Chapter

Single Minute Exchange of Dies: Classical Tool of Lean Manufacturing

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Abstract

Effective utilization of the resources is the need of an hour particularly when it comes to the manufacturing industry. It is having a paramount importance to have a proper utilization of the resources, on the same line in any manufacturing industries to reduce the setup time is also one of the ways to do so. Single Minute Exchange of Dies (SMED) is one of the classical method which is normally used to reduce the setup time. In this technique complete videography of the existing changeover is done and then by analyzing it waste activities identified and other improvement plant has been done in each iteration. The chapter also showcases the SMED technique applications in a gear industry. Remarkable resources and results have been achieved through the implementation of classical tool of Lean manufacturing is made.

Keywords: SMED, rapid change over, waste reduction, lean tool

1. Introduction to SMED

Modern Times every manufacturer wants to produce product in various varieties. This can only be accomplished when we have a shorter setup times in order to change the product from one variety to another. SMED means no setup time should be more than nine minutes. SMED is a systematic procedure to reduce setup time by eliminating waste.

2. History of SMED

It is a special technique of a Lean manufacturing system. It is also an integral part of Toyota production system. It is basically devised by the Shingo. Normally the setup time in the industries at very high and this creates a major obstacle in order to do the rapid change over. This can be easily and effectively compensated by SMED initially owner at Toyota able to reduce the setup time from 24 hours to few minutes. SMED is also considered as one of the tool to increase the flexibility. Shingo shows that this method can be applied to any type of industries. In order to provide the elements it details documentation procedure Shingo has written a classical book "A Revolution in Manufacturing: The SMED System". It is one of the first and most valuable resources available on the SMED. In India

also, the application of SMED in all types of industries have been reported in academic literature [1]. Discussed the SMED methodology in garment manufacturing industry and reported considerable reduction in delay arising out of machine setting time, batch setting time and demonstration delay [2]. Presented the SMED application in automobile industry and reported that changeover time was reduced to 24.5% and considerable improvement in the productivity [3]. Showcased the experimental work carried out at automobile industry, located in Maharashtra, India. Implementation of SMED tool resulted in reduction of setup time by 82.44% and tool change time by 44.21%. This helped to produce additional 23 jobs/shift with same input [4]. Implemented the SMED tool and reported the significant savings with minimum investment and also highlighted the importance of safety and ergonomic factors during die exchange [5]. Presented a case study of the application of SMED in medicinal product based industry and reported remarkable achievement in the form of ability to reduce the batch size which can compensate the market demand fluctuations and also able to reduce the storage of medicinal products that are very closely related to expiration time (expired time).

3. SMED terms and its elements

Following are the most commonly terms associated with the SMED nomenclature. Basic elements of the entire SMED system have also been shown in **Figures 1**, **2** and **3**:

- Changeover: The process of switching from the production of one particular product or model to another on a machine.

