Implementation of JIT to increase productivity in sewing section of a garment industry

1Israt Parveen, 1Md. Arif Mia, 1Md. Sujan Ali, 1Khandoker Rafsun-Ul-Hasan, 1Md. Moshiur Rahman, 1Md. Iqbal Mahmud* and 2Haeng Muk Cho

1Department of Textile Engineering, Mawlana Bhashani Science and Technology University
Santosh, Tangail-1902, Bangladesh

2Department of Mechanical Engineering, Kongju National University
275, Budae-dong, Cheonan-si, Chungcheongnam-do 331-717, South Korea

Email: isratc3@gmail.com, arifjoutuk@gmail.com, sujane13036@gmail.com, rafsunulhasan@gmail.com, khanshishir@gmail.com, mimchanchal@gmail.com, haengmukcho@hanmail.net

*Corresponding author: mimchanchal@gmail.com

Abstract

On time delivery with quality and quantity is important for any manufacturing industry, especially in garment sectors. At present, in RMG industries, lead time is decreasing day by day and customer requirements also continuously changing. The primary objective of this study is to identify the defects in sewing sections that hinders the overall productivity of garments industry in Bangladesh and find out the ways how to reduce those defects in sewing line by implementing Just-in-Time (JIT) techniques. Three different product lines (Jacket, Polo shirt, and T-shirt) have been considered to implement this study. The sample respondents were selected from a reputed textile industry in Bangladesh. Purposive sampling technique is followed by data collection from sewing section and indication of major problems. After indication, improvement proposal is given to the industry from which the productivity as well as line efficiency has compared before and after applying the techniques. The output of the study includes the production capacity, line target, line efficiency, line performance of the respective sewing section that has been increased far well than before within the time duration of three months. It is also suggested that, different techniques like process integration, job sharing, multitasking etc. can also be implemented if responsible authorities of garments industry try to improve the current state situation.

Keywords
Just-in-Time (JIT), Lean manufacturing, Operation layout, Line efficiency, Productivity.

1. Introduction

As the labor wage is increasing in developing countries, the apparel manufacturing has been migrating from the high wage developed country to low wage developing countries. Even the labor cost is cheaper than in developed countries due to the specific market nature of the garment industries. For example, the short production of life cycle, high volatility, low predictability, high level of impulse purchase, the quick market response: garment industries are facing the greatest challenges these days (Lucy Daly and Towers, 2004). Nowadays industries are getting more volumes (orders), but number of styles they have to handle has increased drastically. In recent day, due to small order quantities and complex designs, the garments industry has to produce multiple styles even within a day; this needs higher flexibility in volume and style change over.
In Bangladesh industries have been running in a traditional way for years and rigid to change. Industry owners are happy as long as the business is sustainable. Now the time has come to struggle with global market in garment industries if the owners want to run it further. The best way to cope with all these challenges is the implementation of lean manufacturing. Its implementation has contributed to the success of many organizations and is used by companies worldwide. JIT is an all-encompassing philosophy that is founded on the concept of eliminating waste. The word waste might make one think of garbage, or paper, or inventory. The broad view of JIT is now often termed lean production or lean systems. If this concept is properly maintained, they will serve the purpose of flexibility and save a lot of money by reducing production lead time, reducing inventory, increasing productivity, training operators multiple works and by rework.

2. Methodology

2.1 Management idea that attempts to eliminate wastes

It is a management idea that attempts to eliminate sources of manufacturing waste by producing the right part in the right place at the right. In the manufacturing process size of batches are related to potential errors in part/production, i.e., smaller batches such as used in JIT systems will potentially reduce the average error per part/production population.

![Management ideas to eliminate waste](image)

2.2 JIT Distribution

JIT’s effectiveness depends heavily on having a strategy alliance between buyers and suppliers. JITD requires the exchange of frequent, small lots of items between suppliers and customers, and must have an effective transportation management system, because inbound and outbound material can have a great effect on production when there is no buffer inventory.

