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Productivity Improvement through Line Balancing in Apparel Industries

Md. Rezaul Hasan Shumon, Kazi Arif-Uz-Zaman and Azizur Rahman Dept. of Industrial Engineering and Management Khulna University of Engineering and Technology Khulna, Bangladesh

Abstract

The apparel industries must produce momentous quantities in shorter lead times. Apparel product is highly correlated with high level of productivity; sewing line should be balanced in shorter possible time and effective way for each style and quantity. The focal constraint against the higher productivity is the difference in individual capacity which is the mode of improper line balancing and bottle neck process. This paper is based on an effective layout model where to hit upon the bottleneck process through benchmark capacity and led us to use balancing process using two separate concept of manufacturing processes- modular line and Traditional system both together. The research shows that this balanced layout model has increased the efficiency by 21%, and labor productivity by 22%.

Keywords

Scheduling, Line Balancing, Bundle system, Modular Line.

1. Introduction

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 (\$0.11 per shirt for Bangladesh, \$0.26 for India, \$0.79 for Srilanka [3]), the quality of the garments, efficiency and productivity of Bangladesh RMG sector remain ignored even in the tough competitive market. Factories in Sri Lanka operate at 80% - 90% of efficiency, whereas in Bangladesh, according to some experts, productivity is between 35% and 55% of efficiency with very few exceptions [3]. For the RMG sector in Bangladesh, productivity alone can make a difference between life and death.

3. Methodology

We discussed the paper comparing the productivity and efficiency before and after applying the balancing technique. Considering experience, capacity, one production line is selected from the sewing floor. One garment order is chosen which was started in that line, knowing total amount of order, style description, fabric type and color. Two important attributes have been considered, one is possible standard method for each process and another is considerable time in between the input has been fed to the time study took to record the actual individual capacity of each worker. We have recorded the time to make each process for each and every worker to find out the number of operator and helper, type of machines, basic and standard pitch time and individual capacity. To find out the (standard allowable minute) S.A.M value, process wise capacity has been calculated, in addition to that we have calculated the target, benchmark capacity, theoretical manpower, actual capacity line graph, labor productivity and line efficiency. Line has been balanced considering the bottleneck and balancing process. After balancing, new manpower has been proposed and final capacity of each worker has been reallocated. We have compared the line graph after balancing the line, labor productivity and line efficiency. Finally a proposed production layout has been modeled with balanced capacity.

4. Equations

4.1 Standard Pitch Time (S.P.T) = Basic Pitch Time (B.P.T) + Allowances (%)

| 4.2 Target Total Manpe | ower per line *Total Working Minutes per Day |
|---|--|
| 4.2 Target = | S.A.M |
| 1.3 Theoretical Mannower | Benchmark Target per hour |
| 4.5 Theoretical Manpower | Process Capacity per hour |
| 4.4 L abor Productivity = $\frac{T}{T}$ | otal number of output per day per line |
| 4.4 Labor Floudenvity – | Number of worker worked |
| 4 5 Machine Productivity = | Total number of output per day per line |
| 1.5 Machine Troductivity - | Number of machines used |
| 4.6 Line Efficiency: | Total Output per day per line ×S.A.M * 100% |
| Total | Manpower per line «Total Working Minutes per Day |

5. Data Analysis and Calculations

5.1 Before balancing the line

In Annexure 1: time study sheet is attached showing the different types of machine used, number of operators and helpers, basic and standard pitch time and capacity per hour.