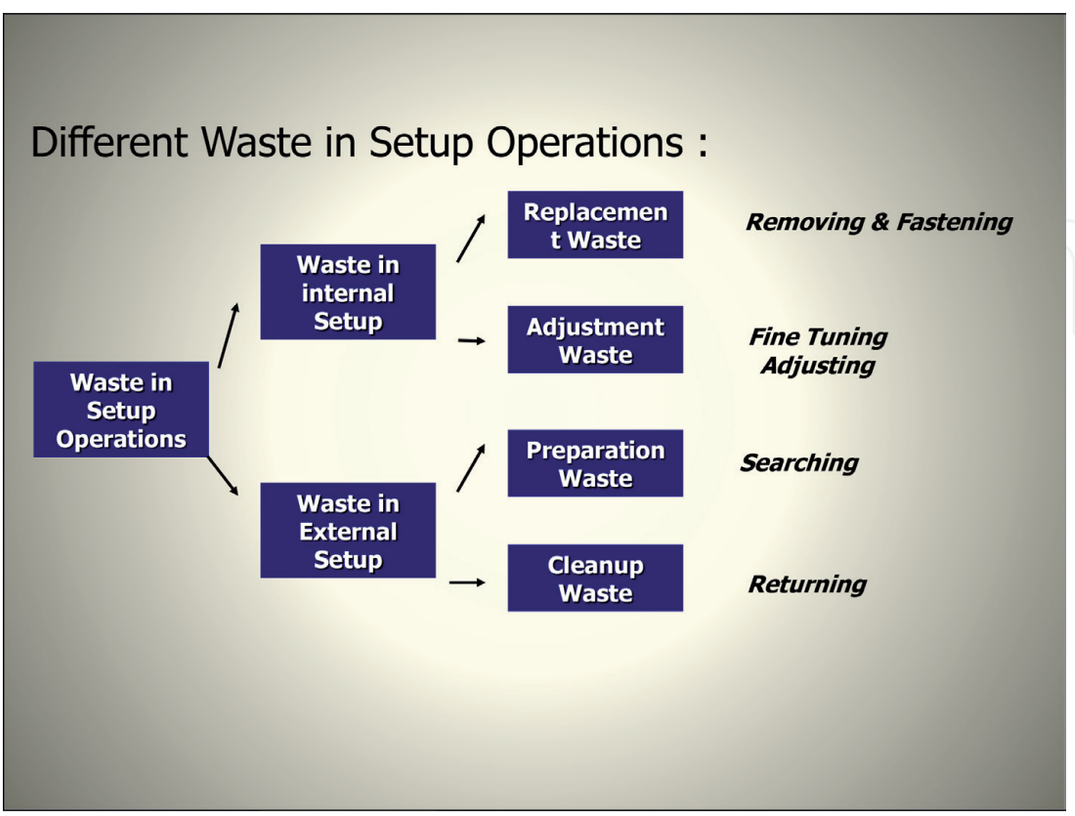

Figure 1.
Different waste in setup Operations.

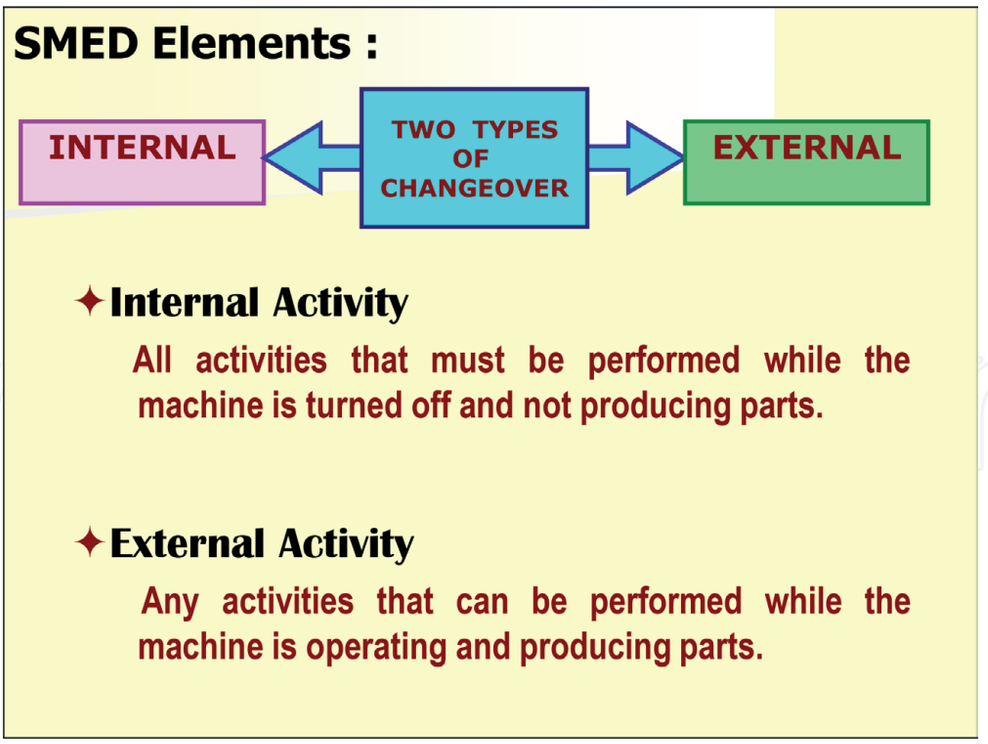

Figure 2.
Basic SMED elements (1).

