SMED (Single-Minute Exchange of Die) methodology in Garment manufacturing Industry: Case study in reducing Style Change over Time

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Abstract

Globalization is a major trend in developing countries. Outsourcing of services from developing countries has become the major trend to mainly reap the benefit of cheap labor cost and raw material to a certain extent. As a result, Textile and Garment industry in developing countries like India, China, Philippines and Bangladesh, Sri Lanka etc. have witnessed a major demand from textile giants in USA, UK and other European countries. Shortening of fashion cycle, shortening of lead time, competitive pricing, high quality product, socially and environmentally compliant work place are the emerging trends of Globalization.

On one hand new management philosophies demand that product lead times are kept as small as possible. On the other hand, product customization has increased, thereby increasing the number of parts in a product family. As a result batch sizes have reduced and continue to shrink [4]. Garment manufacturing units in India are embracing and adopting the various new manufacturing concepts like 5S, Kaizen, Poka Yoke, SMED, DMAIC analysis etc. This paper discusses the SMED concept and methodology as customized for reduction of style changeover time in garment manufacturing industry and demonstrates a live case that reduced style change over time. The result achieved showed considerable reduction in delay arising out of machine setting time, batch setting time and demonstration delay.

Keywords: SMED, Style Change over, Garment industry, Manufacturing

1Introduction

India is one of the World’s second largest producers of textiles and garments. Today India is recognized as one of the leading sourcing destinations for readymade garments in both knitted and woven sectors. But Indian Garment industry is facing the greatest challenge from shorter fashion cycle, highly volatile market, higher disposable income and new emerging manufacturing bases emerging all over the globe. Shorter lead time and smaller order quantity is the by product of shorter fashion cycle which in turn demands for a manufacturing layout that is flexible and with efficient and quick response production system. It has become increasingly important to economically manufacture products in smaller and smaller batches. On one hand new management philosophies demand that product lead times (both development and manufacturing times) are kept as small as possible. On the other hand, product customization has increased, thereby increasing the number of parts in a product family. As a result batch sizes have reduced and continue to shrink [6]. Garment manufacturing units in India are embracing and adopting the various new manufacturing concepts like 5S, Kaizen, Poka Yoke, SMED (Single Minute Exchange of die), DMAIC analysis etc. All these efforts are to reduce the through put time of a garment which includes cutting, sewing and packing. With the lead time getting shorter and order quantity getting smaller it has become imperative for manufacturing units to develop flexible production systems and quick change over systems from one style to another. Quantities and complex design the production line setup has shrunk to such level that sometimes a unit might need to produce multiple orders in a single day. This calls for higher flexibility in terms of volume and style change over [1]. Over a period of time it has been realized that there is a huge loss in terms of time and man power in changing a line from one style to another. This is also referred to as the “start-up loss” in the garment industry. SMED is the recent concept adopted by Indian garment manufacturing units to reduce the style change over time which can reduce the startup loss to a considerable extent and manufacturing units can efficiently run smaller order quantity in complicated styles which is the call for the day. This paper discusses the application of SMED concept on reduction of style changeover time and demonstrates a live case that reduced style change over time.
2 SMED and Garment Manufacturing Units

The concept of SMED that was initially used in other manufacturing industry is gaining huge popularity in Garment manufacturing sectors in India. SMED methodology was developed by Shiegeo Shino in Japan from 1950-80s. This methodology can be adopted economically in any manufacturing process without much financial implication. In the garment manufacturing industry, SMED can be applied in the entire supply chain, starting from fabric store to cutting room, to sewing room and as well as finishing and packaging. But most successful application of SMED is to reduce the set up time required to adapt the sewing line from one style to another. Setup time is the time taken to tune and adapt one production line for a new style. It corresponds to the time required to go from the end of the last good part from one batch to the time when the first good part of the new style is produced [4]

Set Up time
End of last good part produced to First good part of new style

SMED methodology in Garment Manufacturing Sewing Floor in general and style change over time in particular

The following steps describe the process reducing style changeover time in Garment manufacturing units.

