Estimation of the Standard Minute Value of Polo Shirt by Work Study

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Abstract: The aim of this project is to estimate the Standard Minute Value of a polo shirt. Traditionally operated garment industries are facing problems like low productivity, longer production lead time, high rework and rejection, poor line balancing, low flexibility of style changeover etc. These problems were addressed in this study by the implementation of lean tools like cellular manufacturing, single piece flow, work standardization, just in time production, etc. After analysis of our thesis, results observed were highly encouraging. Some of the key benefits entail production cycle time decreased by 8%, number of operators required to produce equal amount of garment is decreased by 14%, rework level reduced by 83%, production lead time comes down to one hour from two days, work in progress inventory stays at a maximum of 100 pieces from around 500 to 1500 pieces. Apart from these tangible benefits operator multi skilling as well as the flexibility of style changeover has been improved. This study is conducted in the stitching section of a polo shirt manufacturing company. Study includes time studies, the conversion of traditional batch production into single piece flow and long assembly line into small work cells.

Keywords: SMV, Polo Shirt, Operation Breakdowns, Production.

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1. INTRODUCTION

The polo-shirt would be better named the tennis shirt, since it was first designed by Jean René Lactose, a world-class tennis player who was fondly called the alligator or crocodile because of his vicious playing tactics.

Lactose, like many tennis players in the early 20th century, felt tennis garb was restrictive, as players had to wear long sleeved shirts and ties. In 1929, Lactose made the polo or tennis shirt out of pique cotton in a loose knit, with a button down collar that could be flipped up for extra sun protection, and thankfully no tie.

Polo players did have button down collars as far back as the late 19th century, but Lactose's design was preferable. By the mid-1930s, most polo players wore Lactose's design, and the name polo-shirt stuck. The modern version may or may not feature a button down color, is most likely to be

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made of cotton knit, has two to three upper buttons and short sleeves. The polo-shirt forms part of the traditional sportswear for several major sports. Tennis players still wear these shirts, as do polo players and golfers. Rugby players also wear a variant of this shirt [1].

As dressing became less formal for men, the polo-shirt migrated into popular culture as semi-casual wear. Ralph Lauren's brand Polo was helpful in setting the style of the polo firmly in place in the 1950s. These shirts have even become popular in school uniforms for private and often Catholic schools. While most private schools in the 1970s insisted on boys wearing the more standard non-knit cotton button down, now many simply require a polo-shirt in the color the school wears.

In the 1980s, Lactose brand polo-shirts were for a time, a status symbol for both young men and women. Though you could certainly get less expensive pools, wearing the Lactose with its tiny alligator insignia on the chest was considered highly fashionable. It was associated with the 1980s "Preppy" look [2]. The modern polo-shirt is still considered popular both in sports and for regular dressing. Men may prefer them to T-shirts since the collar makes them just a bit dressier. In addition to being made out of cotton knit, some include silk or wool knits. The less expensive versions are likely to be made of a cotton/polyester blend, although it may be worthwhile to pay a little more for a 100% cotton shirt over the blended shirt because it tends to breathe better.

Today's business climate for clothing manufacturers requires low inventory and quick response systems that turn out a wide variety of products to meet customers demand. It is especially in the apparel industry that managers are trying to develop their current systems or looking for new production techniques in order to keep pace with the rapid changes in the fashion industry.

Therefore, to develop a new system, good observation is needed. However to observe real manufacturing systems is very expensive and sometimes cumbersome [3]. In garment production, until garment components are gathered into a finished garment, they are assembled through a sub-assembly process. The production process includes a set of workstations, at each of which a specific task is carried out in a restricted sequence, with hundreds of employees and thousands of bundles of sub-assemblies producing different styles simultaneously [4]. The joining together of components, known as the sewing process which is the most labor intensive part of garment manufacturing, makes the structure complex as the some works has a priority before being assembled [5].

Furthermore, since sewing process is labor intensive; apart from material costs, the cost structure of the sewing process is also important. Therefore, this process is of critical importance and needs to be planned more carefully [6]. Assembling process flows from one station to another. In assembly line balancing, allocation of jobs to machines is based on the objective of minimizing the workflow among the operators, reducing the throughput time as well as the work in progress and thus increasing the productivity. Sharing a job of work between several people is called division of labor. Division of labor should be balanced equally by ensuring the time spent at each station approximately the same. Each individual step in the assembly of product has to be analyzed carefully, and allocated to stations in a balanced way over the available workstations. Each operator then carries out operations properly and the work flow is synchronized. In a detailed work flow, synchronized line includes short distances between stations, low volume of work in process, precise of planning of production times, and predictable production quantity [7].

Since the late 1970s, the RMG industry started developing in Bangladesh primarily as an export-oriented industry and the domestic market for

RMG has been increasing fast due to increase in personal disposable income and change in life style. The sector rapidly attained high importance in terms of employment, foreign exchange earnings and its contribution to GDP. Since buyer comes to this region for the lowest labor price the quality of the garments, efficiency and productivity of Bangladesh RMG sector remain ignored even in the tough competitive market [8].

