Journal of Engineering Science 10(2), 2019, 13-18

JES
an international Journal

MANPOWER REDUCTION AND TIME STUDY OF A PRODUCTION LINE OF FULL SLEEVE T-SHIRT WITH FACING

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Received: 30 April 2019 Accepted: 21 October 2019

ABSTRACT

Most of the manufacturing cost of a garment requires for labor wages due to lack of production planning, observation of operations and proper line balancing. The purpose of this study was to calculate SMV of a production line of full sleeve t-shirt at Masco Industries Limited (Composite Knit Garments, Unit: G-1, Gazipur) for manpower reduction which is directly related to cost reduction. The result of this study showed that total 38 manpower was working before modification of the line which was reduced to 33 after modification. The SMV of the line was 16.06 which were increased to 16.34 after modification. So total 5 manpower (3 operator and 2 helper) has been reduced with only 0.28 min increase in SMV without creating any bottleneck in that production line. This modified production line would be able to manufacture full sleeve t-shirt with a lower labor cost than the previous one.

Keywords: *Cost of manufacturing; full sleeve t-shirt; Manpower; SMV; Time study*

1. INTRODUCTION

The economy of Bangladesh is growing rapidly due to prompt increase of foreign exchange earnings from readymade garments sector. A previous work has reported that "Bangladesh stands after China in the garments exporting taking a lead over Vietnam, Turkey, Cambodia, USA and India" (Adnan, 2018). In the fiscal year 2016-2017 Bangladesh has earned 28.14 billion USD from this sector which contributes 80.7% of the total foreign earnings of the country and 12.36% of the GDP (Hossain *et al.*, 2017). So, the development of Bangladesh is very much dependent on garments sector and Bangladeshi garments are popular worldwide. Bangladesh produces and exports both knit and woven products; among knit items t-shirt is very popular for the people of all ages over the world. T-shirt, singlet's and other vest covers more than 68% of total knitwear exports of Bangladesh (BKMEA, 2016). T-shirt or tee shirt is a style of garments which is suitable for both men and women is named after T shape of its body and sleeve. There are different types of t-shirts such as t-shirt with neck, t-shirt without neck, t-shirt with v neck, t-shirt with round neck, long sleeve t-shirt and short sleeve t-shirt etc (Rahman *et al.,* 2014). This study focused on manufacturing process of a full sleeve t-shirt with facing.

Garments manufacturing line is consisting of several workstations which are assigned to operators and helpers according to their skills and expertise. So, there needs a balance between different workstations of a line otherwise production target cannot be met. Imbalanced workload among different workstations of a production line enhances both work in process and creates bottleneck (Morshed *et al.*, 2014). Assembly line balancing is one of the most effective techniques for increasing production efficiency and solving problems related to garments production (Haque *et al.*, 2018). So, for getting proper performance from a production line adequate planning, controlling and observation is necessary. Also, proper breakdown of operations, design of workstations and their assignment to specific operators and helpers is a must for effective production (Jayakumar, 2017).

While increasing the labor force of a production line, it is important to examine the growth of production output as it is related to the production cost (Wei *et al.*, 2016). For assembling a full sleeve t-shirt, a huge number of operations are involved so, a huge number of machineries are needed. Sewing line needs to adjust and align according to garments style (Syduzzaman *et al.*, 2015). For this purpose, it is necessary to assign a number of operators and helpers according to their skill and effectiveness. Although increasing one manpower means increasing production cost, it is important to plan a production line so that it meets production target at a minimum cost of labor and without any bottleneck in the production process. So proper planning and execution is a must and time study are most widely used method (Hanan *et al.*, 2018) for proper observation of manufacturing line.

Several studies online balancing and time study have been conducted in recent years for the purpose of increasing efficiency, layout modification, lead time optimization, increasing productivity etc. Arumugham *et al.* (2017) and Haque *et al.* (2018) worked online balancing to increase productivity by reducing bottleneck and using different techniques like ranked positional weight and layout modification. SMV is a useful technique for

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ISSN 2075-4914 (print); ISSN 2706-6835 (online)

lead time calculation (Hossain *et al.*, 2018), Work in Progress (WIP) can be reduced from 100 pieces to 1500 pieces and lead time can be reduced from 2 days to 1 hour by this technique (Ahmed *et al.*, 2018). Time study and motion study techniques have been used for increasing productivity of garments production lines (Howlader *et al.*, 2015; Khatun, 2014). This study was focused on manpower reduction of a full sleeve t-shirt production line for the purpose of manufacturing cost reduction using time study technique.

