	Rating Factor	Cycle Time (Second)	Normal Time (Second)
		Explanation		Score	Explanation		Score	Explanation		Score	Explanation		Score				
1	Reach Fabric	Excellent	B1	0,11	Excellent	B2	0,08	Excellent	B	0,03	Good	C	0,02	0,24	1,24	4,48	5,55
2	Sew Shirt Sleeve	Good	C1	0,06	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,14	1,14	372,54	424,70
3	Sew Cuff	Good	C1	0,06	Excellent	B1	0,1	Good	C	0,01	Good	C	0,02	0,19	1,19	343,30	408,53
4	Sew the Body Shirt	Good	C1	0,06	Good	C2	0,02	Good	C	0,01	Good	C	0,02	0,11	1,11	205,57	228,18
5	Assembly Pocket	Excellent	B1	0,11	Excellent	B1	0,1	Good	C	0,01	Good	C	0,02	0,24	1,24	183,74	227,84
6	Sew using Serger	Excellent	B2	0,08	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,16	1,16	136,57	158,42
7	Trim	Good	C2	0,03	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,11	1,11	104,44	115,93
8	Assembly Collar	Excellent	B2	0,08	Good	C2	0,02	Good	C	0,01	Good	C	0,02	0,13	1,13	106,17	119,97
9	Assembly Label	Average	D	0	Good	C2	0,02	Average	D	0	Good	C	0,02	0,04	1,04	23,11	24,03
10	Assembly Shirt Sleeve to Body Shirt	Good	C1	0,06	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,14	1,14	112,77	128,56
11	Sew using Serger	Good	C1	0,06	Good	C1	0,05	Good	C	0,01	Good	C	0,02	0,14	1,14	163,50	186,39
12	Trim	Good	C2	0,03	Good	C2	0,02	Average	D	0	Good	C	0,02	0,07	1,07	113,29	121,22
13	Sum	Good	C1	0,06	Excellent	B1	0,1	Good	C	0,01	Good	C	0,02	0,19	1,19	193,19	229,89
14	Put the Finished Shirt	Excellent	B1	0,11	Excellent	B2	0,08	Excellent	B	0,03	Good	C	0,02	0,24	1,24	6,09	7,56

Before performing the standard time calculation, the calculation of normal time is done in advance by considering several factors in accordance with the theory of Westinghouse Rating System such as skill or the ability of workers, consistency of workers, performance of workers and working conditions.

Table 3. Calculation of Standard Time in CMT Margaluyu Village

Number	Work Elements	Unvoidable Delay	Personal Needs	Effort	Work Attitude	Work Movement	Eye Strain	Workplace Temperature	Atmosphere Situation	Workplace Environment	Allowance	Normal Time (Second)	Standard Time (Second)
		Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)			
1	Reach Fabric	1	1	1	0,1	0	1	3	1	1	0,09	6,79	7,4
2	Assembly Pocket	2	1	1	0,2	0	5	3	1	1	0,14	166,27	189,9
3	Sew the Body Shirt	2	1	2	0,5	0	6	3	1	1	0,17	142,75	166,3
4	Sew using Serger	3	1	1	0,5	0,5	7	3	1	1	0,18	120,21	141,8
5	Trim	3	1	1	0,5	0,5	7	3	1	1	0,18	86,30	101,8
6	Sew Shirt Sleeve	2	1,5	2	0,7	1	7	3	1	1	0,19	330,71	394,2
7	Sew Cuff	3	2	1	0,7	1	7	3	1	1	0,20	402,08	481,3
8	Sew using Serger	3	1	1	0,5	0,5	7	3	1	1	0,18	89,46	105,6
9	Trim	3	1	1	0,5	0,5	7	3	1	1	0,18	73,22	86,4
10	Assembly Shirt Sleeve to Body Shirt	3	1,5	1	0,2	0,4	3	3	1	1	0,14	151,54	172,9
11	Assembly Collar	2	1	1	0,2	0	5	3	1	1	0,14	163,06	186,2
12	Assembly Label	1	1	1	0,1	0	5	3	1	1	0,13	26,76	30,3
13	Sum	3	1	1	0,2	0	5	3	1	1	0,15	148,17	170,7
14	Put the Finished Shirt	1	1	1	0,1	0	1	3	1	1	0,09	10,09	11,0