2. MATERIALS AND METHODS

A polo-shirt, also known as a golf shirt and tennis shirt, is a form of shirt with a collar, a placket with typically two or three buttons, and an optional pocket. Polo-shirts are usually made of knitted cloth (rather than woven cloth), usually piqué cotton or, less commonly, silk, merino wool, or synthetic fibers. A dress-length version of the shirt is called a polo dress.

2.1 Materials to prepare pattern of a polo-Shirt:

- Pattern paper
- Measuring Tape
- Scissors
- Pencil
- Eraser
- Curve Ruler

2.1.1 Measurement of the pattern for polo-shirt

Table 1: Measurement of the pattern for polo-shirt

S.L No.	Measuring point flat in cm	For small size	Toll. (+/-)
1	Hem depth(less than 2.5 cm)	2.0cm	0.0
2	Length from SNP to hem	48.0 cm	1.0
3	Chest 2.5 cm below armhole	36.0 cm	1.0
4	Hem width straight	36.0 cm	1.0
5	Back neck width (seam to seam)	15.2 cm	0.0
6	Back neck drop (from imaginary line to centre back neck seam)	2.0 cm	0.0
7	Front neck drop (from imaginary line to centre front neck seam)	5.1 cm	0.5
8	Shoulder seam (side neck point to shoulder point along the seam)	8.9 cm	0.5
9	Armhole straight	15.0 cm	0.5
10	Across front – at half armhole (seam to seam)	28.4 cm	0.5
11	Sleeve length from CB (from centre back neck to cuff end)	30.5 cm	1.0
12	Sleeve opening/cuff width (along edge of sleeve)	11.0 cm	0.5

13	Placket width	2.5 cm	0.0
14	Placket length – top of placket to base of placket	12.9 cm	0.0

Figure 1: Back Part and Front Part

Figure 2: Collar

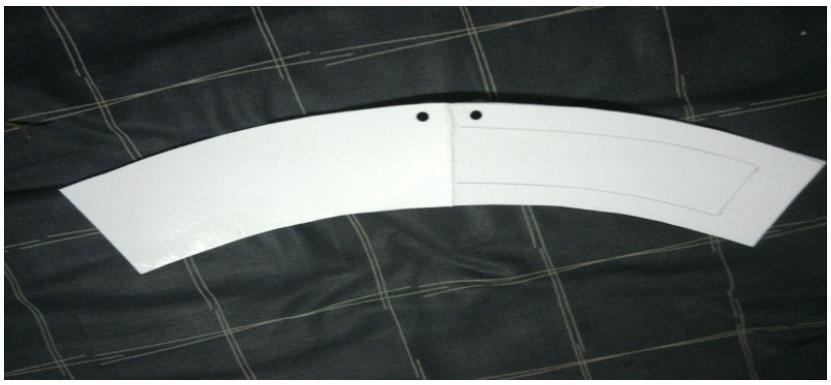

Figure 3: Collar Band

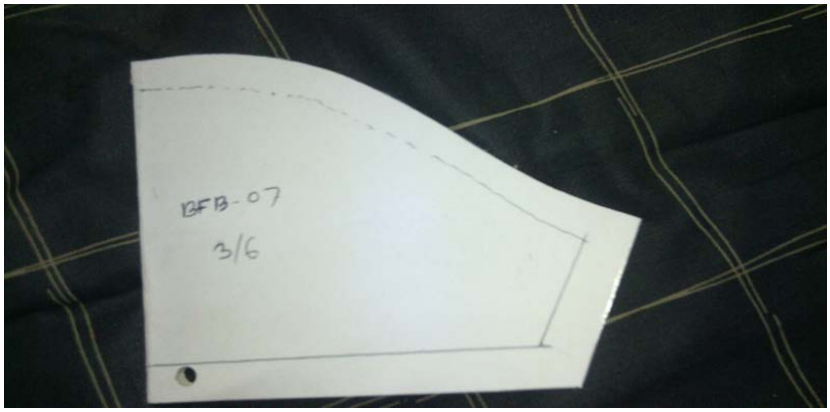

Figure 4: Sleeve

2.2 Methods

2.2.1 Prepare the fabric booking

After approval of fit sample and received the final PO sheet from buyer, pattern/cutting section will make a correct pattern set of all the sizes. In middle class factory normally merchandiser do the consumption with the help of cutting master after placed the pattern of on marker paper. In this regards please always remember one thing if the orders quantity is with size wise ratio then you must consider it during the making marker with pattern. I will discuss more details regarding the marker in near future. After get the consumption and diameter confirmations merchandiser will booked the fabric and hand over the color wise fabric break up sheet to fabric department. During this merchandiser should provide them all labs.