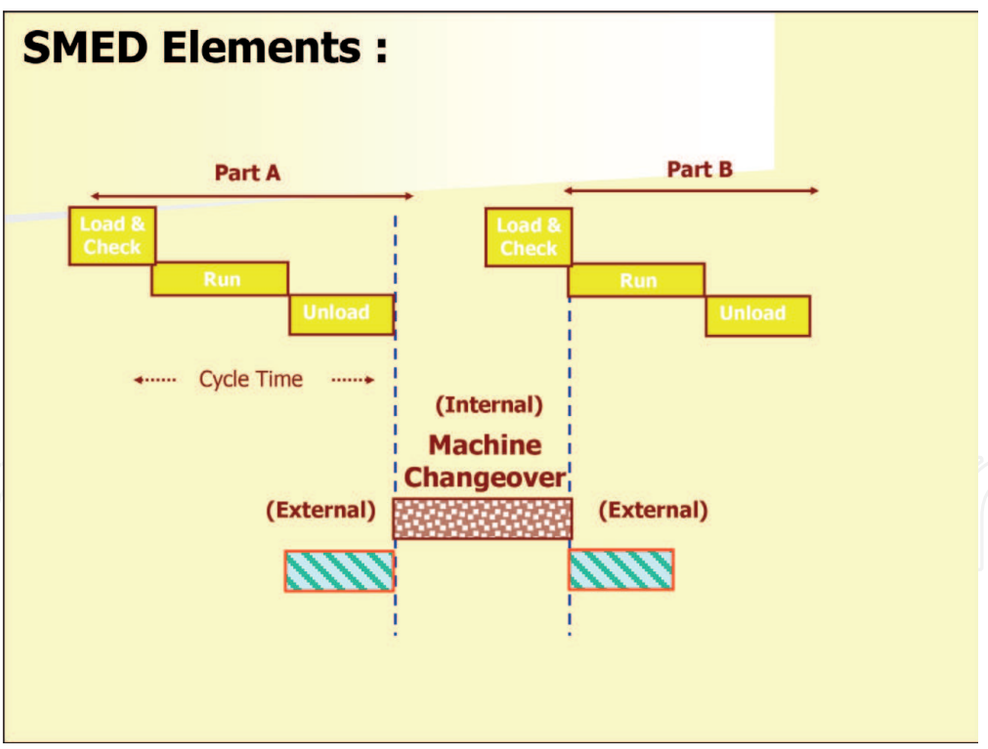

Figure 3.
Basic SMED elements (2).

- Downtime: Production time lost due to unwanted stoppages.
- External Setup activities: Those activities or tasks which can be done while the machine is still running are known as external setup activities.
- Internal Setup activities: Those activities or tasks which can be done while the machine is shut down are known as internal setup activities.

- Non-Value Added Activities: The resource consumed on activities that add costs but no value to an item from the customer's perspective. These activities are known as non-value added activities.

- Shigeo Shingo: Toyota person who has dedicated himself in evolving the detailed procedure and aspects of SMED.

- Waste: Any activity that consumes resources but creates no value for the customer is known as waste.

- 5S: A basic lean tool which is primarily the collection of five Japanese language words used for improving productivity in any organization and industry

4. SMED methodology

The entire methodology and step by step procedure of the SMED technique has been shown in **Figure 4**. It is primarily consists of the following steps:

4.1 Observe the current methodology (changeover)

In this step the entire existing changeover procedure is recorded through video camera

4.2 Separate the internal and external activities

In this step the complete changeover is analyzed frame by frame by the entire SMED team members and all the activities is separated in to three categories namely internal activities, external activities and waste activities.