2.3 JIT Purchasing: The Idea of JITP runs counter to the traditional purchasing practices where materials are brought well in advance before their use. Under this, the supplier selection, product development and production lot sizing become very critical. Implementation of JIT in sewing line basically explains (a) Reduction of waste of motion; (b) Reduction of waste in waiting time; (c) Reduction of waste of inventory; (d) Reduction of waste of defects
2.4 Way to reduce waste of motion
Whilst there will always be some form of motion within process it should be minimized as much as possible, both to reduce overburden and to improve efficiencies; this is a benefit to employees as it is making their work easier. The simplest and most powerful tool eliminate the waste of motion within work cells is that of 5S; 5S challenges the team to review each and every step of operation and eliminate the symptoms of the wastes. These changes will on the whole cost nothing other than the time of team but will result in efficiency gains in the order of 10% to 30% in most cases as well as making work area safer preventing accidents (and the law suit that follows.)
5S also starts the ball rolling with regard to standardized operations; it should lead to develop standard operating procedures (SOP) for your processes defining the best way to conduct a specific operation.
The tool of single minute exchange of Die (SMED) will also remove many wasteful motions from setup process, using similar principles to 5S; they are applied to the setup process of work and will often reduce setups from hours to single minutes.
Motion is a significant factor within the seven wastes and every effort should be made to remove it from processes to both increase efficiencies as well as make work easier for all those involved.

2.5 Way to reduce waste in waiting time
- Balancing of production processes using Takt time and Yamazumi boards will help ensure that the processes are better matched with regards to cycle times.
- Improving machine reliability and quality using Total Productive Maintenance (TPM) and quality tools.
- Reducing overproduction and inventory to minimize transport and movement between and within cells.
- Implement Standard Operating Procedures to ensure that standards and methods are clear.
- Use visual methods of planning combined with daily cell meetings to ensure that everyone is clear what is required for the day.

2.6 Way to reduce waste of inventory
The first thing is to work to the main principles of making value flow at the pull of the customer, the idea of Just in Time (JIT) production. This will cause to remove the main cause of inventory that of overproduction. Factory and cell layout should be followed and then balancing production processes to ensure that work in progress does not build up between processes, it is not important to run every machine as fast as it can be run, at the end of the day it is important to make things as quickly as the customer wants them, no faster; talk time (the time interval between customer call off) and Kanban can be used to help ensure that we balance our processes and prevent the buildup of inventory.

2.7 Way to reduce waste of Defects
This prevention of defects is achieved by a number of different techniques from automation /Jidoka (Machines with “human” intelligence that are able to detect when a non-standard event has occurred) through to Pokayoke devices that detect if a product is defective, either preventing the process from running or highlighting the defect for action.
In this project work, standard operations procedures (SOP) implemented and training provided to ensure that the correct methods are undertaken and standards achieved. The most important factor however is the empowerment of teams to solve and prevent their own problems. By harnessing the talents of employees it would be able to quickly and efficiently prevent the occurrence of defects.
Flow Chart of Current Traditional line layout

Figure 2.2: Flow Chart of Current Traditional line layout

Improvement areas of JIT in Sewing Section

- Not multi-tasking practices
- Using helper for front and back match
- Using helper for body with sleeve match
- Surging of cuff and collar
- Don’t thread trimming by operator
- No bundle wise flow in sewing line from beginning to ending
- Less use of guide, folder and attachment
- Bundle pickup, dispatch and arranging system is not proper way i.e. disorganized way
- Not to use laser for marking
- Less Job sharing practices
- Not multi-machine operating by one worker
- There is a transportation and waiting time from sewing to fusing section.
3. Data analysis and findings