2.2.2 Prepare the accessories booking

In same time of the fabric merchandiser also should booked the accessories. Merchandiser should ensure that, the store will receive all the sewing accessories before in house of the fabric. Sewing accessories means - Sewing thread, main/size label, care label, tape etc. Merchandiser should always follow sewing production because when a minimum quantity will be output he should try to book the finishing accessories like as - Poly, Carton etc. Before booked the poly & back board he must confirm the folding way with buyer. Also merchandiser should take approval of shipping mark, sticker & carton quality from his buyer. Some others accessories like as - hang tag, hang tag string, thinner, spot lifter, inter lining, he must book these at the same time of fabric.

2.2.3 Quality check of fabric

After receive the fabric from dyeing the fabric Q.C department will check the color shade, GSM, diameter, shrinkage, twisting etc. and acknowledged the merchandiser accordingly. The fabric Q.C team will also check the count the collar & check the others quality. A middle class factory needs a strong quality team for fabric because normally they do the dyeing in

2.2.4 Fabric Cutting

After receive the green signal from fabric QC team and merchandiser, cutting section will be start trial cutting at first. At the same time cutting section will check the consumption again in real fabric. They will confirm to the merchandiser that how they can be able to cut from the received fabric. It is very important because some time we need extra fabric due to the increased of fabric GSM. Merchandiser should be book the short quantity fabric if needed.

2.2.5 Size set and PP sample

After received the bulk fabric production section will make size set sample and check the measurement and shrinkage of fabric. After checking the size set sample they will adjust the pattern and will be make a pre-production sample for buyer approval. During the size set sample production department will setup the line layout. Step 5th and 6th will be done at the same time.

2.2.6 Sewing Section

As in our following this style has no print & embroidery so the cut fabric will be go to input section directly. Merchandiser should sit for a PP meeting with production department with the approved trim card, PP sample, accessories in house report production department should discuss.

i. **Placket Making**: Production supervisor will make the placket by the help of sewing operator. At first they will fused the fabric with interlining in fusing machine. After that, they will cut the fabric by use of the pattern of placket. After that, they will mark the placket fabric and stitch with a plain machine.
ii. **Pocket Joint**: In between of the placket making we will attach the pocket with body by use of a plain machine. Regarding the pocket please be careful about placement of pocket. Sometimes sewing operator sews it slanted and wrong position.
iii. **Placket Make and Joint:** After making the placket and joint the pocket with body, the body has goes to next plain machine operator to attached the placket with body. Here normally we used two plain machines.
iv. **Shoulder Joint**: After the placket joint we join the shoulder (front and back part) by use of an over lock machine.
v. **Shoulder Top Stitch**: After shoulder joint we put a top stitch over the shoulder by use of another plain machine.
vi. **Collar tack & Joint**: After the shoulder top stitch at first we tack the collar by use a plain machine then we join the collar with body by use of an over lock machine.
vii. **Back tape joint**: After collar joint we join the back tape in the flat lock machine by used of folder.
viii. **Placket Top stitch**: After back tap joint we put placket top stitch by use two plain machines.
ix. **Placket Box**: After the top stitch of placket we make the placket box by use of plain machine.
x. **Main/size label attachment**: After the placket box making we attached the main/size label inside the back tape by use of plain machine.
xi. **Sleeve rolling/ sleeve hem**: In the mean time we roll or hem the sleeve with flat lock machine.
xii. **Sleeve joint**: Now we will join the sleeve with body by use of over lock machine.
xiii. **Side seam joint**: After these operations we join the both side seam of body and sleeve by use of over lock machine. We also attached the care label in between this operation.
xiv. **Bottom hem**: After the side seam joint we hem the bottom by use of a flat lock machine.

xv. **Sleeve (opening) Tack**: after this process we put a tack in sleeve opening.

xvi. **Button Hole:** Then we make hole on the placket by use of button whole machine. In this regards please note that button hole will be little bit smaller than the button diameter. Also be noted top button hole will be horizontal whereas the others button hole will be vertical. However, you should confirm it with your buyer.

xvii. **Button Stitch**: After button hole we will be attached the button with placket by use of button stitch machine. Please note that, many time buyer asked for extra button. If needed then we will also stitched a button with the body.

2.3 Process layout for assemble its part of polo-shirt

Table 1: Process layout of polo-shirt

SL. No.	Operation	M/C	Man power	
			Helper	Operator
1	Mark of placket position	Helper	1	
2	Placket rolling	Helper	1	
3	Placket scissoring	Helper	1	
4	Placket joint in front part	PM		1
5	Nose tack of placket	PM		1
6	Ryes cut	OL		1
7	Body match	Helper	1	
8	Shoulder joint with piping	PM		1
9	Shoulder top sin	PM		1
10	Care level joint	PM		1
11	Collar mark	Helper	1	
12	Collar joint	PM		1
13	Collar over lock	OL		1
14	Neck Piping	FL		1
15	Neck top sin	PM		1
16	Main level joint	PM		1
17	Lower placket close	PM		1
18	Upper placket close	PM		1
19	Placket tack(upper & lower placket assemble)	PM		1
20	Placket scissoring	Helper	1	
21	Placket box	PM		1
22	Body hem by blind stitch	OL		1
23	Side band servicing	OL		1
24	Sleeve matching & shoulder piping cut	Helper	1	
25	Sleeve joining	OL		1
26	Side band tack	PM		1
27	Side band top sin	PM		1