2.1 Analyze the as is process: The first step is to study and analyze thoroughly the present process. This process would help to identify and separate the non-value added activities in the process that would trigger the areas of improvement.

2.2 Definition of Target Set up Time: It is important to set a target set up time one needs to achieve through the application of SMED. This would be the goal for the team members to achieve. In Garment manufacturing, it would depend on the part of the supply chain and the product. In the style set up time, it would vary from product to product depending on the degree of style variation and capacity of the plant. This would also depend on the phases of SMED application. In a sewing floor, the set up time would range anywhere between half a day to one and half day. Target can be kept as high as 60% to 70% if it is the first time SMED is initiated and subsequently the target would go down as the scope of improvement would get reduced.

2.3 Documenting Elements and Micro elements of batch setting of the existing process: This involves in observing, mapping and documenting the as process of batch setting process. The following things are to be noted – the sequence of work with elements and micro elements well defined with time taken. Then the operators and persons movement are noted to segregate necessary and unnecessary movement in the setup time with the purpose to eliminate unnecessary ones.

2.4 Analysis of the Elements and Micro elements: The machine setup Elements and Micro elements are analyzed so as to distinguish between External and Internal Elements. Internal elements are those where the manufacturing has to come to a halt. External elements are those which can be carried out externally without interfering with the working of the machine. This can be done in two phases-

Phase I: Separation of machine set up elements into External and Internal elements. This can be best done by video recording the process and observing again and again. Then the elements are differentiated into sub elements such as External and Internal process and the wasted time as well as the idle time.

Phase II: From the checklist developed the next important endeavor is to improve the as is style changeover process. This can be achieved by the following method.

- The cycle time for each element is to be noted.
- Brainstorming and discussions should be done to look for scope of improving each element by way of method or process or machine or man improvement. The elements with longer duration should be taken up first followed by next second longest time and so on.
- Developing parallel elements when applicable.
- Reducing human error, reducing time delay due to man power, tools and equipment in availability etc.
- Waste set up time and idle time should be eliminated from the process.
- Finally efforts should be to transform the Internal elements into External Elements.

Phase III: Further steps should be taken to improve the External and Internal elements by means method or process or machine or man improvement.

2.5 Assignment of responsibilities: Finally all the External and Internal Elements are to be listed and responsibilities are to be assigned and a timeline is to be established.

2.6 Implementation of the Plan: The final step is implementation of the planned process and look for continuous improvement.

Real time study in Garment Manufacturing units reveals that time consumed by various activities in batch setting for a style changeover can be classified into 5 major headings – Machine time, Batch Setting Time,
Demonstration time, Time delay due to operator and Run Down Time and Run Up Time.

**Machine time:** Machine time is mainly the time required to set the machine for the new style. Time is also involved in moving the machines from the main shop floor area to the maintenance area and back and rearranging them as per the garment process flow. Most of the time is required in replacing machine with new machine of different specification, setting the machine with folders and attachment as per the new style, setting the stitch length, adjusting the presser foot and minute adjustment for fine tuning etc. Setting folders and attachments consumes huge amount of machine setting time. Reducing machine time requires lots of spare or extra machine so that setting the folders and attachment can be converted into External Element. But there is a need to strike a balance between the two.

**Batch setting time:** Batch setting time can also be assigned as waiting time as it results out of lack of pre-production planning in sewing floor. This is a non-value added activity that can be drastically reduced with proper planning and time & action calendar, checklist, operator’s skill matrix etc. Much of the time is wasted in trying to assemble the required tools, equipment, templates and man power to start the new style. This is due to lack of pre planning for the task of style changeover. It is observed that huge time is wasted in search for right cut parts or cut bundles or the pre-production sample or sealed sample to start the production on time. Flow of information as to which style is to be loaded in which line, lack of on time and appropriate technical specification about the style often leads to huge confusion in the sewing floor that leads to increase in style change over time.