Before implementation layout data

<table>
<thead>
<tr>
<th>SI No</th>
<th>Operation Description</th>
<th>M/C Name</th>
<th>Cycle Time (in sec)</th>
<th>AVG. Time (Sec)</th>
<th>AVG.Time (Min)</th>
<th>AVG. Time with 15% allowance</th>
<th>Rating%</th>
<th>SMV</th>
<th>Capacity /Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1  2  3  4  5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Label Making</td>
<td>SN</td>
<td>11 12 17 13 13 13</td>
<td>0.22</td>
<td>0.253</td>
<td>80% 0.22</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Back Side Label</td>
<td>SN</td>
<td>12 17 11 13 14</td>
<td>0.23</td>
<td>0.2645</td>
<td>80% 0.21 286</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Moon Join</td>
<td>SN</td>
<td>16 15 14 15 15 15</td>
<td>0.25</td>
<td>0.2875</td>
<td>80% 0.23 261</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Placket Join</td>
<td>SN</td>
<td>16 17 18 17 16 16</td>
<td>0.27</td>
<td>0.3105</td>
<td>80% 0.25 240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Nose Tack</td>
<td>SN</td>
<td>11 13 12 11 12 12</td>
<td>0.2</td>
<td>0.23</td>
<td>80% 0.18 333</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Shoulder Join</td>
<td>O/L</td>
<td>18 17 21 16 18 18</td>
<td>0.3</td>
<td>0.345</td>
<td>80% 0.28 214</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Collar Servicing</td>
<td>O/L</td>
<td>4 4 3 4 6 4</td>
<td>0.07</td>
<td>0.0805</td>
<td>80% 0.06 1000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Collar Tack</td>
<td>SN</td>
<td>14 15 13 14 14 14</td>
<td>0.23</td>
<td>0.2645</td>
<td>80% 0.21 286</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Collar Join</td>
<td>O/L</td>
<td>13 16 17 16 14 15</td>
<td>0.25</td>
<td>0.2875</td>
<td>80% 0.23 261</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Collar Piping</td>
<td>PIPING</td>
<td>10 12 12 13 16 13</td>
<td>0.22</td>
<td>0.253</td>
<td>80% 0.2 300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Placket Kacha Topstitch</td>
<td>SN</td>
<td>23 17 15 15 17 17</td>
<td>0.28</td>
<td>0.322</td>
<td>80% 0.26 231</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Placket 1/16</td>
<td>SN</td>
<td>13 16 19 17 18 17</td>
<td>0.28</td>
<td>0.322</td>
<td>80% 0.26 231</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Back Neck Tape Topstitch</td>
<td>SN</td>
<td>15 13 16 14 13 14</td>
<td>0.23</td>
<td>0.2645</td>
<td>80% 0.21 286</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Placket Box</td>
<td>SN</td>
<td>15 17 15 17 16 16</td>
<td>0.27</td>
<td>0.3105</td>
<td>80% 0.25 240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Sleeve Hem</td>
<td>F/L</td>
<td>7 7 8 9 8 8</td>
<td>0.13</td>
<td>0.1495</td>
<td>80% 0.12 500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Sleeve Match &amp; Shoulder Scissoring</td>
<td>H</td>
<td>21 16 23 19 21 20</td>
<td>0.33</td>
<td>0.3795</td>
<td>80% 0.3 200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Sleeve Join</td>
<td>O/L</td>
<td>23 23 30 33 30 28</td>
<td>0.47</td>
<td>0.5405</td>
<td>80% 0.43 140</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Side Join</td>
<td>O/L</td>
<td>33 38 39 42 36 38</td>
<td>0.63</td>
<td>0.7245</td>
<td>80% 0.58 103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Chap Tack</td>
<td>SN</td>
<td>20 21 23 18 22 21</td>
<td>0.35</td>
<td>0.4025</td>
<td>80% 0.32 188</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Placket End Tack</td>
<td>SN</td>
<td>15 17 20 23 14 18</td>
<td>0.3</td>
<td>0.345</td>
<td>80% 0.28 214</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Bottom Hem</td>
<td>F/L</td>
<td>10 13 14 15 16 14</td>
<td>0.23</td>
<td>0.2645</td>
<td>80% 0.21 286</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Button Hole</td>
<td>Button Hole</td>
<td>15 14 15 17 17 16</td>
<td>0.27</td>
<td>0.3105</td>
<td>80% 0.25 240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Button Attach</td>
<td>Button Attach</td>
<td>15 18 21 20 20 19</td>
<td>0.32</td>
<td>0.368</td>
<td>80% 0.29 207</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Thread Cutting</td>
<td>H</td>
<td>25 20 20 18 21 21</td>
<td>0.35</td>
<td>0.4025</td>
<td>80% 0.32 186</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Button Close</td>
<td>H</td>
<td>10 8 12 13 14 11</td>
<td>0.19</td>
<td>0.2185</td>
<td>80% 0.17 353</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© IEOM Society International
After implementing layout plan & data