28	Side seam	OL		1
29	Sleeve tack	PM		1
			7	22
			Total Man = 29	

2.4 Types of Machines and stitches are needed to make Basic Polo-Shirt

Table 2: Stitches and machines are needed to make polo-shirt

SL. No.	Operations	Stitch Type	Machines
1	Placket Rolling	1N Lock Stitch	PM
2	Placket Join	1N Lock Stitch	PM
3	Nose Tuck	1N Lock Stitch	PM
4	Shoulder Join	Over edge Stitch	OL
5	Collar Join	1N Lock Stitch	PM
6	Collar Piping	Over edge Stitch	OL
7	Upper Placket Top	1N Lock Stitch	PM
8	Lower Placket Top	1N Lock Stitch	PM
9	Back Neck Top	1N Lock Stitch	PM
10	Placket top	1N Lock Stitch	PM
11	Placket Box	1N Lock Stitch	PM
14	Sleeve Cuff Join	Over edge Stitch	OL
15	Cuff Top Stitch	Chain / Flat bed Stitch	FL
16	Sleeve Join	Over edge Stitch	OL
17	Arm Hole Top	Chain / Flat bed Stitch	FL
18	Side Seam	Over edge Stitch	OL
19	Body Hem	Flat lock	FL
20	Sleeve tuck	1N Lock Stitch	PM
21	Button Hole	Button Holing	BH
22	Button Stitch	Button Attaching	BA
		Total Machine	**22**

2.5 Estimate assembles time of polo-shirt:

Table 3: Operation Breakdown for polo shirt (**HAKRO-MARCO**)

SL. No.	Operation	Standard time	SMV
1	Mark of placket position	24.4	0.35
2	Placket rolling	28.8	0.41

3	Placket scissoring	30.4	0.44
4	Placket joint in front part	52	0.75
5	Nose tack of placket	23.2	0.33
6	Ryes cut	21	0.30
7	Body match	35.2	0.50
8	Shoulder joint with piping	40	0.58
9	Shoulder top sin	33.8	0.49
10	Care level joint	18	0.26
11	Collar mark	24	0.35
12	Collar joint	36.4	0.52
13	Collar over lock	32	0.46
14	Neck Piping	28.2	0.40
15	Neck top sin	43	0.62
16	Main level joint	20.8	0.29
17	Lower placket close	39	0.57
18	Upper placket close	38.8	0.56
19	Placket tack(upper and lower placket assemble)	25	0.36
20	Placket scissoring	18	0.26
21	Placket box	30.4	0.44
22	Body hem by blind stitch	28	0.40
23	Side band servicing	36	0.52
24	Sleeve matching & shoulder piping cut	40	0.58
25	Sleeve joining	44.2	0.63
26	Side band tack	21	0.30
27	Side band top sin	32.6	0.47
28	Side seam	36	0.52
29	Sleeve tack	18	0.26
Total Estimated SMV		**12.92 (min)**	

2.6 Process layout & SMV calculation of polo-shirt

Table 5: Operation Breakdown for polo shirt (**HAKRO-BREMEN**)

SL. No.	**Operation**	**Used machine**	**Operator**	**Helper**	**SMV**
01	Back moon join	SNLS	01		.35
02	Placket rolling	SNLS	01		.30
03	Placket join	SNLS	02	01	.50
04	Placket nose tack	SNLS	01		.35
05	Shoulder join both side	OL	02		.30
06	Collar tack to body	SNLS	01		.30
07	Collar join	OL	02	01	.30
08	Back neck piping	FL	01		.35

09	Size & main label make	SNLS	01		.45
10	Back neck top stitch with label	SNLS	01	01	.50
11	Upper & lower placket close	SNLS	01		.40
12	Upper & Lower Placket Top stitch	SNLS	01		.40
13	Placket end tack	SNLS	01		.40
14	Placket potti join	SNLS	01		.65
15	Pocket piping	FL	01		.70
16	Pocket tiken & tack	SNLS	01		.40
17	Pocket join	SNLS	01		.40
18	Pocket bartack	BTK	01		.30
19	Sleeve join	OL	01	01	.40
20	Flag label attach	SNLS	01		.30
21	Side seam	OL	01		.50
22	Cuff make	SNLS	01	01	.30
23	Cuff join	SNLS	01		.35
24	Bottom make	OL		01	.30
25	Bottom join	SNLS	01		.35
26	Button attach	OL	01		.40
		Total	**29**	**06**	**10.25**

2.7 Process layout & SMV calculation of polo-shirt

Table 6: Operation Breakdown for polo shirt (**KANZ - GORGONA**)

