PRODUCTIVITY IMPROVEMENT THROUGH MODULAR LINE IN GARMENT INDUSTRIES

B. Sudarshan¹, Dr. D. Nageswara Rao²

¹Research scholar, Mail id: sudarshan765@gmail.com
²Vice Chancellor, Mail id: vc@cutm.ac.in

Centurion University of Technology and Management, Paralakhemundi-761200.

Abstract:

The readymade garment (RMG) industries produce momentous quantities in shorter cycle times. Garment product is highly correlated with high level of productivity as sewing line is balanced in shorter possible time and effective way for each style of garment and required quantity. The focal constraint against the higher productivity is the difference in individual capacity leading to improper line balancing and thus about neck. This paper is based on an effective layout model to clear the bottleneck process through benchmark capacity leading for a balancing process using two separate concepts of manufacturing processes—modular line and Traditional system both together. The results show that this balanced layout model has increased the efficiency by 22%, and labor productivity by 24%, based on the two folded objective of investigation of value stream mapping in existing production line and to altering the same with new cellular or Modular based layout. Work in progress (WIP) will be analyzed in all sewing room production lines to realize the significance.

Keywords: Productivity, Value Stream Mapping, Modular manufacturing, Work-In-Process

1. Introduction:

Modular Manufacturing (MM) is defined as systematic approach to divide, identify and eliminate the process wastages through continuous improvement [Rajab Abdullah Hokoma]. Module is the Pull based lean manufacturing approach, also known as the Toyota Production system, which was established in 1970’s by Taichi Ohno and Shigeo Shingo at Toyota Motor Company [Rajab Abdullah Hokoma]. This results in an integrated and efficient manufacturing environment [Mc Mueller Patrick r.]. Elimination of waste [Womack, J.P and Joes]. Value stream mapping towards the value added and non-value (NV) added activity is very much essential for manufacture a product from raw material to finished product [Rother. M Shook.]. With this understanding one can find out the way to minimize the non-value added activity towards the value chain instead replacing the useful value added activity. In a Lean organization people try to minimize the NV continuously [Rother. M Shook.]. Modular layout divides the manufacturing facilities into small groups called cells which are exclusively utilized for specific task [Nicoletti, and S. Nicosia.]. A cell constitutes of equipment and work stations that are arranged to maintain the smooth of production without much of waiting time [Farwaz A.]. The advantage of this module based layout is to achieve the single piece flow besides improving the productivity and quality of the product, minimizing the WIP, reduce the throughput time and reduce the setup time [Burbidge, J.]. In addition to this the modular layout minimizes the material movement between the production process centres [Thomopoulos, N.T.] and creates better human relation among the members in the cell.

2. Problem definition:

In general, Garment manufacturing is carried out with “Progressive Bundling System (PBS)”. Each PBS is setup for exclusive product. Compare to other sections in the garment production, sewing room handles high skill jobs with high quality requirements. PBS system generates high amount of WIP, thus throughput time as well as the rework time area alarmingly high. Line balancing between the operations is a critical task, with defective parts being hidden in between the products, so that many garment professionals work like fire fighters. Secondly PBS system does not provide flexibility, which is the current requirement in the garment industry with decreasing order size and increasing the number of styles. To meet such requirement product layout should be designed for minimum WIP between the processes creating flexibility to change the order quickly with minimum line setting time.

3. Approach:

The Present Study covers detailed value stream mapping (VSM) of existing production facility of T-shirt Manufacturing units at Bangalore based...
PRODUCTIVITY IMPROVEMENT THROUGH MODULAR LINE IN GARMENT INDUSTRIES

Garment factory in India to understand the parameters responsible increase in WIP between the processes in the present system of VSM. It is also aimed to examine some of the suitable Lean tools and techniques to adopt and propose the new system of value stream mapping. Finally the variations in the WIP between the both the systems is to be compared.