Table 1: Bench mark Target, Labor and machine productivity and Line Efficiency before balancing line.

| | | | ÷ |
|----------------------|------|-----------------|------------|
| Total Output Per Day | 1200 | | |
| Total Manpower = | 37 | | |
| Working Time = | 600 | Minutes | |
| S.A.M = | 8.90 | | |
| Target /Hour = | 250 | 100% Efficiency | |
| Target /Hour = | 200 | 80% Efficiency | Bench Mark |
| = | 150 | 60% Efficiency | |
| = | 100 | 40% Efficiency | |
| Labor Productivity = | | 32 | |
| Machine Productivity | | 55 | |
| Line Efficiency % = | | 48 | |

Process wise capacity of each work station has been shown in Annexure 2 where Standard allowable minutes (S.A.M) has been calculated by adding S.P.T of each process. Table: 1 shows the target per hour for the line calculating total 37 manpower worked on that line for 600 minutes with a S.A.M value of 8.90. We have standardized the Bench mark target of 200 pieces of garment at 80% efficiency. Observation before balancing the line has been reflected as labor and machine productivity is 32 and 55, line efficiency is 48%.where the total production has been attached in Annexure 4.



Figure 1: Variation in each process capacity per hour compare to bench mark target per hour

Plotting process wise capacity in a line graph shows the variation of each process from the bench mark target as the upper capacity is 490 pieces per hour where the lower capacity is only 115 pieces per hour compare to the bench mark target of 200 pieces. This shows the imbalance situation in the line and bottleneck condition through out the process of the whole garment making as lots of WIP stations in the line.

| SI No. | | | Bottlenec | k | | | Balancing | |
|--------|--------------------------------|----------------|-------------------|----------------------|------------------------------------|----------------|-------------------|----------------------|
| | Process Name | Process No. | Capacity /Hour | Balanced Capacity | Process Name | Process No. | Capacity /Hour | Balanced Capacity |
| | | | | | | | - | |
| 1 | Make & Join Care Label | 6 | 178 | 208 | Neck Rib Make Width | 7 | 261 | 217 |
| | Remarks : | | Process # | 7 can work f | or 50 min. and share work with pr | ocess # 6 fo | r last 10 mir | ı. |
| | | • | | | | | | |
| 2 | Back Neck Elastic Tape Joint | 12 | 153 | 216 | Back Neck Elastic Top | 13.B | 327 | 258 |
| | Remarks : | F | Process # 13 | .B can work | for 35 min. and share work with p | rocess # 12 | for last 25 n | nin. |
| | | • | | | | | | |
| 3 | Match Slv Pair & Sleeve & body | 16 | 167 | 195 | Main Label position Mark | 14 | 242 | 201 |
| | Remarks : | | Process # 1 | 4 can work 1 | or 50 min. and share work with pr | ocess # 16 f | or last 10 m | in. |
| | | - | | | | | | |
| 4 | Sleeve Hem | 23 | 175 | 198 | Bottom Hem | 25 | 231 | 200 |
| | Remarks : | | Process # 2 | 25 can work | for 52 min. and share work with p | rocess # 23 | for last 8 mi | n. |
| | | | | | | | | |
| 5 | Churi Hem Raw edge Cut | 24 | 115 | 153 | Body Folding after Side seam | 20 | 300 | 200 |
| | Remarks : | | Process # 2 | 0 can work | for 40 min. and share work with pr | ocess # 24f | or last 20 mi | n. |
| | | | Process | # 24 can im | prove the method or use floater to | balance th | e processs. | |
| | | - | | | | | | |
| 6 | Security Tack | 27 | 184 | 199 | Sleeve Hem Tack | 22 | 223 | 204 |
| | Remarks : | | Process # 2 | 22 can work | for 55 min. and share work with p | rocess # 27 | for last 5 mi | n. |

Table 2: Balancing Processes to equalize the bottleneck process Balancing Capacity Per Hour

5.3 Bottleneck processes

From Figure 1: we have identified some variations in process capacity from the bench mark target and the lower capacity from the bench mark target is the bottleneck process as production flow would stuck on the bottleneck point. Comparing total capacity of each process to the 80% bench mark target, we have identified the bottleneck processes named make and join care label, back neck elastic tape joint, match sleeve pair and sleeve and body, sleeve hem, churi hem raw edge cut, security tack and thread cut body turn in Annexure 3: marked with light brown color. Total production has been blocked in these seven work stations and large work in process (WIP) has been stuck in these bottleneck processes.