Sl. No.	**Operation**	**Used machine**	**Operator**	**Helper**	**SMV**
01	Shoulder join	OL	01		.24
02	Neck rib make	SNLS	01		.30
03	Neck tack	SNLS	02		.30
04	Neck rib join	OL	01		.35
05	Placket servicing	OL	02		.30
06	Placket join	SNLS	01		.50
07	Placket nose tack	SNLS	02	01	.20
08	Back neck piping	FL	01		.30
09	Size & main label make	SNLS	01		.28
10	Back neck top stitch with label	SNLS	01	01	.50
11	Upper & lower placket close	SNLS	01		.40

12	Placket show stitch	FL	01		.40
13	Placket box tack	SNLS	01		.30
14	Placket potti join	SNLS	01		.50
15	Sleeve rib join	OL	01		.30
16	Sleeve rip top stitch	FL	01		.30
17	Sleeve join	OL	01		.30
18	Flag label attach	SNLS	01		.25
19	Side seam right side	OL	01	01	.35
20	Bottom piping	FL	01		.35
21	Bottom piping tack	SNLS	01		.40
22	Side seam left side	OL	01	01	.40
23	Bottom piping chapa tack	SNLS	01		.20
24	Button attach	BA		01	.50
		Total	**27**	**05**	**9.84**

2.8 Process layout & SMV calculation of polo-shirt

Table 7: Operation Breakdown for polo shirt (**KANZ - BLUE EYE**)

Sl. No.	Operation	Used machine	Operator	Helper	SMV
01	Back moon join	SNLS	01	01	.30
02	Shoulder join	OL	02		.35
03	Neck rib make	SNLS	01		.30
04	Neck rib join	OL	02		.30
05	Neck tack	SNLS	01		.30
06	Placket servicing	OL	01	01	.35
07	Placket join	SNLS	01		.35
08	Placket nose tack	SNLS	01		.50
09	Back neck piping	FL	01		.20
10	Size & main label make	SNLS	01		.30
11	Back neck top stitch	SNLS	01		.20
12	Upper & Lower Placket close	SNLS	01		.50
13	Placket show stitch	FL	01		.40
14	Placket box tack	SNLS	01	01	.30
15	Placket label join	SNLS	01		.30
16	Sleeve rib join	OL	01		.40
17	Sleeve rib top stitch	FL	01		.40
18	Sleeve join	OL	01		.30
19	Care label join	SNLS	01		.40
20	Side seam	OL	02		.40

21	Bottom facing join	OL	02	01	.50
22	Bottom facing tack	SNLS	01		.30
23	Bottom hem	FL	01		.35
24	Button attach	BT	01		.30
		Total	**28**	**04**	**8.30**

3.0 Results and Discussion

SMV means standard minute value. It is a numerical value which is represented the standard time of a process or operation in a standard environment for standard worker. Add machine allowance only to those elements where machine is running and fatigue and personal needs to all elements.
Sum up all elemental time and convert seconds into minutes. This is Standard Minute Value (SMV).