Table 4. Calculation of Standard Time in CMT Purabaya Village

Number	Work Elements	Unvoidable Delay	Personal Needs	Effort	Work Attitude	Work Movement	Eye Strain	Workplace Temperature	Atmosphere Situation	Workplace Environment	Allowance	Normal Time (Second)	Standard Time (Second)
		Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)	Score (%)			
1	Reach Fabric	1	1	1	0,1	0	1	3	1	1	0,09	5,6	6,1
2	Sew Shirt Sleeve	2	1,5	2	0,7	1	7	3	1	1	0,19	424,7	506,2
3	Sew Cuff	3	2	1	0,7	1	7	3	1	1	0,20	408,5	489,0
4	Sew the Body Shirt	2	1	2	0,5	0	6	3	1	1	0,17	228,2	265,8
5	Assembly Pocket	2	1	1	0,2	0	5	3	1	1	0,14	227,8	260,2
6	Sew using Serger	3	1	1	0,5	0,5	7	3	1	1	0,18	158,4	186,9
7	Trim	3	1	1	0,5	0,5	7	3	1	1	0,18	115,9	136,8
8	Assembly Collar	2	1	1	0,2	0	5	3	1	1	0,14	120,0	137,0
9	Assembly Label	1	1	1	0,1	0	5	3	1	1	0,13	24,0	27,2
10	Assembly Shirt Sleeve to Body Shirt	3	1,5	1	0,2	0,4	3	3	1	1	0,14	128,6	146,7
11	Sew using Serger	3	1	1	0,5	0,5	7	3	1	1	0,18	186,4	219,9
12	Trim	3	1	1	0,5	0,5	7	3	1	1	0,18	121,2	143,0
13	Sum	3	1	1	0,2	0	5	3	1	1	0,15	229,9	264,8
14	Put the Finished Shirt	1	1	1	0,1	0	1	3	1	1	0,09	7,6	8,2

3.3 Theory of Constraint (TOC)

After obtaining the standard time of each workstation, the Theory of Constraint is performed to see which work station becomes the constraint (in the form of processing time constraints exceeding the time capacity available in producing the shirt).

The formulation to calculate the TOC is:

First, we calculate the total amount of time for process work on each sewing machine.We need to know how much the cost of materials and the price of each shirt.And we calculate the market potential per week with this formula[3]:

$$Market\ Potential\ each\ Week = \frac{Target\ Amount\ of\ Shirt\ Production\ each\ Year}{Total\ Weeks\ per\ Year} \quad (4)$$

Then, calculate the Gross Profit[3]:

$$Gross\ Profit = Price\ of\ Shirt - Cost\ of\ Materials \quad (5)$$

We get the number of capacity requirement of each machine by use this formula[3]:

$$Capacity\ Requirement = Market\ Potential\ each\ Week\ x\ Total\ Amount\ of\ Time\ on\ Each\ Machine \quad (6)$$

Here are the calculation of time for each work station:

Table 5. Processing Time in each CMT Work Station of Margaluyu Village

Product	Price	Market Potential per Week (dozen)	Processing Time per Unit (minutes)					
			Sewing Machine 1	Sewing Machine 2	Sewing Machine 3	Ham Machine	Cost of Materials	Gross Profit
Forboys Shirt	70000	288,5	12,5	2,8	14,6	7,3	6250	63750

Table 6. Calculation of Theory of Constraint in CMT Work Station of Margaluyu Village

			Capacity Requirement			
Product	Price	Market Potential per Week (dozen)	Sewing Machine 1	Sewing Machine 2	Sewing Machine 3	Ham Machine
Forboys Shirt	70000	288,5	3605,6	799,5	4209,1	2094,4

Based on the calculation in the table above, it shows that Sewing Machine 1 and Sewing Machine 3 become the constraint due to over time (in 2640 minutes for 4 working days, in one day work for 11 hours).

Table 7. Processing Time in Each CMT Work Station of Purabaya Village

			Processing Time per Unit (minutes)				
Product	Price	Market Potential per Week (dozen)	Sewing Machine	Obras Machine	Ham Machine	Cost of Materials	Gross Profit
Kid Dream Shirt	70000	288,5	34,9	6,8	4,7	6250	63750

Table 8. Calculation of Theory of Constraint in CMT Work Station of Purabaya Village

			Capacity Requirement		
Product	Price	Market Potential per Week (dozen)	Sewing Machine	Serger	Ham Machine
Kid Dream Shirt	70000	288,5	10081,6	1956,1	1345,4

From the calculation of TOC at CMT work station in Purabaya Village as the table above, it is seen that the Sewing Machine is also a constraint due to the workmanship time exceeds the available work time. Therefore, at the CMT work station both in Margaluyu and Purabaya Village, there are several possible solutions that can be done so that the process of working time does not exceed the working time previously set.

1. The division of work on the work station must be more structured, because the previous data show that the sewing machine 2 only does 1 job that is the front and rear assembly, while the sewing machine 1 works on 5 types of work and sewing machine 3 does 2 kinds of work. If the problem lies in a less competent workforce in sewing, it should be necessary to train the worker.
2. To add the work station (in this case sewing machine) if possible.