Table 2: After Implementation layout plan and data

<table>
<thead>
<tr>
<th>Style No</th>
<th>BSS-0378</th>
<th>Buyer</th>
<th>Brand Machine Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S.M.V.</td>
<td>5.75</td>
</tr>
<tr>
<td>Current Production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observer</td>
<td></td>
<td>Line</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Operation Description</th>
<th>M/C Name</th>
<th>Cycle Time (in sec)</th>
<th>AVG. Time (Sec)</th>
<th>AVG.Time (Min)</th>
<th>AVG. Time with 15% allowance</th>
<th>Rating %</th>
<th>SMV</th>
<th>Capacity /Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Label Making</td>
<td>SN</td>
<td>12 10 11 12 11 11</td>
<td>0.18</td>
<td>0.207</td>
<td>80%</td>
<td>0.17</td>
<td>353</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Back Side Label Join at Moon</td>
<td>SN</td>
<td>13 15 11 12 14 13</td>
<td>0.22</td>
<td>0.253</td>
<td>80%</td>
<td>0.2</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Moon Join</td>
<td>SN</td>
<td>14 11 15 11 12 13</td>
<td>0.22</td>
<td>0.253</td>
<td>80%</td>
<td>0.2</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Placket Join</td>
<td>SN</td>
<td>17 15 14 16 13 15</td>
<td>0.25</td>
<td>0.2875</td>
<td>80%</td>
<td>0.23</td>
<td>261</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Nose Tack</td>
<td>SN</td>
<td>10 12 11 10 11 11</td>
<td>0.18</td>
<td>0.207</td>
<td>80%</td>
<td>0.17</td>
<td>353</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Shoulder Join</td>
<td>O/L</td>
<td>16 14 17 14 15 15</td>
<td>0.25</td>
<td>0.2875</td>
<td>80%</td>
<td>0.23</td>
<td>261</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Collar Servicing</td>
<td>O/L</td>
<td>5 4 3 3 4 4</td>
<td>0.07</td>
<td>0.0805</td>
<td>80%</td>
<td>0.06</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Collar Tack</td>
<td>SN</td>
<td>14 12 11 13 12 12</td>
<td>0.2</td>
<td>0.23</td>
<td>80%</td>
<td>0.18</td>
<td>333</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Collar Join</td>
<td>O/L</td>
<td>13 14 16 14 13 14</td>
<td>0.23</td>
<td>0.2645</td>
<td>80%</td>
<td>0.21</td>
<td>286</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Collar Piping</td>
<td>PIPING</td>
<td>10 12 11 13 12 12</td>
<td>0.2</td>
<td>0.23</td>
<td>80%</td>
<td>0.18</td>
<td>333</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Placket Kacha Topstitch</td>
<td>SN</td>
<td>21 16 14 15 15 16</td>
<td>0.27</td>
<td>0.3105</td>
<td>80%</td>
<td>0.25</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Placket 1/16</td>
<td>SN</td>
<td>13 16 15 14 18 15</td>
<td>0.25</td>
<td>0.2875</td>
<td>80%</td>
<td>0.3</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Back Neck Tape Topstitch</td>
<td>SN</td>
<td>14 15 12 13 12 13</td>
<td>0.22</td>
<td>0.253</td>
<td>80%</td>
<td>0.2</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Placket Box</td>
<td>O/L</td>
<td>15 14 16 15 14 15</td>
<td>0.25</td>
<td>0.2875</td>
<td>80%</td>
<td>0.23</td>
<td>261</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Sleeve Hem</td>
<td>F/L</td>
<td>7 7 6 8 7 7</td>
<td>0.12</td>
<td>0.138</td>
<td>80%</td>
<td>0.11</td>
<td>545</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Sleeve Match &amp; Shoulder Scissoring</td>
<td>H</td>
<td>18 15 17 15 16 16</td>
<td>0.27</td>
<td>0.3105</td>
<td>80%</td>
<td>0.25</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Sleeve Join</td>
<td>O/L</td>
<td>25 24 23 23 24 24</td>
<td>0.4</td>
<td>0.46</td>
<td>80%</td>
<td>0.37</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Side Join</td>
<td>O/L</td>
<td>33 32 31 32 32 32</td>
<td>0.53</td>
<td>0.6095</td>
<td>80%</td>
<td>0.49</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Chap Tack</td>
<td>SN</td>
<td>20 19 21 18 22 20</td>
<td>0.33</td>
<td>0.3795</td>
<td>80%</td>
<td>0.3</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Placket End Tack</td>
<td>SN</td>
<td>15 18 15 16 16 16</td>
<td>0.27</td>
<td>0.3105</td>
<td>80%</td>
<td>0.25</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Bottom Hem</td>
<td>F/L</td>
<td>11 13 14 13 15 13</td>
<td>0.22</td>
<td>0.253</td>
<td>80%</td>
<td>0.2</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Button Hole</td>
<td>Button Hole</td>
<td>15 14 15 16 16 15</td>
<td>0.25</td>
<td>0.2875</td>
<td>80%</td>
<td>0.23</td>
<td>261</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Button Attach</td>
<td>Button</td>
<td>17 18 20 17 18 18</td>
<td>0.3</td>
<td>0.345</td>
<td>80%</td>
<td>0.28</td>
<td>214</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Thread Cutting</td>
<td>H</td>
<td>22 20 18 19 21 20</td>
<td>0.33</td>
<td>0.3795</td>
<td>80%</td>
<td>0.3</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Button Close</td>
<td>H</td>
<td>11 10 8 9 12 10</td>
<td>0.17</td>
<td>0.1955</td>
<td>80%</td>
<td>0.16</td>
<td>375</td>
<td></td>
</tr>
</tbody>
</table>
3.1 Ways of reducing WIP