4. Value Stream Mapping:

VSM has been designed based on the data collected from the Sewing room of the Garment factory such as basic pitch time (BPT) of each operation, personal fatigue allowance (PFA) of the operator who is performing the particular task in the Production line. PFA is derived concern based on the operation criticality. Time study & Method study are conducted on the floor for each operation in the T-Shirt production line observations are made on hourly production as well as total production in a specified time for the entire product line for better results, each operation is repeated for at least 15 cycles. With the Support of BPT and Personal Fatigue Allowance (PFA), Cycle time between the operations is found and tabulated (Table 1).

4.1 Cycle time

It is defined as how frequently a finished product comes out from the production facility. Cycle time includes all types of delays take place while completing a job.

4.2. Basic Pitch Time (BPT):

It is defined as the time required to perform a task by a normal operator working at a standard pace with no allowance for personal delays, unavoidable delays or fatigue [Khanna].

4.3. Standard Pitch Time (SPT):

It is defined as the amount of time required to complete a unit of work, (a) under existing working conditions, (b) using a specified method or machinery, (c) by an operator able to do the work in a proper manner and (d) at a standard place (rate) [Khanna]

4.4. Standard allowed minutes (SAM):

Standard allowed minutes (SAM) = (Basic minute + Bundle allowances + machine and personal allowances). Add bundle allowances (10%) and machine and personal allowances (20%) to basic time. Now you got Standard Minute value (SMV) or SAM.

4.5. New (Proposed) Value stream mapping with modular Layout:

The proposed VSM has been developed for the same product by segregating the similar operation together. By keen observation on the existing VSM it is understood that many operations are non value added (NV) activities. As many of these NV activities have been eliminated in the proposed VSM. In addition to this looking at the current state map, (a) large inventories i.e. up to nearly 400 in Numbers to be maintained (b) Higher production lead time i.e. nearly 2 days require to deliver the first piece from the supply chain. Inventory and Lead time may be viewed as two related issues [Farwaz A.]. For creating new ideal VSM, modular layout is utilized. Unlike PBS system the cellular layout is like a U-shaped modular. As the figure 1. BPT and personal fatigue allowance (PFA) of cycle time between the operations are evaluated for the proposed VSM and is tabulated (Table 2, 3 & 4.)

4.5.1. Grouping the Manufacturing Operations:

The first step in the proposed VSM is grouping of similar operations in the production in the present case 3 different cells are created: (a) Shoulder joining cell (b) Neck attachment cell (c) Sleeve and hem attachment cell. In general any garment contains these three important components where as the style with in the components may differ drastically. So these 3 modules can be utilized to prepare any kind of knitted men’s Top garment in figure 1.

4.5.2. U-shaped Modular Layout:

(i). Since the existing progressive bundle system creates higher work in process (WIP) critical analysis is done to minimize the WIP, which in turn affect the internal inventory as well as the manufacturing cost subsequently. As per the earlier literature U-Shaped modular layout minimize the WIP significantly and proposed modular layout is shown figure 1.
ii). In new modular layout some of the operations are removed from the existing layout. First Quality check points are removed as the initial operator should be aware of quality standard. On need basis some of the operations are combined in this new layout for e.g., in the existing layout there are two operations via front and back matching and shoulder joining where as in the proposed layout these two are is combined to form a single operation.

(iii). this eliminates movement from preparatory to assembly. This layout does not require WIP storage area. Operators are not allowed to build WIP, rather they change their operation immediately if WIP seems increasing. Quality checkers are completely removed from the operation so that the operator is solely responsible for the quality as well.

4.5.3 Work balancing between operators

After defining work flow balancing, the work load among the operators is a big challenge. Each operator to be assigned equal amount of work and to achieve this few key changes are made.

(i). All sitting operations are converted into stand up operations or rotary sitting chair has been utilized. This helps to travel between machines easily so that operator can handle multiple operations.

(ii). Operator to be trained in 3 to 4 operations of his/her respective workcell. This helps the operator to rotate between the operations which is called cross training.

(iii). To create pull based system. By which the capacity of the final cell is marginally increased compared to other cells so that other cells produce more.