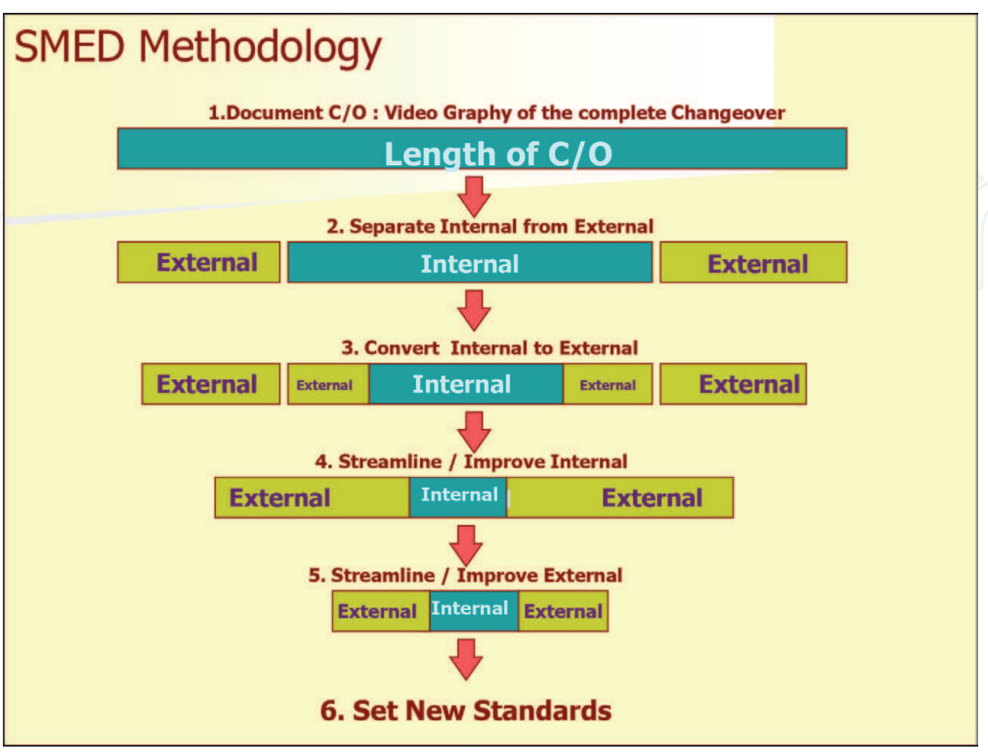

Figure 4.
SMED methodology.

4.3 Convert (where possible) internal activities into external ones

After segregation of the activities, SMED team converts as possible as internal activities in to external activities by implementing the rigid improvement plan and kaizen activities

4.4 Training to all operators

If any improvement plan requires the change in working of the operator's method then it is most important to impart the rigorous training of the change procedure to the entire operator team not only to teach them about the new procedure but also to inculcate the trust among them about the new changed procedure.

4.5 Do it all again

As the concept of SMED tells us to achieve the setup time in single digit minute time but in practical conditions it is not possible to achieve this goal in single iteration. It needs lots of iteration in order to achieve the goal. So it is always required that keep doing the entire procedure until and unless goal is achieved.

4.6 Set new standards

After everyiteration, new standard should be setup by the team and it should also be treated as benchmark in order to haveworld class manufacturing level

5. Example of SMED technique application

The implementation of the SMED technique is little bit complicated but it can be implemented effectively if structured methodology is adopted. In this example SMED methodology is applied at the gear manufacturing unit for reducing setup time of shaving machine of a Gear company cell producing a large diameter gears (**Figure 5**) and following steps are followed:

5.1 Understanding the current situation

The current situation and layout of the gear manufacturing cell is shown in **Figure 5**. Here in this step the complete videography of the changeover procedure of a set up time of shaving machine is done and by watching and analyzing the videography of the changeover procedure the changeover sheet has been prepared as shown in **Table 1**.

5.2 Identification of waste or abnormalities

As shown in the **Table 2** there is lot of waste activities in the complete setup procedure of the shaving machine. Total time consumed by the waste activities is 44 minutes approximately. In first iteration itself, all the waste activities are eliminated.

5.3 Analysis of the causes

On analyzing the complete changeover sheet and various brainstorming session with all stakeholders are organized. Following prominent causes which were surfaced during this exercise was as follows (**Figure 6**).

i. Training of set up change procedure was not given properly to the setup personnel and there were no Master personnel of setup for particularly Shaving Machine.

ii. 5S of setup trolley is not properly organized.

iii. Lot of time is being wasted due to lead andprofile (L & P) is not ok at the first time itself.

To analyze the cause of Lead and Profile problem more deeply, a detailed study has beencarried out to find the root cause of the problem which is shown in the **Figure 7.**

5.4 Improvement plan and implementation

After finding the root cause of all waste activities found in first iteration a time bound improvement plan has been made and all the improvement has been made as per the plan which is shown in **Figure 8**.

5.5 Result and Kaizen done in first iteration

In this way all the wasteactivities which has found in first iteration completely eliminated. The major result achieved by this exercise is that by eliminating all waste activities which are acting as a hindrance to convert the internal activities in to the external activities can now be taken up in second iteration. By doing the first iteration of the reducing set up time cycle the total 44 minutes have been saved.

Kaizen done: In this complete exercise following kaizen has been done which is listed as follows: **Kaizen 1**: As shown in **Figure 7**, cutter head angle is the responsible factor for wrong lead profile because during setup (first iteration) it was wrongly set as per the requirement to suit the shaving cutter. To solve this issue Cutter head angle is made mandatory check point in the standard operating procedure.