5.4 Balancing Processes

Balancing method is very essential to make the production flow almost smoother compare to the previous layout. Considering working distance, type of machines and efficiency, workers who have extra time to work after completing their works, have been shared their work to complete the bottleneck processes. Previously identified seven bottleneck processes have been plotted in the left side of the Table 2. Make and join care label and Back neck elastic tape joint both have been made by lock stitch machine and these have been shared by two lock stitch machine processes. Operator who work in Process no. 7 Neck rib make width, have been worked for 50 minutes per hour in her first process, capacity 217 pieces and then have been worked in the process no. 6 make and join care label for last 10 minutes to make additional 30 pieces for overall capacity of 208 pieces on process no. 6. Similarly Process

no. 13.B back neck elastic top have been worked for 35 minutes and rest 25 minutes have been worked on process no. 12 to make total capacity of 216 pieces which was originally 153 pieces shown in Table 2. Process no.14, 25, 20 and 22 have been similarly worked on the process no.16, 23, 24 and 27 for the capacity of 195, 198, 153 and 199 pieces per hour. Process no. 24 churi hem raw edge cut have been suggested an extra floater to use after being shared worked from process no. 20.

5.5 Proposed Layout

| Balanced Capacity/Hr | Previous Capacity | S.A.M | Process Name | Process No. | | | | Process No. | Process Name | S.A.M | Previous Capacity | Balanced Capacity/Hr |
|-------------------------|----------------------|-------|-----------------------------|----------------|-------|--|-------|----------------|------------------------|-------|----------------------|-------------------------|
| 124 | 124 | 0.483 | Front Back Match | 1.A | | Table | | 1.B | Front Back Match | 0.483 | 124 | 124 |
| 191 | 191 | 0.314 | Shoulder Joint | 2 | 0/L-4 | | HP | 3 | Sldr Cut Mark | 0.246 | 244 | 244 |
| 219 | 219 | 0.274 | Thread Cut | 5 | HP | | C/S-1 | 4 | Sldr Top | 0.285 | 211 | 211 |
| 208 | 178 | 0.337 | Make & Join Care Lbl | 6 | L/S-1 | F | | | | | • | |
| | 1 | | | | | | | | | | | |
| 217 | 261 | 0.23 | Rib Make Width | 7 | L/S-1 | $\stackrel{\checkmark}{\longrightarrow}$ | L/S-1 | 8 | Neck Rib Fold Tack | 0.266 | 226 | 226 |
| | | | | | | | | | | | | |
| 208 | 208 | 0.288 | Neck Joint | 9 | 0/L-4 | K | HP | 11 | Cut Twill Tape | 0.231 | 260 | 260 |
| 219 | 219 | 0.274 | Thread Cut | 10 | HP | | L/S-1 | 12 | Bck Neck Tape Joint | 0.391 | | 216 |
| 163 | 163 | 0.367 | Bck Neck Elst Top | 13.A | L/S-1 | \leq | | | | | | |
| 201 | 242 | 0.248 | Main Lbl Post Mark | 14 | HP | Cepter | L/S-1 | 13.B | Bck Neck Elst Top | 0.367 | 163 | 95 |
| 233 | 233 | 0.257 | Join Main & Co Label | 15 | L/S-1 | Table | | | | | | |
| 195 | 167 | 0.359 | Mtch slv pair & Slv-Body | 16 | HP | | 0/L-4 | 17.A | Sleeve Joint | 0.476 | 126 | 126 |
| 126 | 126 | 0.476 | Sleeve Joint | 17.B | 0/L-4 | \leq | HP | 18 | Body Turn | 0.29 | 207 | 207 |
| | | | | | | | 0/L-4 | 19.A | Side Seam | 0.475 | 126 | 126 |
| 126 | 126 | 0.475 | Side Seam | 19.B | 0/L-4 | \leq | HP | 20 | Fold Body | 0.2 | 300 | 200 |
| | | | | | | | L/S-1 | 21 | Bottom Hem Tack | 0.27 | :22 | 222 |
| 204 | 223 | 0.269 | Sleeve Hem Tack | 22 | L/S-1 | \leq | | | | | | |
| | | - | | | | | F/L-3 | 23 | Sleeve Hem | 0.342 | .7! | L 198 |
| | | | | | | | HP | 24 | Chury Hem Edge Cut | 0.522 | ¥ <u>.</u> 1! | 153 |
| 211 | 211 | 0.285 | Bttom Hem Edge Cut | 26 | HP | | F/L-3 | 25 | Bottom Hem | 0.26 | 23: | 200 |
| 199 | 184 | 0.326 | Security Tack | 27 | L/S-1 | | | | | | | |
| 181 | 181 | 0.331 | Thrd Cut Bottom Turn | 28 | | Table | | | | | | |