Layout planning and machine planning is often seen to be done during the Set up time which stands as bottleneck point during style change over.

**Demonstration time:** Demonstration time is the time required to demonstrate the critical operations in the new style to the operators with the right method and the right equipment. This is an important activity but a time consuming as the learning ability depends on the skill level of the operator and the style of the product. Repeat orders or simpler styles may require very less or no demonstration. At times re-demonstration takes a huge time.

**Time delay due to Operator:** Due to lack of pool of skilled operators, demonstration of critical operations cannot be converted to an External Element. Only after the completion of the previous order can the demonstration of the new order take place. Again a less skilled operator takes more time in following a demonstration and at many instances requires re-demonstration. Absenteeism of operators also poses a huge obstacle in pre assigning operation for the new style as per the skill matrix. As they are more in numbers and usually idle at this time they should be involved in various activities in style changeover.

**Run Down Time and Run Up Time:** Run Down Time is the time when the current style under production leaves the first machine in the line and the capacity drops. This Run Down Time continues till the current style leaves the last machine in the line. Run Up Time starts from the time the first piece or first bundle is loaded on to the first machine of the line and till the first good piece is produced and steady production at full capacity occurs. Style Change over time starts with the start of Run Down time than Set Up Time to the end of Run up time. One should start style change over activities from the Run Down Time in order to reduce the style change over time. It has been observed that in India, in most cases style change over starts only from the Set Up time. Garment manufacturing have to make the Run Down time productive in order to reduce the style change over time. SMED methodology successful in reducing the style change over time by making use of the Run Down time and reducing the Run Up Time.

3 CASE STUDY:
Reducing the style change over time in export garment manufacturing unit.

3.1 Objective:
- To reduce the style change over time using SMED.
- To formulate a standardized action plan for batch setting / style change over.

4 Research Methodology:

1. Recording and Mapping the entire process of style change over from the time when the previous style is reaching completion and new style reaches a perfect flow.
2. Analysis of the activity with time line and noting down all the value added, non-value added and necessary non value added elements.
3. Then categorizing the elements into Material Time, Batch Setting time, Demonstration time, time delay due to operator.
4. Than the elements consuming more time are noted and highlighted.
5. With the information of the As IS process, the elements are separated into Internal, External and Parallel elements.
6. Finally finding the smarter ways to perform the work.

Study was conducted on the sewing floors to note down the list of activities/elements that are involved in batch setting. The elements along with their time line were noted and classified under the following headings:
Machine time, Batch Setting time, Demonstration time, Time delay due to operator. Run Down time and Run Up time is not under the scope of study. The following graphs represent the analysis of the 3 batch setting and the percentage of time consumed by each head.

Style Change over time: Run Down Time + Set Up Time + Run Up Time.

Case 1
Out-going style: Knitted Ladies polo shirt (Basic style)
New style to be loaded: Knitted Ladies top with metal zippers at the back (Critical Style)

Fig 1: Elemental Breakdown of Set Up Time: Case 1

The new style has critical operations like zipper attachment and requires special finishes (binding) that requires special attachments and guides. The degree of workmanship involved is very high. As a result, the demonstration level increased and time consumed for demonstration was 49% followed by batch setting time and machine time which is 25% and 22% respectively. Time delay due to operators (4%) was mainly due to the negligence and reluctance. Waiting for line supervisor for demonstration, waiting for operators, waiting for sealed sample and waiting for templates were some of the reasons for delay due to lack of pre-production planning that contributed to Batch setting time. Style Change over time starts only when the current order is out of the line completely.