(iv). Number of operations are made less than the work stations which help in balancing the work load between the operators by rotating them. Floating balance is shown in figure-1.

5. Equations:

Basic Pitch Time (B.P.T) = Observed Time X Rating in Percent/100................................. (i)


Standard allowable minutes (SAM) = (Basic minute + Bundle allowances + machine and personal allowances)............................................. (iii)

Target = Line Efficiency = 

\[
\text{Target} = \frac{\text{Total manpower} \times \text{Total working minutes/day}}{\text{SAM(Standard allowed minutes)}}
\]

\[
\text{Line Efficiency} = \frac{\text{Total output per day} \times \text{SAM}}{\text{Total man power per line} \times \text{X100}}
\]

Theoretical Manpower = 

\[
= \frac{\text{Bench mark target/hour}}{\text{Process capacity/hour}}
\]

5.1. Sample Calculations from Table-1:

(i) (B.P.T) = Observed Time X Rating in Percent/100

= 0.83 X 110/100 = 0.913min = 54.78sec

From equation (ii)

(ii) S.P.T = 0.913 + 0.913 X 20/100 = 1.5min., = 65.76Sec

(iii) S.A.M = 0.913 + 0.913 X 0.1 + 0.913 X 2 = 71.20sec

= 1.12min.,

Capacity per hour = total time require to finish the task/S.P.T = 60/1.5 = 40 pieces

From equation (iv)

Target = \(\frac{37 \times 600}{11.12}\) = 1996 pieces

From equation (vi)

Theoretical manpower = 250/40 = 6.25 = 7 Operators

Line Efficiency: \(= \frac{1996}{1996} \times 100 = 99.5\%

5.2. Revised VSM through Modular Layout (T-shirt production)

(i) Basic Pitch Time (B.P.T) = .89 X 110/100 = .979 min


= .979 + .979 X 10/100 = 1.06 min = 66 Sec

(iii) S.A.M = .973 + .973 X 0.1 + .973 X 2 = 86.20 Sec

= 1.26 min.

Capacity per hour for 3 machines = total time require to finish the task/S.P.T

For one machine = 60/1.06 = 56.60

For 3 machines = 56.60 X 3 = 169.81

(iv) Target = \(\frac{6 \times 600}{126}\) = 2857 pieces

(v) Theoretical Manpower = (Bench mark target per hour) / (Process capacity per hour) = 250/56.60 = 4.47 = 5 Operators

(vi) Line Efficiency: \(= \frac{\text{Total output per day per line} \times \text{SAM}}{\text{Total man power per line} \times \text{X100}}
\]