Figure 2: Proposed Layout Model to balance the bottleneck processes

Research has been customary through this model which indicates that the processes are almost balanced from previous layout through the combination of balancing and bottleneck processes. The blue arrow on the centre table indicates the production flow through the process no. as semi zigzag combination and green arrow shows the sharing of works in between balancing and bottleneck processes. First column on both side of center table shows the

machine type and then followed by process no. process name, S.A.M value, previous capacity and after balance capacity. After first process front and back match, bundle of garments have been come to process no. 2 shoulder joint, then the bundle have been passed diagonally to process no. 4 shoulder top and in between the processes, one helper has been worked in process no. 3 shoulder cut mark which is shown in fig 1. The working bundle then has been passed to process no. 6 and so on. From process no. 6 to 7 and process no. 23 to 25, work has been flowed vertically not diagonally because of balancing out the bottleneck processes of no. 6 and 23 as diagonal flow would have create the long distance and much time to balance. For balancing 6 possible stations, we have used the short possible distance; similar machines (process 6, 7, 12, 13.B, 22, 27 have been utilized in lock stitch machines, process 23 and 25 have been utilized in flat lock machines and process 14 and 16 are service operators.

6. Result and Findings

Changing from traditional layout to balanced layout model, there are considerable improvements have moved toward us. Among the three operators who were replaced to another line, have been used in the lock stitch and flat lock machines and machine productivity for these less used machines has been increased from 55 to 66 where for the total worker of 32 instead of 37, labor productivity has been increased to 39 from 32.

| rable 5. Denen mar | k Taiget, Labor and ma | terme productivity and Line Efficiency after i | me balanem <u>z</u> . |
|----------------------|------------------------|--|-----------------------|
| Total Output Per Day | 1250 | | |
| Total Manpower = | 32 | | |
| Working Time = | 600 | Minutes | |
| S.A.M = | 8.90 | | |
| Target /Hour = | 216 | 100% Efficiency | |
| Target /Hour - | 172 | 800/ Efficiency | New |
| | 175 | 80% Efficiency | Bench Mark |
| = | 129 | 60% Efficiency | |
| = | 86 | 40% Efficiency | |
| Labor Productivity = | | 39 | |
| Machine Productivity | | 66 | |
| Line Efficiency % = | | 58 | |

Table 3: Bench mark Target, Labor and machine productivity and Line Efficiency after line balancing.

In a day we have boost up the production up to 1250 and with manpower of 32, line efficiency has been improved from 48% to 58% which is shown in Table 3. In an improved layout, target has been decreased at each efficiency level. At 80% efficiency, target is now 173 pieces per hour which has been considered as new bench mark target.



Figure 3: Variation in each process capacity per hour compare to bench mark target per hour After balancing the process flow, figure- 3: shows the less variation of each process from the bench mark target as the upper capacity is 260(previous one was 490) pieces per hour where the lower capacity is only 153(previous one was 115) pieces per hour compare to the bench mark target of 200 pieces which shows that the variation in each process has been decreased from the previous one and reflects much better balanced production flow in the line. For Process no. 24 churi hem raw edge cut, an extra floater has been suggested to utilize.