3.1 Estimated Standard Minute Values for HAKRO Buyer (**STYLE: MARCO**)

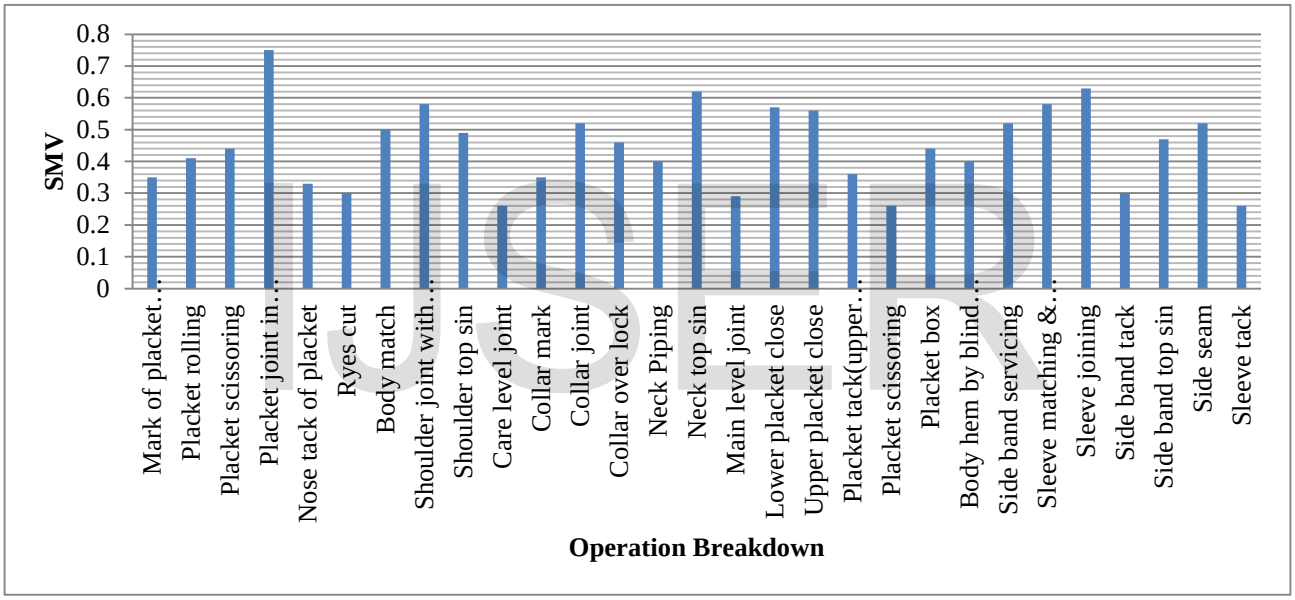

Figure 5: Estimated Standard Minute Values for MARCO style

Figure 5 shows that there are twenty nine (29) operation breakdowns where most of the values for SMV are below 0.5. So, it is said that for a qualified operator the target per hour will be 120pcs. On the other hand, operation SMV above 0.5, Double manpower is required to balance the line to get the same production at estimated time frame.

No. of Operator: **35**

Standard Minute Value (SMV): **12.92 (min)**

Target per hour: (35×60)/12.92 = **163 pcs**

3.2 Estimated Standard Minute Values for HAKRO Buyer (**STYLE: BREMEN**)

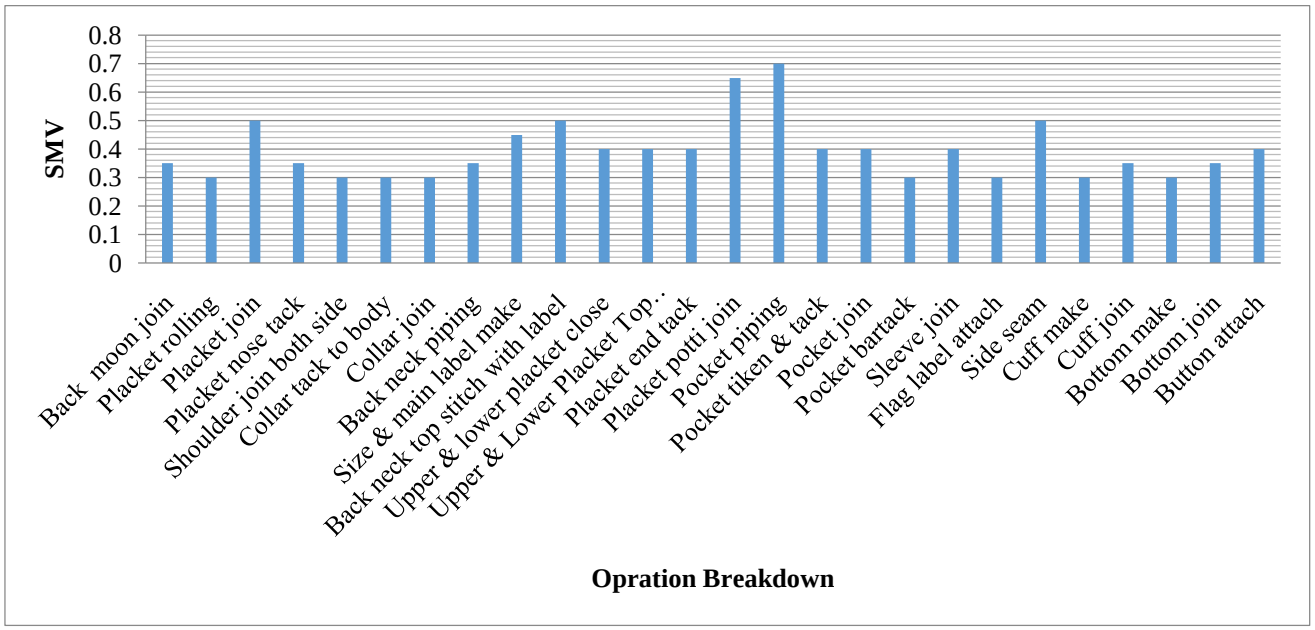

Figure 6: Estimated Standard Minute Values for BREMEN style

Figure 6 shows that there are twenty six (26) operation breakdowns where most of the values for SMV are below 0.5. So, it is said that for a qualified operator the target per hour will be 120pcs. On the other hand, operation SMV above 0.5, Double manpower is required to balance the line to get the same production at estimated time frame.