\[
\text{line Efficiency: } = \frac{2857 \times 1.269}{6 \times 600} \times 100 = 97\%
\]
Table 1-Value Stream of Existing T-Shirt Production line.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Operator Name</th>
<th>Process</th>
<th>Operator involvement</th>
<th>Helper involvement</th>
<th>B.P.T</th>
<th>Allowances</th>
<th>S.P.T</th>
<th>Capacity/hr.</th>
<th>WIP between operations</th>
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<tr>
<td>1</td>
<td>A1</td>
<td>Front back matching</td>
<td>0</td>
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<td>.83</td>
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<td>.99</td>
<td>60.2</td>
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<td>2</td>
<td>A2</td>
<td>Shoulder joint</td>
<td>1</td>
<td>0</td>
<td>.287</td>
<td>15</td>
<td>.330</td>
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<td>15</td>
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<tr>
<td>3</td>
<td>A3</td>
<td>Shoulder cut mark</td>
<td>0</td>
<td>1</td>
<td>.215</td>
<td>20</td>
<td>.25</td>
<td>232.5</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>A4</td>
<td>Shoulder top stitching</td>
<td>1</td>
<td>0</td>
<td>.248</td>
<td>20</td>
<td>.297</td>
<td>201.6</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>A5</td>
<td>Thread cut</td>
<td>0</td>
<td>1</td>
<td>.238</td>
<td>20</td>
<td>.285</td>
<td>210.0</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>A6</td>
<td>Make care label</td>
<td>1</td>
<td>0</td>
<td>.138</td>
<td>20</td>
<td>.165</td>
<td>362.3</td>
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<tr>
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<td>join Label stitch</td>
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<td>.163</td>
<td>20</td>
<td>.195</td>
<td>306.7</td>
<td>15</td>
</tr>
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<td>A8</td>
<td>Neck rib make width</td>
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<td>.242</td>
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<td>14</td>
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<td>9</td>
<td>A9</td>
<td>Neck rib fold tack</td>
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<td>.267</td>
<td>224.2</td>
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<td>.274</td>
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<td>12</td>
<td>B2</td>
<td>Cut will tape</td>
<td>0</td>
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<td>.194</td>
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<td>.232</td>
<td>257.7</td>
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<td>13</td>
<td>B3</td>
<td>Back neck elastic tape joint</td>
<td>1</td>
<td>0</td>
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<td>3</td>
<td>0</td>
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<td>20</td>
<td>1.08</td>
<td>55.24</td>
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<td>B5</td>
<td>Main label position mark</td>
<td>0</td>
<td>1</td>
<td>.209</td>
<td>20</td>
<td>.250</td>
<td>239.2</td>
<td>14</td>
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<tr>
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<td>B6</td>
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<td>0</td>
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<td>.215</td>
<td>20</td>
<td>.258</td>
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<td>B7</td>
<td>Match sleeve pair</td>
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<td>1</td>
<td>.143</td>
<td>20</td>
<td>.171</td>
<td>349.6</td>
<td>16</td>
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<tr>
<td>18</td>
<td>B8</td>
<td>Match sleeve and body</td>
<td>0</td>
<td>1</td>
<td>.159</td>
<td>20</td>
<td>.190</td>
<td>314.4</td>
<td>13</td>
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<td>B9</td>
<td>sleeve joint</td>
<td>2</td>
<td>0</td>
<td>.829</td>
<td>15</td>
<td>.953</td>
<td>62.93</td>
<td>18</td>
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<tr>
<td>20</td>
<td>B10</td>
<td>Body turn</td>
<td>0</td>
<td>1</td>
<td>.244</td>
<td>20</td>
<td>.292</td>
<td>204.9</td>
<td>12</td>
</tr>
<tr>
<td>s.no</td>
<td>operation process</td>
<td>machine</td>
<td>operator</td>
<td>Helper/inspector</td>
<td>B.T.</td>
<td>Cycle time</td>
<td>No. of m/c s available in Cap. hour</td>
<td>Total WIP b/w the operation</td>
<td>Total WIP b/w the operation</td>
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<td>---------</td>
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<td>1.00</td>
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<td>.201</td>
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<td>Flat lock</td>
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<td>.273</td>
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<td>0</td>
<td>Flat lock</td>
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<td>20</td>
<td>.630</td>
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<td>.689</td>
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<td>.825</td>
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<td>.286</td>
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<td>.333</td>
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<td>21</td>
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<td></td>
<td>9.77</td>
<td>12.1</td>
<td>Mean WIP</td>
<td>419</td>
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Table 2. Revised Value Stream Mapping through Modular Layout(T-Shirt production Line).
6. Results:

Implementation of Lean approach to production process in a T-Shirt based Garment industry has reduced the WIP significantly. A cycle reading taken at various levels of the cellular layout shows that nearly 70% to 80% WIP is reduced from the PBS Layout to Lean based cellular layout. By reducing various Non-Value activities in the Cellular layout the production lead time is reduced from 2 days to 20 min, which would enhance the manufacturer to go with short term order quantity also. Since this cellular layout ensures the floating balance the change in pitch time is around 69% as compared to PBS type of layout.

7. Conclusions:

Modular or cellular manufacturing implementation technique is the Garment sector in customized way has reduced the WIP drastically. High WIP is a big concern for the apparel manufacturers in India. It can be concluded from the observations made that Lean initiative can address the present manufacturing issues like minimizing WIP & Pitch time, cost of manufacturing and Manufacturing cycle time.

References:

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