8. Recommendations for Future Research

Result would have been more effective if we would have taken some large quantity order and balancing the process is highly related to the type of machines as machine utilized in bottleneck and balancing process should be similar.

Further improvements in the productivity can be achieved by considering large amount of order minimum 10000pieces. Table 2 shows the new bench mark target which can be the further chance of improvements to balance the line with this new bench mark target. Proposed layout model has been followed the logic of modular system (one worker works more than two processes who is skilled on all processes and these combination of skilled workers finish their work in piece flow production) and traditional system (one worker works in one process and all the workers who may be skilled or not finish their work in bundle flow production) both together where only modular production system can be applicable with a series of skilled workers to achieve more productivity. On this occasion, skilled workers are eligible for the production processes and proper training and supervision is essential to achieve the optimum improvements on productivity and efficiency.

9. Conclusion

Maximum outputs have been increased to 1272 pieces a day which was previously recorded to 1192 pieces a day. Before balancing the line 4791 pieces of garments have been produced for 5 days where 4522 pieces have been produced for 4 days after balancing the line. We have saved one day lead time for that style of 9000pieces and almost 600 minutes of labor work value time. We have replaced 3 operators and 2 helpers into different lines and relatively saved 5 workers work time of 3000 minutes from that line and almost \$130 (Tk1441 BDT for helper and Tk2000 BDT for operator on an average) [4].

References

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Annexure 1: Time study sheet showing total operator and helper with standard pith time and capacity.