No. of Operator**= 35**

Standard Minute Value (SMV): **10.25(min)**

Target per hour: (35×60)/10.25 = **205 pcs**

3.3 Estimated Standard Minute Values for KANZ Buyer (**STYLE: GORGONA**)

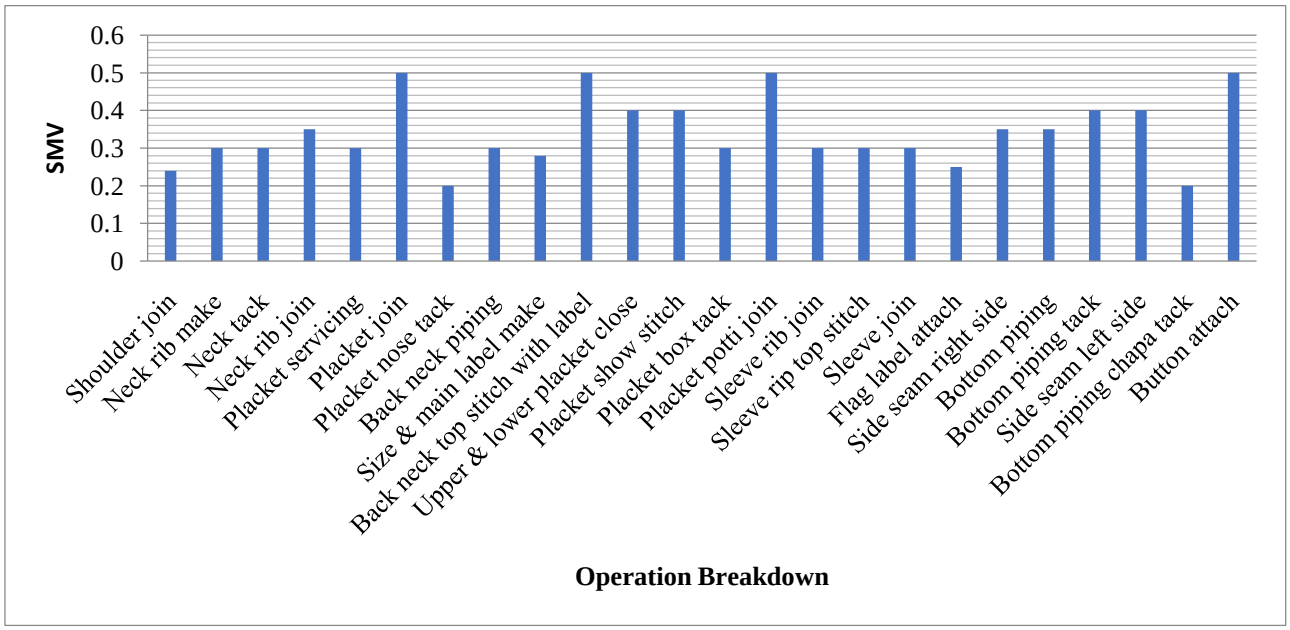

Figure 7: Estimated Standard Minute Values for GORGONA style

Figure 7 shows that there are twenty four (24) operation breakdowns where most of the values for SMV are below 0.5. So, it is said that for a qualified operator the target per hour will be 120pcs. On the other hand, operation SMV above 0.5, Double manpower is required to balance the line to get the same production at estimated time frame.