**Proper job distribution and line balancing**
To reduce WIP it is important properly work distribution. Without proper work balance & line balance there will be a bottleneck and it will create the WIP.

**Keep 10 pieces bundling system**
If 25 or more pieces are kept in one bundle, it will create WIP in lines. Lean concept is a single piece flow in assembly line and if it cannot be done then it is needed to keep it as much as low quantity. In most of the knit factory in Bangladesh, production quantity is generally higher than others. For this reason, small quantity bundle is difficult. So in that case, target should be to keep the bundle size minimum 10 pieces, which will be helpful for maintaining WIP minimum quantity level.

**Maintaining two bundle flows**
In traditional system there is no control of bundle flow. In this project work, there was maintained two bundle flow from the starting to ending. So that, controlling of line WIP, identifying the bottleneck process, balancing the line would be easy.

**Implementation of traffic light system**
It is a quality system designed to identify problems and get help from management to solve those problems. The purpose of this system is to identify quality problems within the needlepoint and to immediately give remedies to stop it from recurring. The chart always starts with YELLOW and moves to either RED or GREEN but will never directly between RED and GREEN. In other words RED and GREEN are always separated by YELLOW.

![Figure 3.1: SOP of Traffic Light System for maintaining quality](image-url)
4. Results and discussion

SMV calculation is used for determining workers efficiency, line capacity of a factory unit. It can determine the efficiency of production line, production cost. What should be the production target for the specific operation & for the production line of a specific style can also be measured by using SMV.