| | Designers Limited | | | | | | | | |
|--------|-----------------------|------------------------------|-----------|-----------|-------------|----------|---------------|-------|-------------------|
| | | | Tim | e Study S | heet | | | | |
| Shipme | ent Quantity : | 9000 Pcs Colour : D | eep Green | | Style : | Round Ne | eck Tee Shirt | | Date : 11 /04/ 09 |
| | | _ | 1 | | | | | | |
| SL. No | Name | Process | Operator | Helper | Machine | B.P.T | Allowances% | S.P.T | Capacity/ Hour |
| 1 | Soheli | Front Back Matching | | 1 | HP | 0.374 | 20% | 0.449 | 134 |
| 2 | Akram | Front Back Matching | | 1 | HP | 0.436 | 20% | 0.523 | 115 |
| 3 | Russel | Shoulder Joint | 1 | | 0/L-4 | 0.273 | 15% | 0.314 | 191 |
| 4 | Aleya | Shoulder cut mark | | 1 | HP | 0.205 | 20% | 0.246 | 244 |
| 5 | Nazrul | Shoulder Top | 1 | | C/S-1 | 0.238 | 20% | 0.285 | 211 |
| 6 | Nusrat | Thread cut | | 1 | HP | 0.228 | 20% | 0.274 | 219 |
| 7 | Alim | Make Care Label | 1 | | L/S-1 | 0.128 | 20% | 0.154 | 390 |
| 8 | Rokeya | Join Care Label | 1 | | L/S-1 | 0.153 | 20% | 0.183 | 328 |
| 9 | Hasna | Neck Rib Make Width | 1 | | L/S-1 | 0.192 | 20% | 0.230 | 261 |
| 10 | Taniya | Neck Rib Fold Tack | 1 | | L/S-1 | 0.222 | 20% | 0.266 | 226 |
| 11 | Selim | Neck Joint | 1 | | 0/L-4 | 0.250 | 15% | 0.288 | 208 |
| 12 | Mohona | Thread cut | | 1 | HP | 0.228 | 20% | 0.274 | 219 |
| 13 | Selina | Cut Twill Tape | | 1 | HP | 0.193 | 20% | 0.231 | 260 |
| 14 | Amena | Back Neck Elastic Tape Joint | 1 | | L/S-1 | 0.326 | 20% | 0.391 | 153 |
| 15 | Yousuf | Back Neck Elastic Top | 1 | | L/S-1 | 0.301 | 20% | 0.361 | 166 |
| 16 | Ariful | Back Neck Elastic Top | 1 | | L/S-1 | 0.310 | 20% | 0.372 | 161 |
| 17 | Hasna hena | Back Neck Elastic Top | 1 | | L/S-1 | 0.308 | 20% | 0.369 | 163 |
| 18 | Ratna | Main Label position Mark | | 1 | HP | 0.207 | 20% | 0.248 | 242 |
| 19 | Mohsin | Main and Co Label joint | 1 | | L/S-1 | 0.214 | 20% | 0.257 | 233 |
| 20 | Sifat | Match Sleeve Pair | | 1 | HP | 0.141 | 20% | 0.169 | 355 |
| 21 | Saniida | Match Sleeve and Body | | 1 | НР | 0.158 | 20% | 0.190 | 316 |
| 22 | Ali hossain | Sleeve Joint | 1 | | 0/L-4 | 0.410 | 15% | 0.472 | 127 |
| 23 | Ataur | Sleeve Joint | 1 | | 0/L-4 | 0.418 | 15% | 0.481 | 125 |
| 24 | Movna | Body Turn | | 1 | HP | 0.242 | 20% | 0.29 | 207 |
| 25 | Mahfuia | Side Seam | 1 | - | 0/1-4 | 0.417 | 15% | 0.479 | 125 |
| 26 | Motaher | Side Seam | 1 | | 0/1-4 | 0.410 | 15% | 0.472 | 127 |
| 27 | Lima | Body Folding after Side seam | - | 1 | HP | 0.167 | 20% | 0.200 | 300 |
| 28 | Lotifa | Bottom Hem Tack | 1 | - | 1/5-1 | 0.226 | 20% | 0.271 | 221 |
| 29 | Nisha | Sleeve Hem Tack | 1 | | 1/5-1 | 0 224 | 20% | 0.269 | 223 |
| 30 | Novon | Sleeve Hem | 1 | | E/J_3 | 0.224 | 17% | 0.205 | 174 |
| 31 | Maibbarul | Sleeve Hem | 1 | | F/L-3 | 0.204 | 17% | 0.344 | 174 |
| 22 | Dino | Churi Hem Pow edge Cut | 1 | 1 | | 0.291 | 20% | 0.541 | 1/0 |
| 22 | Ihuma | Churi Hem Raw edge Cut | + | 1 | НО | 0.403 | 20% | 0.333 | 122 |
| 24 | JIIUIIId | Pottom Hom | 1 | T | | 0.410 | 20% | 0.492 | 221 |
| 24 | nullidyuli Dachida | Dottom Hom Dow odeo Cut | | 1 | Г/L-Э Цр | 0.222 | 2,00/ | 0.200 | 231 |
| 35 | Naihhar | | 1 | T | | 0.238 | 20% | 0.285 | 211 |
| 30 | iviajnnar Trino | | 1 | 4 | L/S-1 | 0.272 | 20% | 0.326 | 184 |
| 37 | irina | Inread cut Body Turn | | 1 | нр | 0.276 | 20% | 0.331 | 181 |

| Total | 22 | 15 |
|----------------|----|----|
| | | |
| Total Manpower | 3 | 7 |

