Manufacturing Lead Time Improvement by Reducing Changeover Time with The Application of SMED

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Abstract— In global market, a manufacturing company has to deal with many buyers concurrently and they have to produce multifarious products in their industry so that they can meet DIFOT (delivery in full, on time). To stand with this competition, Apparel industry needs to follow smart way to improve productivity and operating principle which helps to reduce manufacturing lead time. It is challenging for an industry to reduce lead time and increase productivity because these are affected by many factors like changeover time, machine breakdown, startup time, set up time, adjusting time, none productive time, unavailability of raw materials etc. which are very difficult to eliminate. The main objective of this study is to reduce changeover time of sewing section which leads to improve productivity as well as reduce manufacturing lead time. The methodology of this study is to analyze the current changeover procedure and introduce a new changeover process. As a conclusion, this paper presents a proposal of changeover procedure for sewing section of an apparel industry that helps effective identification of waste activities and eliminates them so that manufacturer can easily produce small batch size in order to meet multiple buyer demand.

1. INTRODUCTION

The RMG sector is the most promising earning sector of Bangladesh. Today's competitive world, the most important driver for success is time; the company that delivers goods with a shorter lead time is the market winner. When the rest of the world is using lean tools to minimize waste and increase productivity; in the meantime, in Bangladesh, RMG sector runs in a traditional way [1, 2]. To compete with the global competitors', local garment industries have to adopt-lean manufacturing techniques [3]. SMED can be applied significantly in optimizing product and process transition in garment manufacturing industry [4].It's standard implementation procedure under lean manufacturing techniques can bring a great improvement in productivity and efficiency in garment industry.Lean manufacturing process is an extensive way comprises many useful tools to reduce wastefrom any manufacturing industry which causes excess cost without adding any value to the finished product.Single Minute Exchange of Die (SMED) is one of them to improve flexibility in manufacturing processes as well as to reduce waste. SMED works in a certain way that it classifies the works and converts internal works to external works. SMED is nothing but to complete any change over activity within single digit minute (1 to 9 min) allowing lot size reduction and manufacturing flow improvements [5]. A changeover is defined as the elapsed time between the last good product of current style ("A") leaving the machine until the first good product of next style("B") comes out. It consists of two types of time such as setup time and startup time. Setup time required for adjustment or replacement of machine parts. Started time required for achieve perfect process, right speed and desired quality [14]. The advantage of less setup and started up time are that manufacturer can produce small lots to meet changing customer needs with required time and material. It also reduces lead time that means less waiting time. It is desired to reduce this time so that the machines will be free to process more parts [6, 8].

2. LITERATURE RIVIEW

The SMED which is important lean tool can be implemented in most of the industries, but it has been applied to manufacturing process, administration services, and assembly operations. The potential improvements in the changeover time can be done either by changing the sequence of activities without any variation in the way of performing tasks or by altering the existing activities to complete the task more rapidly [9,10]. Lean tools focused on certain aspect of a manufacturing process to eliminate waste and improve the quality while production time and cost were reduced [11]. While implementing SMED the first thing to start is to identify the changeover process and sort it into internal and external activity. Internal activities have to be converted to external wherever possible. Maintaining of 5S is important at each level of implementation [12]. In this case study the changeover improvement was done in six basic steps [13]; i- observe and measure the tool changeover time, ii- separate the internal and external steps, iii- convert as many internal steps as possible to external steps, iv- eliminate waste from internal steps, v- eliminate wastes from external steps, vi- standardize and maintain the new changeover procedure.

3. METHODOLOGY

A case study is considered for sewing section to produce readymade garment which is one of the major process in apparel industry. The average monthly production of the company is 130,000 units and monthly working days 24. For this study a production line was selected to observe 30 days in where five styles were run in a month. So, to meet the buyers demand five changeovers were necessary to continue production. To complete one style delivery manufacturer should start with fabric inspection then cutting, sewing, ironing, packaging andstoring sequentially. Sewing is the most time consuming and critical process to make readymade garment. In sewing,

the major time killing non value added process was style changeover. That's why if sewing changeover time can be reduced, manufacturing lead time would bebe reduced automatically. The 3G's (Gemba, Gembutsu, Genjitsu) werepracticed in this study to gather the data and information at the sewing line for two months. It includes to study previous changeover process, production rate after changeover, defect rate after changeover, WIP rate after changeover, process flow and standard operating procedure. The measurement includes the cycle time, processing time, changeover time, changeover process, production rate, defect rate, WIP rate to establish a baseline for data analysis. Using this data previous changeover status is structured and observed the impact of it on the production line. With brainstorming and applying the improvement opportunity a changeover method is proposed and to verify its performance previous measurement data was collected and compare. The methodology of implementing SMEDto reduce changeover timein sewing section is presented in Table-1.