Case 2
Out-going style: Mandarin collar full sleeve woven shirt with 3 button placket
New style: Half sleeve woven classic shirt with two pockets with pocket flap

Fig 2: Elemental Breakdown of Set Up Time: Case 2

In the above case the out-going style and the new style belong to the same category and same level of workmanship is involved. Hence time consumed for demonstration is less than the machine setting time. Here the time consumption for demonstration is much less than case 1 as this factory specializes in manufacturing shirt only and the style variations are nominal. As the number of operations in the shirt is more hence the number of machines required is more. This lead to increase in the machine time required which is 59%. As the more number of machines are involved, the Batch setting time is more which is 24%. Time delay due to operator is 6% and the reasons accounted to are same as in case 1. In this case too Style Change over time starts only when the current order is out of the line completely.

Thus it is observed that style change over time can be broadly classified into 5 headings: Machine time, Batch Setting time, Demonstration time, Time delay due to operator. The time content under each heading may vary case to case. The factors for time variation will mainly depend on the style variation and between the out-going style and the new style. The level of critical operation and difficulty in workmanship will account for variation in style change over time. This will not only increase the demonstration time but also involve re-demonstration and longer machine set up time with more numbers of attachment and folders for efficient production. The number of operation breakdown of the product is also another influencing factor in style changeover time. More the number of operations more machines are required and thus increases the machine set up time. More machine set up time is also dependent on the number of folders, guides and attachment required. Demonstration time is dependent on the degree of style variation and the criticality in operation. Operator’s skill also depends on time consumed for demonstration and re-demonstration.
Implementation of SMED:

After the analysis of the present process of style change over SMED methodology was applied for the next style change over. Although a direct comparison between one change over with another cannot be compared in absolute figure as the product may not be identical but comparison was done between similar styles. Style Change over started as the Run Down time reaches its peek which not only reduced the Set Up time but also reduced the Style Changeover time overall. Run Down time was made productive.

Table 1: The current status of the changeover process of the factory as summarized

<table>
<thead>
<tr>
<th>Activity</th>
<th>Actual</th>
<th>Before SMED</th>
<th>After SMED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout Planning</td>
<td>External</td>
<td>Internal Sparsingly External</td>
<td>External</td>
</tr>
<tr>
<td>Layout Change</td>
<td>Internal</td>
<td>Internal</td>
<td>Internal</td>
</tr>
<tr>
<td>Machine movement</td>
<td>Internal</td>
<td>Internal Sparsingly External</td>
<td>Internal/ External</td>
</tr>
<tr>
<td>Machine Maintenance</td>
<td>Internal/ External</td>
<td>Internal/ External</td>
<td>Internal/ External</td>
</tr>
<tr>
<td>Machine setting</td>
<td>Internal/ External</td>
<td>Internal/ External</td>
<td>Internal/ External</td>
</tr>
<tr>
<td>Demonstration</td>
<td>Internal/ External</td>
<td>Internal/ External</td>
<td>Internal/ External</td>
</tr>
<tr>
<td>Style Analysis</td>
<td>External</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>WIP planning</td>
<td>External</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Trims Status</td>
<td>External</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Operator Allocation</td>
<td>External</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Buffer Allocation</td>
<td>External</td>
<td>Internal</td>
<td>External</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supervisor(LS)</th>
<th>(LI)/Line Supervisor(LS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair and fine tuning of idle or spare machines were done during the set up time. Action: Mechanic/Technician</td>
<td>Repair and fine tuning of the idle machines are done during the run down period. Action: Mechanic/Technician</td>
</tr>
<tr>
<td>Gauge Setting, Needle plate setting, Machine oiling was done during Set Up time only. Action: Mechanic/Technician</td>
<td>Gauge setting, Needle plate setting and Machine oiling starts from Run Down time and spills over to Set Up time. Action: Mechanic/Technician</td>
</tr>
<tr>
<td>Machine cleaning was done during the setup time. Action: Operator</td>
<td>Machine cleaning starts from the run down period. Action: Operator</td>
</tr>
<tr>
<td>Un raveling of Bobbin Thread and filling of bobbin done during machine set up time. Action Operator</td>
<td>Un raveling of bobbin thread and filling of bobbin thread starts from Run Down period. Spare Bobbins are also used. Action: Operator</td>
</tr>
<tr>
<td>Fine tuning of machines such as SPI, thread tension, presser foot setting etc. were done during Run Up time. Action: Operator</td>
<td>Fine tuning of machines such as SPI, thread tension, presser foot setting etc. were done during Run Down and Set Up time. Action: Operator</td>
</tr>
<tr>
<td>Changing needle and threading was done only during the Set Up time. Action: Operator /Mechanic</td>
<td>Changing needle and threading starts from Run Down time and spills over to Set Up time. Action: Operator</td>
</tr>
</tbody>
</table>