2. METHODOLOGY AND WORKING AREA

Most of the manufacturing cost of a garment requires for labor cost especially for assembling it in sewing section. The cost of manufacturing varies style to style of a garment as it depends on number of operations and their complexity. This study focused on proper observation of a sewing line of a full sleeve t-shirt with facing.

2.1 Machineries and Materials

Different types of machines are used for different types of garments with specific style. The observed line was consisting of iron, flat lock sewing machine, over lock sewing machine, chain stich sewing machine, buttonhole machine and button attaching machine. The fabric was 160 GSM single jersey knitted fabric. Also, different types of trimmings and auxiliary items were used to complete all operations.

2.2 Observations

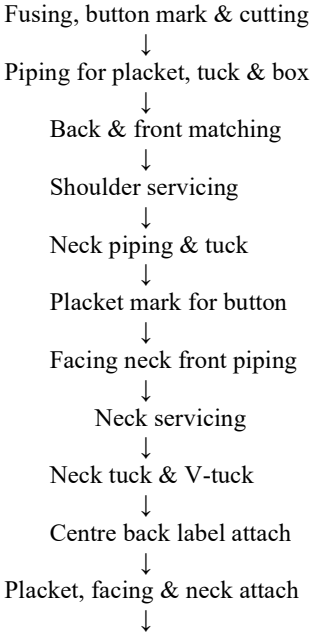
At first the production line of a full sleeve t-shirt was observed visually, number of operators and helpers were calculated, and time study method was used for calculating SMV of that line. Then the line was observed again and manpower was reduced to form a modified production line without creating any bottleneck in the process. After that, SMV was calculated for the modified line and compared with the previous one.

2.3 SMV Calculation

SMV stands for standard minute value which means time required manufacturing a product with some defined conditions and its unit is measured in minute. SMV of garments depends on types of garments, size of garments, design of garments, types of fabric, types of machine used, speed of operators and helpers, manufacturing process etc. The formula for SMV is given below:

SMV = Basic time + Allowances
Basic time = Observed time * Workers rating/100

Basic time of an operation does not contain any allowances for workers, but it is not possible to work all the time of a shift. So that different types of allowances are added during SMV calculation. Allowances includes machine allowance, personal needs allowance, policy allowance, fatigue allowance, special allowance, contingency allowance etc. Rating is the speed of an operator at which he/she performs the job. The process flowchart of a full sleeve t-shirt is given below:



Back tack & back tuck
↓
Sleeve hem &sleeve join
↓
Side seam & tuck for side seam
↓
Care label attach
↓
Body hem
↓
Show hole & button attach
↓
Button close & Extra thread removal

3. RESULTS AND DISCUSSIONS

This study was conducted at a sewing floor of Masco Industries Limited, for around 7 working days and average values with CV% of the data is presented in this paper. Before and after modification of the production line, the required manpower was observed and calculated which is shown in Table 1. Value added and non-value added operations were identified and operations using same machine were tried to combine for the purpose of reduction of manpower.

Table 1: Required manpower of the full sleeve t-shirt production line (Before and After modification)

Serial No	Name of Operation	Manpower (Before)		Manpower (After)		Machine
		Operator	Helper	Operator	Helper	
1	Fusing lining		1		1	Iron
2	Marking for button		1			
3	Cutting for placket		1		1	
4	Piping for placket	1		1		Flat lock machine
5	Tuck	1				Flat lock machine
6	Box pleat	1		1		Flat lock machine
7	Back & front matching		1		1	
8	Shoulder servicing	1		1		Over lock machine
9	Neck piping	1		1		Flat lock machine
10	Neck tuck closing	1		1		Flat lock machine
11	Placket mark for button		1		1	
12	Facing shoulder	1		1		Over lock machine
13	Facing neck front piping	1		1		Flat lock machine
14	Neck servicing	1		1		Over lock machine
15	Neck tuck	1		1		Flat lock machine
16	V-tuck	1		1		Flat lock machine
17	Centre back label attach	1		1		Flat lock machine
18	Placket & facing attach	1	1	1	1	Flat lock machine
19	Neck & facing attach	4		3		Flat lock machine
20	Back tack(piping)	1	1	1		Chain stitch machine
21	Back tuck	1	1	1	1	Flat lock machine
22	Sleeve hem	1		1		Flat lock machine
23	Sleeve match		1		1	
24	Sleeve join	1		1		Over lock machine
25	Side seam	2		2		Over lock machine
26	Close tuck for side seam	1				Flat lock machine
27	Care label attach	1		1		Flat lock machine
28	Body hem	1		1		Flat lock machine
29	Show hole	1		1		Buttonhole machine
30	Button attach	1		1		Button attaching machine
31	Button close		1		1	
	Sub-total	28	10	25	8	
	Total	38		33		

Before modification the number of operators was 28 and number of helpers was 10, so total number of manpower was recorded 38 for total 31 operations. Required SMV of the previous and modified line was calculated which is shown in Table 2. For the operation of fusing lining one helper was working with iron, which was kept unchanged in modified line and SMV of that operation was 0.37.