TABLE.1

THE RELATION BETWEEN RESEARCH METHODOLOGY AND STEPS OF SMED

Methodology		6 Steps of SMED
1	Collecting Data	Step 1: Observe and measure the total changeover time
2	Observe current changeover process	
3	Brainstorming and Applying the Improvement Opportunities	Step 2: Separate internal and external activities
		Step 3: Convert as many internal activities to external activities as possible
		Step 4: Streamlining the internal activities
4	Designing a standard changeover process	Step 5: Standardize and maintain the new changeover procedure
5	Implementing of standard changeover process	
6	Monitoring and auditing the new changeover process	Step 6: Monitoring the result and further improvement by following previous 5 steps
7	Performance Analysis	
8	Intermediate repetition analysis new changeover process	

To improve changeover process SMED (single minute exchange of dice) is used. It consists of six steps they are explain below.

Step3.1: Observe and measure the total changeover time.

Changeover time should be recorded as the interval between the stopping and full-speed restart of operations - normally between the last good part produced in a production run and the first good part produced in the next production run. In this step previous changeover time should be observed and measure with standard time unite.

A trouser line has been chosen consisting 60 sewing machines, 5 in-line pressing machines and 3 quality checking tables and where each machine is handled by a single operator.

TABLE.2

EXISTING CHANGE OVER PROCESS

SL No.	Activities	Machine or Process Nos.	Current time		
			Time (sec)	Total time per activity (sec)	Total time (hr.)
1	Arrange and supply the cut panel, 50cm Strip, Extra fabric, Gloves fabric, and trims	1	123	123	12.86
2	Arrange the Production Sample	1	75	75	
3	Arrange the sewing patterns	1	185	185	
4	Check and confirm sewing pattern fitness and measurement	8	96	768	
5	Check and confirm process wise trims	40	42	1680	
6	Arrange all inline pressing pattern	5	135	675	
7	Train pressing man	5	225	1125	
8	Allocate helper for machine transportation	65	22	1430	
9	Transportation of M/C	65	28	1820	
10	Supply all parts and components and Connect electrical cables	65	18	1170	
11	Adjust the new machine brought	12	296	3552	
12	Adjust the existing machine	53	19	1007	
13	Guideline for the line mechanics	65	17	1105	
14	Arrange 50cm strip as sample stitch	60	12	720	
15	Select process operator	65	16	1040	
16	Process training	65	145	9425	
17	Critical Process training	10	356	3560	
18	Method finalization	65	136	8840	

19	Check and Ensure the quality of the process	65	28	1820	
20	Arrange process sample	65	33	2145	
21	Prepare standard work-sheet for QC	3	412	1236	
22	Train the quality checker on check points and defect identification	3	625	1875	
23	Ensure proper guideline for the quality supervisor	1	915	915	

Step 3.2: Separate internal and external activities

Internal activities are the activities occurring during the changeover that can only be performed when production is shut down. External activities are the activities that could be performed during a production run. Thisstep is the critical driver for Quick Changeover improvements – a high percentage of operations are usually external steps that could be donebefore or after the changeover process.

TABLE3

INTERNAL ACTIVITIES OF CHANGE OVER PROCESS

Internal Activities					
SL NO.	Activities	Machine or Process Nos.	Current time		
			Time (sec)	Total time per activity (sec)	Total time (hr.)
4	Check and confirm sewing pattern fitness and measurement	8	96	768	9.83
6	Arrange all inline pressing pattern	5	135	675	
7	Train pressing man	5	225	1125	
8	Allocate helper for machine transportation	65	22	1430	
9	Transportation of M/C	65	28	1820	
10	Supply all parts and components and Connect electrical cables	65	18	1170	
11	Adjust the new machine brought	12	296	3552	
12	Adjust the existing machine	53	19	1007	
13	Guideline for the line mechanics	65	17	1105	
14	Arrange 50cm strip as sample stitch	60	12	720	
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22	Train the quality checker on check points and defect identification	3	625	1875	
23	Ensure proper guideline for the quality supervisor	1	915	915	

TABLE.4

EXTERNAL ACTIVITIES OF CHANGE OVER PROCESS

External Activities					
SL NO.	Activities	Machine or Process Nos.	Current time		
			Time (sec)	Total time per activity (sec)	Total time (hr.)
1	Arrange and supply the cut panel, 50cm Strip, Extra fabric, Gloves fabric, and trims	1	123	123	3.03
2	Arrange the Production Sample	1	75	75	
3	Arrange the sewing patterns	1	185	185	
5	Check and confirm process wise trims	40	42	1680	
18	Method finalization	65	136	8840	

Step3.3: Convert as many internal activities to external activities as possible

Any activity that does not have to be performed when the ma-

chine is not running should be converted to an external activity. Using lean tools many internal activities can convert into external activities which can reduce changeover time.