| | Process Wise Capacity Per Hour | | | | | |
|--------|-----------------------------------|-------|----------|--------|-------------|----------|
| | | | T | | | 1 |
| SL. No | Process | S.A.M | Capacity | Target | Theoretical | Actual |
| | | | / Hour | @80% | Manpower | Manpower |
| 1 | Front Back Matching (2 Person) | 0.483 | 248 | 200 | 0.8 | 2 |
| 2 | Shoulder Joint | 0.314 | 191 | 200 | 1.0 | 1 |
| 3 | Shoulder cut mark | 0.246 | 244 | 200 | 0.8 | 1 |
| 4 | Shoulder Top | 0.285 | 211 | 200 | 1.0 | 1 |
| 5 | Thread cut | 0.274 | 219 | 200 | 0.9 | 1 |
| 6 | Make Care Label | 0.154 | 390 | 200 | 0.5 | 1 |
| 7 | Join Care Label | 0.183 | 328 | 200 | 0.6 | 1 |
| 8 | Neck Rib Make Width | 0.230 | 261 | 200 | 0.8 | 1 |
| 9 | Neck Rib Fold Tack | 0.266 | 226 | 200 | 0.9 | 1 |
| 10 | Neck Joint | 0.288 | 208 | 200 | 1.0 | 1 |
| 11 | Thread cut | 0.274 | 219 | 200 | 0.9 | 1 |
| 12 | Cut Twill Tape | 0.231 | 260 | 200 | 0.8 | 1 |
| 13 | Back Neck Elastic Tape Joint | 0.391 | 153 | 200 | 1.3 | 1 |
| 14 | Back Neck Elastic Top (3 Person) | 0.367 | 490 | 200 | 0.4 | 3 |
| 15 | Main Label position Mark | 0.248 | 242 | 200 | 0.8 | 1 |
| 16 | Main and Co Label joint | 0.257 | 233 | 200 | 0.9 | 1 |
| 17 | Match Sleeve Pair | 0.169 | 355 | 200 | 0.6 | 1 |
| 18 | Match Sleeve and Body | 0.190 | 316 | 200 | 0.6 | 1 |
| 19 | Sleeve Joint (2 Person) | 0.476 | 252 | 200 | 0.8 | 2 |
| 20 | Body Turn | 0.290 | 207 | 200 | 1.0 | 1 |
| 21 | Side Seam (2 Person) | 0.475 | 252 | 200 | 0.8 | 2 |
| 22 | Body Folding after Side seam | 0.200 | 300 | 200 | 0.7 | 1 |
| 23 | Bottom Hem Tack | 0.270 | 222 | 200 | 0.9 | 1 |
| 24 | Sleeve Hem Tack | 0.269 | 223 | 200 | 0.9 | 1 |
| 25 | Sleeve Hem (2 Person) | 0.342 | 350 | 200 | 0.6 | 2 |
| 26 | Churi Hem Raw edge Cut (2 person) | 0.522 | 115 | 200 | 1.7 | 2 |
| 27 | Bottom Hem | 0.260 | 231 | 200 | 0.9 | 1 |
| 28 | Bttm Hem R edg Cut (2 Person) | 0.285 | 421 | 200 | 0.5 | 2 |
| 29 | Security Tack | 0.326 | 184 | 200 | 1.1 | 1 |
| 30 | Thread cut Body Turn | 0.331 | 181 | 200 | 1.1 | 1 |

Annexure 2: Process wise capacity per hour showing S.A.M value, and theoretical manpower.
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8.90