Table 2: Detailed discussion of the summary:

Table 2.1 Machine Setting

<table>
<thead>
<tr>
<th>Before Implementation</th>
<th>After Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of machine was done during set up time. Action: Line In charge (LI)/Line</td>
<td>Identification of machine is done during Run down period of the previous style. Action: Line In charge</td>
</tr>
</tbody>
</table>

Table 2.2 Batch Setting Time

<table>
<thead>
<tr>
<th>Before Implementation</th>
<th>After Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style Analysis was done during the Set Up time. Action: Production Manager (PM) / Line In charge (LI) / Line Supervisor (LS).</td>
<td>Style Analysis is done much before the Set up time and critical operations and Bottle neck operations are identified for special attention and demonstration. Action:</td>
</tr>
</tbody>
</table>
SMED (Single-Minute Exchange of Die) methodology in Garment manufacturing Industry: Case study in reducing Style change over Time

<table>
<thead>
<tr>
<th>Action</th>
<th>Before Implementation</th>
<th>After Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration for critical operations was solely a part of Set up time. This used to take place much after machine setting time.</td>
<td>Demonstration for critical operations commences as soon as the Run down time starts. This can be parallel operation.</td>
<td>Re-demonstration was reduced as operators allocation is pre planned according to skill matrix.</td>
</tr>
<tr>
<td>PM / LI / LS</td>
<td>PM / LI / LS</td>
<td>PM / LI / LS</td>
</tr>
</tbody>
</table>

Table 2.3 Demonstration time

<table>
<thead>
<tr>
<th>Before Implementation</th>
<th>After Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-going style: Knitted Ladies top with metal zippers at the back (Critical Style)</td>
<td>No: of Operations: 25</td>
</tr>
<tr>
<td>New Style: Knitted pant with slant pocket and elasticated waist band for top.</td>
<td>No: of Operations: 42</td>
</tr>
</tbody>
</table>

It is observed that after implementation of SMED the Style changeover time got considerably reduced. As discussed above internal elements were converted to external elements and the external elements started as the Run Down Time reached its peak. Batch setting planning was meticulously pre planned and waiting time got drastically reduced. Machine setting time was 113 minutes for 42 operations after SMED implementation against 90 minutes for 25 operations before SMED implementation. Parallel activities of demonstration lowered the demonstration time although the number of operations is more. Spare machines were efficiently used for external elements.

Fig3: Style Change over Time after SMED implementation

Fig4: Elemental Breakdown of Style Changeover – Before and After SMED Implementation

Conclusion: Style Change over time can be greatly reduced and channelized by application of SMED methodology with minimum financial implication. SMED and Value Stream Mapping can further increase the productivity of Set Up time and make Run down Time productive. The case study reveals that there are 5 main factors affecting style change over time in garment manufacturing units in India, they are Machine time, Batch Setting time, Demonstration time, and Time delay due to operator. The time required for each factor is affected by the variations in style of the product between two subsequent batches which is evident from the above cases. Application of SMED concept in the above case study showed considerable reduction in delay arising out of machine setting time, batch setting.
time and demonstration delay. SMED is surely not a destination but a continuous and gradual process.

References

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