Then we use some formulas to calculate the capacity utilizations :
First, we calculate the gross profit per constraint resource minute[3]:

$$Gross\ Profit\ per\ Constraint\ Resource\ Minute = \frac{Gross\ Profit\ per\ Unit}{Processing\ Time\ per\ Unit\ in\ a\ Machine} \quad (7)$$

Then, we calculate the net profit [3]:

$$Net\ Profit = Throughput - Expenses \quad (8)$$

Table 9. Capacity Utilization at CMT Work Station of Margaluyu Village

Work Center	Product	Process Time (minute)	Available Capacity (minute)	Capacity Utilization %
Sewing Machine 1	Forboys Shirt	77.25(12.5) = 965.625	2640	36,58
Sewing Machine 2	Forboys Shirt	288.5(2.8) = 807.8	2640	30,60
Sewing Machine 3	Forboys Shirt	107.54(14.6) = 1570	2640	59,47
Ham Machine	Forboys Shirt	288.5(7.3) = 2106.3	2640	79,78

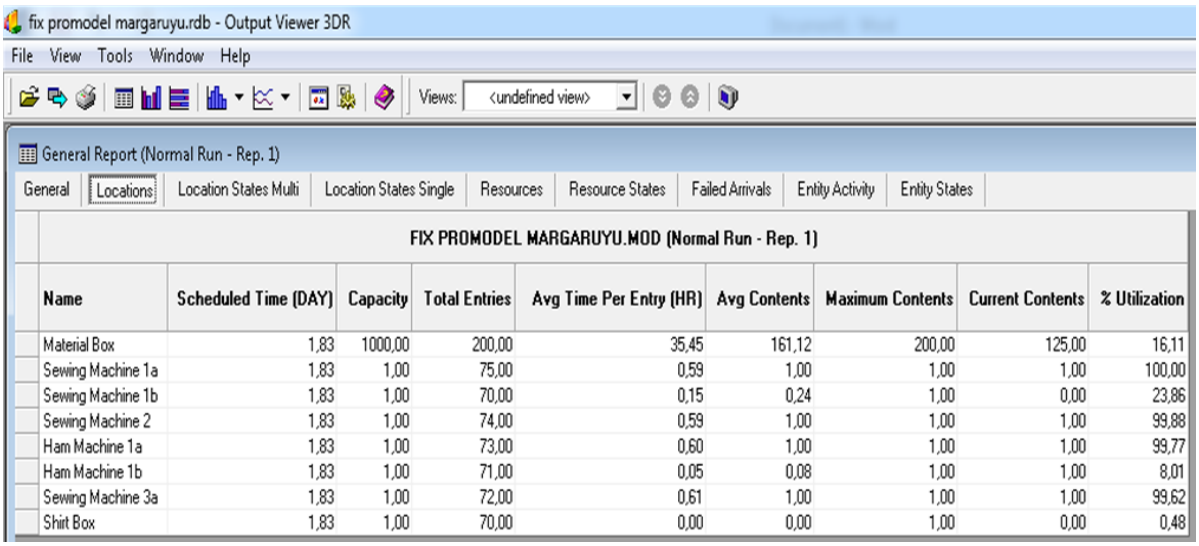
Table 10. Capacity Utilization at CMT Work Station of Purabaya Village

Work Center	Product	Process Time (minute)	Available Capacity (minute)	Capacity Utilization %
Sewing Machine	Kid Dream Shirt	213.2(34.9)= 7440.68	2640	100,00
Serger	Kid Dream Shirt	288.5(6.8)= 1961.8	2640	74,31
Ham Machine	Kid Dream Shirt	288.5(4.7)=1355.95	2640	51,36

Based on the calculation in table 9 and 10, it is seen that the machine with the largest capacity utility is on the Ham Machine at CMT work station Margaluyu Village that is 79,78%, while at CMT Purabaya Village the Sewing Machine has the largest capacity utility that is 100%.