S.A.M

| SL. No | Process | posed Ca | pacity P | er Hour | | | |
|--------|----------------------------------|--------------|----------|---------|-------------|----------|----------|
| SL. No | Process | | | | | | |
| SL. No | Process | | | | | | |
| JL. NU | FIOCESS | C A M | Total | Target | Theoretical | Actual | Proposed |
| | | 3.A.IVI | Capacity | @80% | Manpower | Manpower | Manpower |
| 1 | Front Back Matching (2 Person) | 0.483 | 248 | 200 | 0.8 | 2 | 2 |
| 2 | Shoulder Joint | 0.314 | 191 | 200 | 1.0 | 1 | 1 |
| 3 | Shoulder cut mark | 0.246 | 244 | 200 | 0.8 | 1 | 1 |
| 4 | Shoulder Top | 0.285 | 211 | 200 | 1.0 | 1 | 1 |
| 5 | Thread cut | 0.274 | 219 | 200 | 0.9 | 1 | 1 |
| 6 | Make & Join Care Label | 0.337 | 178 | 200 | 1.1 | 2 | 1 |
| 7 | Neck Rib Make Width | 0.230 | 261 | 200 | 0.8 | 1 | 1 |
| 8 | Neck Rib Fold Tack | 0.266 | 226 | 200 | 0.9 | 1 | 1 |
| 9 | Neck Joint | 0.288 | 208 | 200 | 1.0 | 1 | 1 |
| 10 | Thread cut | 0.274 | 219 | 200 | 0.9 | 1 | 1 |
| 11 | Cut Twill Tape | 0.231 | 260 | 200 | 0.8 | 1 | 1 |
| 12 | Back Neck Elastic Tape Joint | 0.391 | 153 | 200 | 1.3 | 1 | 1 |
| 13 E | Back Neck Elastic Top (2 Person) | 0.367 | 327 | 200 | 0.6 | 3 | 2 |
| 14 | Main Label position Mark | 0.248 | 242 | 200 | 0.8 | 1 | 1 |
| 15 | Main and Co Label joint | 0.257 | 233 | 200 | 0.9 | 1 | 1 |
| 16 | Match Slv Pair & Sleeve & body | 0.359 | 167 | 200 | 1.2 | 1 | 1 |
| 17 | Sleeve Joint (2 Person) | 0.476 | 252 | 200 | 0.8 | 2 | 2 |
| 18 | Body Turn | 0.290 | 207 | 200 | 1.0 | 1 | 1 |
| 19 | Side Seam (2 Person) | 0.475 | 252 | 200 | 0.8 | 2 | 2 |
| 20 | Body Folding after Side seam | 0.200 | 300 | 200 | 0.7 | 1 | 1 |
| 21 | Bottom Hem Tack | 0.270 | 222 | 200 | 0.9 | 1 | 1 |
| 22 | Sleeve Hem Tack | 0.269 | 223 | 200 | 0.9 | 1 | 1 |
| 23 | Sleeve Hem | 0.342 | 175 | 200 | 1.1 | 2 | 1 |
| 24 | Churi Hem Raw edge Cut | 0.522 | 115 | 200 | 1.7 | 2 | 1 |
| 25 | Bottom Hem | 0.260 | 231 | 200 | 0.9 | 1 | 1 |
| 26 | Bottom Hem Raw edge Cut | 0.285 | 211 | 200 | 1.0 | 2 | 1 |
| 27 | Security Tack | 0.326 | 184 | 200 | 1.1 | 1 | 1 |
| 28 | Thread cut Body Turn | 0.331 | 181 | 200 | 1.1 | 1 | 1 |

Annexure 3: Proposed capacity per hour for each process showing proposed manpower and bottleneck processes.

Total 37 32

Annexure 4: Total production status for the style 810105 showing production start date, complete date and date of balance the line.

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| Style : Round Neck Tee Shirt | | Color : | Deep Green | Order Quantity: 9000 Pcs | |
|------------------------------|----------|---------|------------|--------------------------|-----------------|
| Date/ 09 | Ma | npower | | Production | Remarks |
| | Operator | Helper | Total | | |
| | 22 | 15 | 37 | | |
| 6-Apr | 22 | 15 | 37 | 632 | |
| 7-Apr | 22 | 15 | 37 | 856 | |
| 8-Apr | 22 | 15 | 37 | 1011 | |
| 9-Apr | 22 | 15 | 37 | 1100 | |
| 11-Apr | 22 | 15 | 37 | 1192 | |
| 12-Apr | 19 | 13 | 32 | 900 | Line Balanced |
| 13-Apr | 19 | 13 | 32 | 1090 | |
| 15-Apr | 19 | 13 | 32 | 1260 | |
| 16-Apr | 19 | 13 | 32 | 1272 | Order Completed |