4.1 Production capacity calculation

Before JIT implementation,

\[
\text{Production capacity per hour (in pcs)} = \frac{\text{Total man power } \times \text{ working hour } \times 60}{6.29} \times \text{ Line efficiency\%}
\]

\[
= \frac{25 \times 1 \times 60}{6.29} \times 61\%
\]

\[
= 145.4689 \text{ Pcs}
\]

\[
\approx 146 \text{ Pcs}
\]

∴ Production Capacity per shift (in pcs) = (146 \times 8) \text{ Pcs}

\[
= 1168 \text{ Pcs}
\]

After JIT implementation,

\[
\text{Production capacity per hour (in pcs)} = \frac{\text{Total man power } \times \text{ working hour } \times 60}{5.75} \times \text{ Line efficiency\%}
\]

\[
= \frac{25 \times 1 \times 60}{5.75} \times 61\%
\]

\[
= 160 \text{ Pcs}
\]

∴ Production Capacity per shift (in pcs) = (160 \times 8) \text{ Pcs}

\[
= 1280 \text{ Pcs}
\]

∴ Increased production per shift (in pcs) = (1280 – 1168) \text{ Pcs}

\[
= 112 \text{ Pcs}
\]

After calculation, Production capacity per shift 1168 pcs and after JIT implementation production capacity per shift is 1280 Pcs and production per shift increased by 112 Pcs.

4.2 Line target calculation

Before JIT implementation:

\[
\text{Line Target per hour} = \frac{\text{Total man power } \times \text{ Working hour } \times 60}{6.29}
\]

\[
= \frac{25 \times 1 \times 60}{6.29}
\]

\[
= 238.4738 \text{ Pcs}
\]

\[
\approx 239 \text{ Pcs}
\]

Line Target per shift = (239 \times 8) \text{ Pcs}

\[
= 1912 \text{ Pcs}
\]

After JIT implementation:

\[
\text{Line Target per hour} = \frac{\text{Total man power } \times \text{ Working hour } \times 60}{5.75}
\]

\[
= \frac{25 \times 1 \times 60}{5.75}
\]

\[
= 260.8696 \text{ Pcs}
\]

\[
\approx 261 \text{ Pcs}
\]

Line Target per shift = (261 \times 8) \text{ Pcs}

\[
= 2088 \text{ Pcs}
\]

∴ Increased line target per shift = (2088 – 1912) \text{ Pcs}
Before JIT implementation the line target was 1912 Pcs and after JIT implementation the line target became 2088 Pcs. Line target per shift increases by 176 Pcs.

4.3 Line efficiency calculation

Before JIT implementation-

\[
\text{Line Efficiency per hour (\%)} = \frac{\text{Total production} \times SMV}{\text{Total man power} \times \text{Working hour} \times 60} \times 100
\]

\[
= \frac{146 \times 6.29}{25 \times 1 \times 60} \times 100
\]

\[
= 61.22\%
\]

After JIT implementation-

\[
\text{Line Efficiency per hour (\%)} = \frac{\text{Total production} \times SMV}{\text{Total man power} \times \text{Working hour} \times 60} \times 100
\]

\[
= \frac{160 \times 5.75}{25 \times 1 \times 60} \times 100
\]

\[
= 61.33\%
\]

∴ Increased Line Efficiency per hour (\%) = (61.33-61.22) \%

= 0.11\%

Before JIT implementation the Line efficiency per hour was 61.22\% and after JIT implementation the line efficiency become 61.33 \%. Line efficiency per hour increased by 0.11\%.

4.4 Line performance calculation

Before JIT implementation-

\[
\text{Line Performance per hour (\%)} = \frac{\text{Line Output} \times 100}{\text{Line Target}}
\]

\[
= \frac{146 \times 100}{239}
\]

\[
= 61.09\%
\]

After JIT implementation-

\[
\text{Line Performance per hour (\%)} = \frac{\text{Line Output} \times 100}{\text{Line Target}}
\]

\[
= \frac{160 \times 100}{261}
\]

\[
= 61.30\%
\]

∴ Increased Line Performance per hour (\%) = (61.30 – 61.09) \%

= 0.21\%

Before JIT implementation Line Performance was 61.09\% and after JIT implementation Line Performance become 61.30\%. The increased Line Performance per hour was 0.21\%. 
4.5 Column chart for comparison of production capacity

![Comparison of Production Capacity](image)

Figure 4.1: Production capacity before and after JIT implementation.

4.6 Column chart for comparison of line target

![Comparison of Line Target](image)

Figure 4.2: Line target before and after JIT implementation.