No. of Operator: **32**

Standard Minute Value (SMV): **9.84 (min)**

Target per hour: (32×60)/9.84 = **195 pcs**

3.4 Estimated Standard Minute Values for KANZ Buyer (STYLE: BLUE EYE)

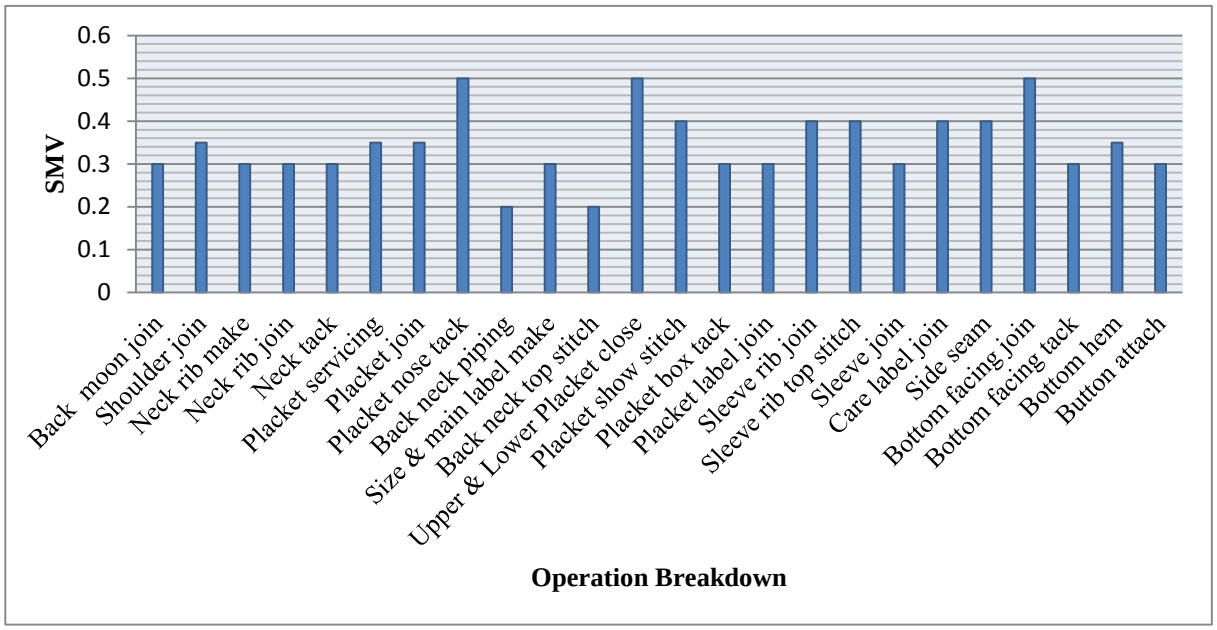

Figure 8: Estimated Standard Minute Values for BLUE EYE style

Figure 8 shows that there are twenty four (24) operation breakdowns where most of the values for SMV are below 0.5. So, it is said that for a qualified operator the target per hour will be 120pcs. On the other hand, operation SMV above 0.5, Double manpower is required to balance the line to get the same production at estimated time frame.

No. of Operator: **32**

Standard Minute Value (SMV): **8.30 (min)**

Target per hour: (32×60)/8.30 = **231 pcs**

3.5 Observation

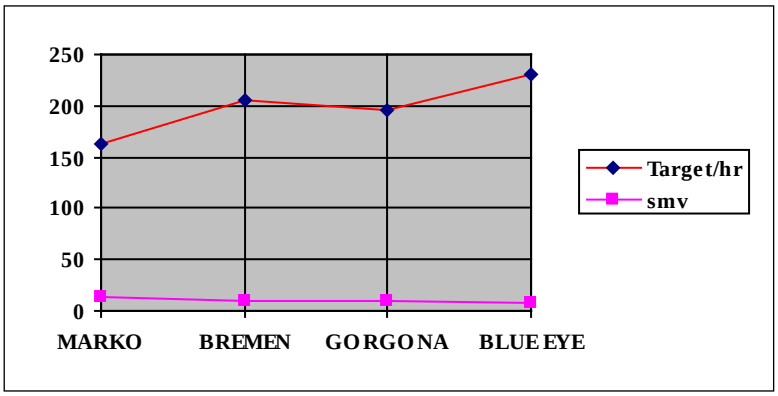

Figure 9: Estimated Standard Minute Values for BREMEN style

Figure 9 shows that for MARKO and BREMEN style, the man power is same but target per hour is not equal (163 & 205) due the variation of number of operation breakdowns and smv for the style (12.92 & 10.25). On the

other hand, for GORGONA and BLUE EYE style, the man power is same but target per hour is not equal (195 & 231) due the variation of number of operation breakdowns and the style smv(9.84 & 8.30). With the increasing of number of operation, operator will be increased to meet up the production per hour for a desired style. And for same number of operator, if smv is less, In this case, production per hour will be increased for the style.

4.0 CONCLUSION

This project work is based on an effective layout model of polo-shirt. This investigates different types of machines are used such as: cutting machine, sewing machine etc. Knit fabrics are mostly used as a raw material for making polo-shirt garments manufacturing process for polo-shirt production. Here we have worked centering a polo-shirt having parts: Body, Collar, Sleeve and Cuff .The no. of operations and man power required to produce the polo-shirt is depend on the target per hour of the line. Different types of sewing machine have been used for sewing the shirt such as: Plain machine, over lock machine, Flat Lock machine, Button hole and Button attach. After calculating each and every operations SMV we have got the ultimate SMV required to produce the Polo-shirt. Here we have set single line balancing.

REFERENCES

[1] Ponedjeljak (2011), An optional pocket for polo ralph lauren shirts,

http://blog.dnevnik.hr/pepoloralph/

[2] Raza, S.S., (2015), "An Introduction with Thermal Analysis", Global Journal of Researches in Engineering: Industrial Engineering, 15(2):25-30.

[3] Howlader, M.R., Islam, M.M., Sajib, M.T.H., Ripon, Prasad, R.K., (2015), "Practically observation of standard Minute Value of T-shirt", International Journal of Engineering and Computer Science, 4(3):10685-10689.

[4] Rahaman, H., Roy, P.K., Karim, R. & Biswas, P.K., (2014) "Effective Way to Estimate the Standard Minute Value (SMV) of A T-Shirt By Work Study", European Scientific Journaledition, 10:196-203.

[5] Syduzzaman & Golden, A.S., (2015) "Apparel Analysis for Layout Planning in Sewing Section", International Journal of Current Engineering and Technology, 5:1736-1742.

[6] Azim, A.Y.M.A., Momtaz, F., Datta, E. & Mica, M.T., (2016) "Effective Machine Layout to Minimize the CM for T-shirt &Polo-shirt", American Journal of Engineering Research, 5(4):174-178.

[7] Jalil, M.A., Hossain, T., Islam, M. & Prashan, M.R., (2015) "To Estimate the Standard Minute Value of a Polo-Shirt by Work Study", The Global Journal of Researches in Engineering, 2:25-30.

[8] Raihan, S., (2016) "Effect of Sewing Work Aid in Garments Production", International Journal of Textile Science, 5(3):49-56.