TABLE.5
CONVERSION OF INTERNAL TO EXTERNAL

Converted Internal to External		
4	Check and confirm sewing pattern fitness and measurement	Internal to External
6	Arrange all inline pressing pattern	Internal to External
7	Train pressing man	Internal to External
8	Allocate helper for machine transportation	Internal to External
13	Guideline for the line mechanics	Internal to External
15	Select process operator	Internal to External
17	Critical Process training	Internal to External
21	Prepare standard worksheet for Quality Checker	Internal to External
22	Train the quality checker on check points and defect identification	Internal to External
23	Ensure proper guideline for the quality supervisor	Internal to External

Step3.4: Streamlining the internal activities

The first principle of lean is reducing waste such as delay, over production, over motion etc from operation. To eliminate waste ones should be map out current walking path used in current state changeover and after that brainstorming is done to eliminate these wastes.

TABLE. 6
EXPLANATION OF THE WAY OF IMPROVEMENT

Streamlining Internal Activities					
SL	Activities	Before time (min)	After time (min)	Improved	Way of Improvement
9	Transportation of M/C	30.33	13.00	17.33	Segregate machines of running styles by Green, Yellow, Red card. Green-Machine will be in position, Yellow-Machine will be in line but in different position and the future position will be mentioned, Red- Machine will be removed from line.
10	Supply all parts and components and Connect electrical cables	19.50	6.50	13.00	All machines' plugs and sockets are uniform which were different and consumed more time to change
11	Adjust the new machine brought	59.20	3.60	55.60	Machines will be adjusted before bringing in the line as per new style's process and fabrics.
12	Adjust the existing machine	16.78	15.90	0.88	A changeover cart introduced where required changeable parts and components are kept mentioning new layout's machine
14	Arrange 50cm strip as sample stitch	12.00	6.00	6.00	50cm strip fabric pieces are arranged by the changeover cart.
16	Process training	157.08	92.08	65.00	Operator selection is done previously, critical operations are trained before changeover, sewing technicians are well trained before changeover
19	Check and Ensure the quality of the process	30.33	27.08	3.25	Quality supervisor and Quality checker are trained before changeover so that they are well known about required quality and

					checking times have been reduced.
20	Arrange process sample	35.75	13.00	22.75	Previously process sample was given after completing 4 pieces good work. Now it is given after completing 2 two good pieces.
Total		**360.98**	**177.17**	**183.82**	**3.06hr Improved and current changeover time 2.95 hr.**

Step3.5: Standardize and maintain the new changeover procedure

In this step, most important think is documentation. All activities which are performed inprevious five steps will be preserving in a proper way. Workers have to be given training to introduce with new process. All activities will be monitored to reach in certain goal.

Step3.6: Monitoring the result and further improvement

Monitoring and evaluation are essential component of SMED and should not be neglected. Trigger indicators and performance indicators can be monitored and the results used to determine when actions should be implemented and to track the success of the SMED. Effective monitoring and evaluation can help to sustain the improvement. A bar chart or control chart can be used to monitor the changeover time and the above 5 standardized steps should be followed to stabilize and to bring further improvement. It's been suggested that the changeover time can be reduced to single minute by continuous improvement.

TABLE 7

DATA COLLECTED FROM PRODUCTION LINE

Monitoring the next 5 changeover in the same production line		
1	Changeover time (hr.)	2.85
2	Changeover time (hr.)	3.24
3	Changeover time (hr.)	2.5
4	Changeover time (hr.)	2.41
5	Changeover time (hr.)	2.38

4. CONCLUSION

The purpose of this study was to reduce change over time from a production line of readymade garment. This will help a manufacturer in many ways. When it is possible to continue production with less change over time, production lead time will be declined automatically. It also facilitates a producer to produce with short batch size. It can be noticed from this case study that it is possible to minimize changeover time with proper planning and scheduling of change over activities. SMED method is used to evaluate and rearrange change over activities. In this case study, changeover time was count for existing system and that time was 12.86 hours. With the help of selected method, a proper plan and schedule was proposed to monitoring external and internal activities. The proposed change over process was then applied on 5 production lines to check it efficiency and every time the recorded change over time was around 3 hours which is one sixth of previous time. So, this change over time will give anyone a basic idea to prepare related change over process.

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