Two helpers were working for button mark and cutting for placket and these two operations were flexible for both of them. In modified line one helper was reduced from these two operations, the SMV of two operations was 0.61 before modification and 0.63 after modification, which is almost unchanged.

For placket piping one operator was working with flat lock sewing machine which is kept unchanged in modified line and operation SMV was 0.55. For placket tuck and box pleat two operators was working with two flat lock machine and SMV of these two operations was 1.08. In modified line one operator was reduced from these two operations and the combined SMV was 1.11, which indicates no significant change in time also. There was not found any bottleneck in the process.

Table 2: SMV of full sleeve t-shirt production line (Before and after modification)

Sl No.	Operations	Before Modification			After Modification		
		Average cycle time (sec)	CV%	SMV	Average cycle time (sec)	CV%	SMV
1	Fusing lining	21.4	3.82	0.37	21.4	3.82	0.37
2	Marking for button	15.3	2.85	0.26	36.8	1.98	0.63
3	Cutting for placket	20.0	2.12	0.35			
4	Piping for placket	32.0	3.01	0.55	32.0	3.05	0.55
5	Tuck	25.4	2.38	0.44	64.2	1.21	1.11
6	Box pleat	37.2	1.77	0.64			
7	Back & front matching	15.6	3.02	0.27	15.6	3.02	0.27
8	Shoulder servicing	32.4	1.30	0.56	32.4	1.30	0.56
9	Neck piping	42.2	1.19	0.73	42.2	1.19	0.73
10	Neck tuck closing	20.4	3.03	0.35	20.4	3.03	0.35
11	Placket mark for button	16.4	2.87	0.28	16.4	2.87	0.28
12	Facing shoulder	21.8	3.23	0.38	21.8	3.23	0.38
13	Facing neck front piping	41.6	1.15	0.72	41.6	1.21	0.72
14	Neck servicing	33.2	1.38	0.57	33.2	1.14	0.57
15	Neck tuck	23.2	1.84	0.40	23.2	1.84	0.40
16	V-tuck	28.2	1.67	0.49	28.2	1.98	0.49
17	Centre back label attach	26.4	1.99	0.46	26.4	1.99	0.46
18	Placket & facing attach	36.2	2.14	0.62	36.2	2.14	0.62
19	Neck & facing attach	51.6	1.72	0.89	53.8	1.30	0.93
20	Back tack(piping)	35.0	2.25	0.60	41.8	0.66	0.72
21	Back tuck	28.4	3.03	0.49	31.0	1.10	0.53
22	Sleeve hem	39.0	1.49	0.67	39.0	1.49	0.67
23	Sleeve match	18.0	1.27	0.31	18.0	1.61	0.31
24	Sleeve join	52.0	1.27	0.90	52.0	1.37	0.90
25	Side seam	63.8	1.26	1.10	63.8	1.26	1.10
26	Close tuck for side seam	22.4	2.61	0.39	41.4	0.93	0.71
27	Care label attach	17.8	2.85	0.31			
28	Body hem	51.6	0.98	0.89	51.6	0.98	0.89
29	Show hole	21.8	1.93	0.38	21.8	1.93	0.38
30	Button attach	25.8	3.01	0.45	25.8	3.01	0.45
31	Button close	15.2	3.02	0.26	15.2	3.02	0.26
	Total	931.30		16.06	947.20		16.34

For back and front matching one helper was working which is kept unchanged in modified line and the SMV recorded was 0.27. For shoulder servicing one operator was working in an over lock machine which was also kept unchanged in modified line and the SMV found was 0.56. For the operations of neck piping and neck tuck closing two operators were working separately in two flat lock sewing machines which is also kept constant in new line and SMV of the two operations were 0.73 and 0.35 respectively. For placket mark one helper was working which is kept same in the modified line and SMV was 0.28. Shoulder facing was done by one operator using an over lock sewing machine which is also kept unchanged and the SMV was recorded 0.38. Facing neck front piping was done by one operator using flat lock sewing machine in both previous and modified line and the SMV of that operation was 0.72. The operation of neck servicing was done by one operator using one over

lock sewing with SMV of 0.57 which is also unchanged. For neck tuck and v-tuck two operators were working with two flat lock machines separately which was kept constant in modified line and the SMV were 0.40 and 0.49 respectively.