4.7 Column chart for comparison of line efficiency

![Comparison of Line Efficiency](image)

Figure 4.3: Line efficiency before and after JIT implementation.

4.8 Column chart for comparison of line performance

![Comparison of Line Performance](image)

© IEOM Society International
5. Conclusion

The standard minute value (SMV) is a visualization tool and its goal is to identify, demonstrate and elimination of waste in the process. Before eliminating waste, we must be able to see it. SMV can serve as a starting point to help management, engineers, production associates, schedulers, suppliers, and customers, recognize waste and identify its causes. Before implementation of tools & techniques of JIT training were provided to the people specially supervisor and make them knowledgeable about different types of waste and how to identify waste also reduce waste. Operator also trained on kaizen how small change make work simple and improve visibility of off-standards and they were introduced to changing for better.

In current state assessment it was found that Production Capacity per shift (in pcs) is 1168, line efficiency 61.22% which shows huge opportunities for improvement in those areas. It has started with 5 pieces bundling system in sewing section and then following up the line regularly and capacity study from time to time. After implementation of team work, process integration, job sharing, multi machine operating and balancing the task, eliminating unnecessary activities, team has achieved 61.33%-line efficiency, Production capacity per shift (in pcs) 1280. Besides defects, WIP, transportation also reduced than previous traditional systems.

The study was done with a limited scope as there were limited time and restriction of permission from industrial authority during research work .As industry always go for profit, desired production line allocation were also quite difficult for collecting data. Future work may include super market pull between cuttings and sewing section .Also implementation of SMV and Kanban system to keep WIP at minimum level. The future work may include helper less zero defect line where each operator will be the quality at the source and creation of standard operating procedure (SOP) for each sections and for incentive policy also.

References


Shaman Gupta,Sanjib Kumar Jain,The SS and Kaizen concept for overall improvement of the organization::a case study,Int. J. Lean Enterprise Research,Vol.1,No.1,2014


B. Senthil Kumar and Dr.V.R.Sampath, Garments Manufacturing Lean Initiative –An Empirical Study On WIP Fluctuation In T-Shirt Production Unit, International Journal of Lean Thinking, Volume 3, Issue 2, December 2012.


Biographies

Israt Parveen is continuing her M.Sc. in Textile Engineering study in the Department of Textile Engineering at Mawlana Bhashani Science and Technology University. She earned her B.Sc. in Textile Engineering degree from the same university in 2016 and secured the first position in her class. She has published number of journal papers and participated in conferences.

Md. Arif Mia earned his B.Sc. in Textile Engineering from the Department of Textile Engineering of Mawlana Bhashani Science and Technology University in 2017. He is working as a Management Trainee in Southeast Limited, Tangail, Bangladesh.


Khandoker Rafsun-Ul-Hasan earned his B.sc in Textile Engineering in the Department from the Department of Textile Engineering of Mawlana Bhashani Science and Technology University in 2017.

Md. Moshiur Rahman earned his B.sc in Textile Engineering in the Department from the Department of Textile Engineering of Mawlana Bhashani Science and Technology University in 2017.

Professor Dr. Md. Iqbal Mahmud is working in the Department of Textile Engineering at Mawlana Bhashani Science and Technology (MBSTU), Bangladesh. He received his B.Sc. (2002), M.Sc. (2010) and Ph.D. (2015) degree in Mechanical Engineering from Islamic University of Technology (IUT), Bangladesh and Kongju National University (KNU), South Korea respectively. He has published number of research articles in reputed journal and participated in national and international conferences. His teaching and research activities have been focusing on Mechanical Engineering, Industrial Engineering, Renewable Energy, Ergonomics, and Operations Management.

Professor Dr. Haeng Muk Cho is a Professor of Mechanical Engineering and System Design in the division of Mechanical and Automotive Engineering at Kongju National University (KNU), South Korea. His teaching and research activities have been focusing on Internal Combustion Engines, Car Alternative Fuel, Biodiesel, Car Emission Control, Hybrid Vehicles etc.