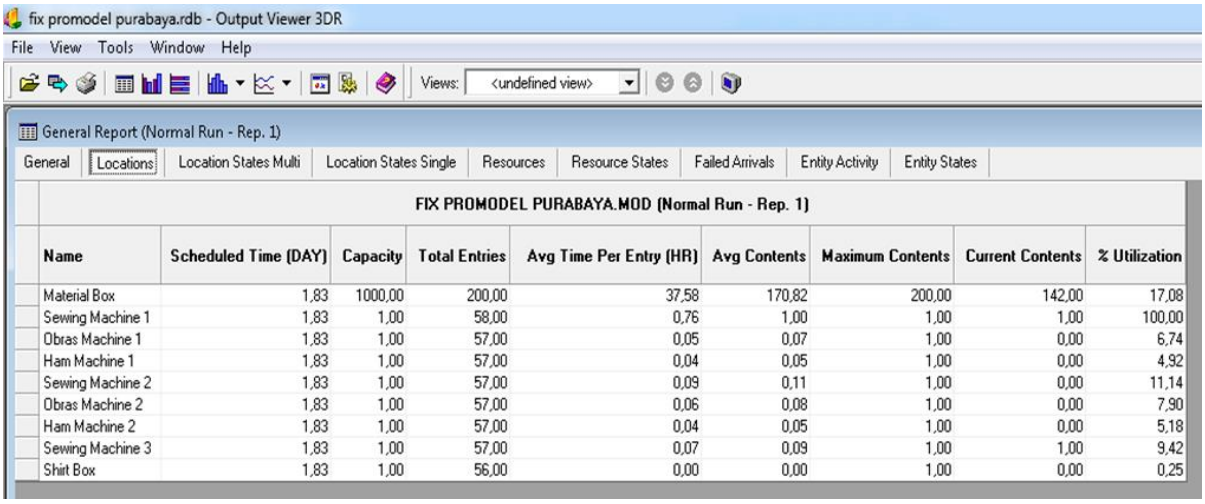
3.4 Promodel Simulation

After getting the TOC calculation result, the simulation of shirt production process at CMT of Margaluyu and Purabaya Village is done, with the following result:



Name	Scheduled Time (DAY)	Capacity	Total Entries	Avg Time Per Entry (HR)	Avg Contents	Maximum Contents	Current Contents	% Utilization
Material Box	1,83	1000,00	200,00	35,45	161,12	200,00	125,00	16,11
Sewing Machine 1a	1,83	1,00	75,00	0,59	1,00	1,00	1,00	100,00
Sewing Machine 1b	1,83	1,00	70,00	0,15	0,24	1,00	0,00	23,86
Sewing Machine 2	1,83	1,00	74,00	0,59	1,00	1,00	1,00	99,88
Ham Machine 1a	1,83	1,00	73,00	0,60	1,00	1,00	1,00	99,77
Ham Machine 1b	1,83	1,00	71,00	0,05	0,08	1,00	1,00	8,01
Sewing Machine 3a	1,83	1,00	72,00	0,61	1,00	1,00	1,00	99,62
Shirt Box	1,83	1,00	70,00	0,00	0,00	1,00	0,00	0,48

Figure 2. Promodel Results at CMT Margaluyu Village



Name	Scheduled Time (DAY)	Capacity	Total Entries	Avg Time Per Entry (HR)	Avg Contents	Maximum Contents	Current Contents	% Utilization
Material Box	1,83	1000,00	200,00	37,58	170,82	200,00	142,00	17,08
Sewing Machine 1	1,83	1,00	58,00	0,76	1,00	1,00	1,00	100,00
Obras Machine 1	1,83	1,00	57,00	0,05	0,07	1,00	0,00	6,74
Ham Machine 1	1,83	1,00	57,00	0,04	0,05	1,00	0,00	4,92
Sewing Machine 2	1,83	1,00	57,00	0,09	0,11	1,00	0,00	11,14
Obras Machine 2	1,83	1,00	57,00	0,06	0,08	1,00	0,00	7,90
Ham Machine 2	1,83	1,00	57,00	0,04	0,05	1,00	0,00	5,18
Sewing Machine 3	1,83	1,00	57,00	0,07	0,09	1,00	1,00	9,42
Shirt Box	1,83	1,00	56,00	0,00	0,00	1,00	0,00	0,25

Figure 3. Promodel Results at CMT Purabaya Village

It can be seen that at CMT Purabaya Village in 44 hours the workers can produce as many as 56 pieces of shirts, while in CMT Margaluyu Village with the same time the number of shirts produced is 70 pieces. We use the promodel to see that if the simulation is same with the real situation and the calculation we had. Based on the result, CMT Margaluyu Village has more produced the shirt rather than CMT Purabaya Village, with the same time. Eventhough CMT Margaluyu Village only has 4 workers and 2 sewing machines and 1 ham machine while CMT Purabaya Village has 8 workers with 4 sewing machines, 1 ham machine and 1 serger, it seems like the process method that CMT Margaluyu Village (the sequent working process) is more effective than the process method that the worker should run from one work station to another work station until the shirt is finished.

4. Conclusion

Based on the result of the research on the standard time of child shirt production in SME FBS located in Sukabumi, with 2 CMT locations that is CMT Margaluyu and CMT Purabaya Village, the result is that the standard time of shirt work at CMT Margaluyu Village is less than that of at CMT Purabaya Village. It appears that the more effective in the production of sewing shirts in SME FBS is by process method, each person has his own type of work, because it is feared that if with the method 1 worker must make 1 shirt from the beginning until the shirt is finished, it will create cummulation at a work station and increase the time because the worker must walk to one work station to another work station.
Based on the calculation of TOC, the result is that the constraint at 2 CMT is the work station on the sewing machine.

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6. References

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