The operation of center back label attaching was done by one operator using a flat lock sewing machine with 0.46 SMV which was kept unchanged in the modified line. The operation of placket and facing attach was done by one operator using a flat lock sewing machine which was assisted by one helper and the SMV was recorded 0.62. This operation was kept constant in modified line. Neck and facing attaching are a complex and time-consuming operation. So, four operators were working for this operation using four flat lock sewing machine but after modification one operator was reduced from this operation and no bottleneck was found. The SMV of the operation was 0.89 and 0.93 before and after modification respectively, which indicates a slight change of SMV. For back tack piping and back tuck closing two operators were working using a chain stitch machine and a flat lock machine and two helpers were assisting. After modification one helper was reduced from these two operations as their works was seen flexible. Before modification the SMV of the two operations were 0.60 and 0.49 which was changed to 0.72 and 0.53 after modification. The operations of sleeve hem and sleeve match was done by one operator and one helper separately which remained same in modified line and the SMV of these two operations were recorded 0.67 and 0.31 respectively.

Sleeve joining was done by one operator using over lock sewing machine with 0.90 SMV which was also kept unchanged in new line. The operation of side seam was done by two operators using two over lock machine which was same in modified line and the SMV was recorded 1.10 for this operation. For closing tuck and care label attaching two operators were working using two flat lock machines but in modified line these two operations were combined to reduce one operator without hampering production. The combined time of the two operations was 0.70 and 0.71 before and after modification which is almost unchanged. Body hem was done by one operator using a flat lock sewing machine which was same before and after modification and required SMV was calculated 0.89. Show hole was prepared by one operator using buttonhole machine and operation SMV was 0.38 which was also constant. The operation of button attaching, and button closing was done by one operator and one helper separately and SMV of these two operations were recorded 0.45 and 0.26 respectively, which was also kept unchanged in modified line.

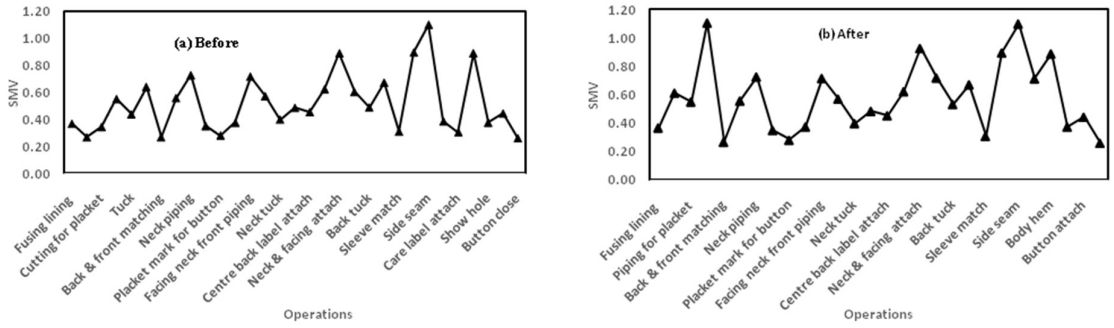


Figure 1: SMV versus operations of the production line (a) Before modification (b) After modification.

The relation of SMV and operations for previous and modified line is shown in Figure 1, which indicates the two graphs are almost same. So, there is no significant change in SMV of the operations before and after modification. A slight change of SMV is found for only the combined operations which has increased workload, but no bottleneck was found in the operations.

Number of operators required for the modified line was 25 and number of helper was 8, so total manpower required for the modified line was 33 which was previously 38, so five manpower has been reduced from the line which might reduce the production cost of the full sleeve t-shirt than previous line. The SMV of the modified line indicates a slight change of SMV than the previous one. Before modification of the production line SMV was 16.06, which has changed to 16.34 after reducing five manpower from the line. The increment of SMV compared to five manpower's wage is negligible, so the cost of assembling might decrease than the previous line. So, this line would be applicable for producing full sleeves t-shirt at a reduced cost without any bottleneck in the production process.

4. CONCLUSIONS

For export purpose and domestic use, garment industries of Bangladesh produce a huge amount of knit and woven products every year. It is one of the major sources of revenue of the country. Among all knit items t-shirt is popular worldwide. Most of the cases the manufacturing cost of a garment may increase due to lack of proper

planning, balancing and observation of the production line. Sometimes manpower assigned less than required which creates bottleneck and sometimes manpower assigned more than required which increases non-value added operations as well as labor cost. This study has focused on proper observation of a full sleeve t-shirt production line and balanced manpower of the line without hampering the production process. Total five manpower has been reduced from the line without creating any bottleneck. The SMV of the line has increased slightly due to manpower reduction which is very negligible compared to labor wages.

ACKNOWLEDGEMENT

The authors are thankful to Masco industries Limited (Composite Knit Garments), Gazipur, for giving the opportunity of conducting this study.

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