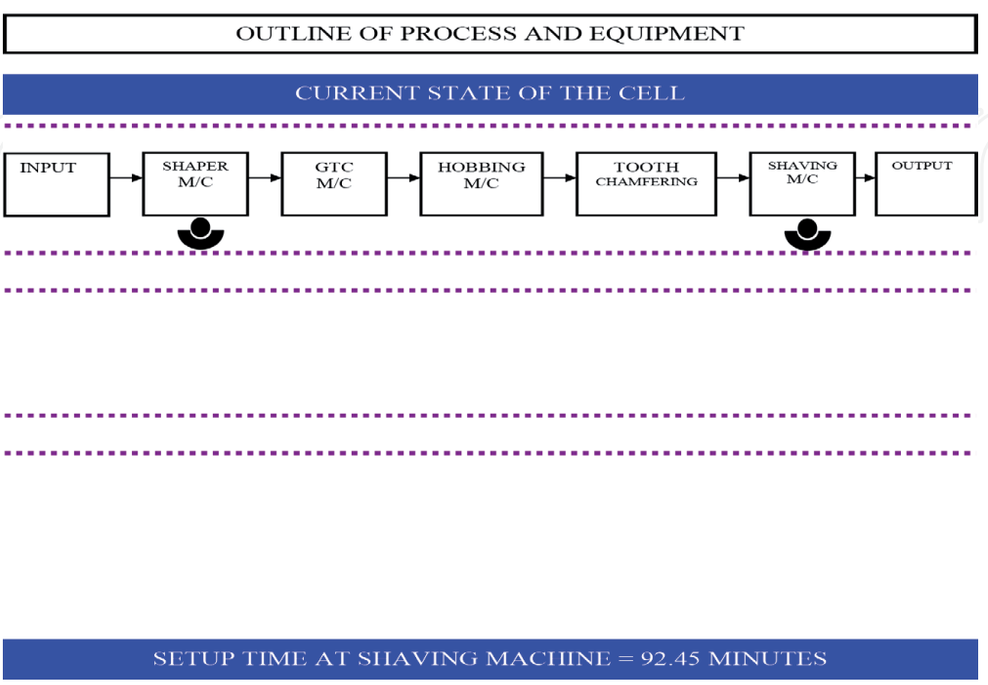

Figure 5.
Outline of process and equipment.

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CHANGEOVER OPERATIONS ANALYSIS CHART

TOTAL MINUTES 92.45		**DEPT. PRODUCTION**		**DESCRIPTION OF CHANGEOVER From MODEL 808 to 809**			
		MACHINE(S) SHAVING		**SET-UP PERSONNEL Vishesh**			
NO.	**CHANGEOVER ELEMENTS**	**RUNNING TIME**	**ELEMENT TIME (sec.)**	**CHANGEOVER CATEGORIES**			**IMPROVEMENT PLAN**
				INTERNAL	**EXTERNAL**	**WASTE**	
1	Loosening cutter arbor guide bolts.	1:13:40	1:13:40				
2	Taking out guide	2:00:00	0:46:20				
3	Cleaning cutter housing face	2:15:00	0:15:00				
4	Loosening locknut locking bolts	2:40:00	0:25:00				
5	Loosening locknut & taking out cutter	5:54:00	3:14:00				
6	Putting 808 cutter in box	7:00:00	1:06:00				
7	Cleaning cutter area & arbor face	8:02:00	1:02:00				
8	Cleaning 809 cutter	8:30:00	0:28:00				
9	Mounting cutter on arbor (Spacer/cutter/spacer/locknut) cleaning every part before assembly (Activity stopped due to grub screw damage)	11:32;00	3:02:00				
10	Changing helix angle (Unlocking cutter head/ change angle/ lock cutter head)	14:47:00	3:15:00				
11	Locking cutter (after procuring grub screw)	17:09:00	2:22:00				
12	Mounting arbor guide (after cleaning face & ID)	22:52:00	5:43:00				
13	Reading QAP for DOB size	23:28:00	0:36:00				
14	Changing crowning angle	26:03:00	2:35:00				
15	Setting depth for 0809	28:03:00	2:00:00				

CHANGEOVER OPERATIONS ANALYSIS CHART

TOTAL MINUTES 92.45 | **DEPT. PRODUCTION** | **DESCRIPTION OF CHANGEOVER From MODEL 808 to 809**

MACHINE(S) SHAVING | **SET-UP PERSONNEL Vishesh**

NO.	CHANGEOVER ELEMENTS	RUNNING TIME	ELEMENT TIME (sec.)	CHANGEOVER CATEGORIES			IMPROVEMENT PLAN
				INTERNAL	EXTERNAL	WASTE	
16	Checking component centre	28:35:00	0:32:00				
17	Setting depth for 0809	29:51:00	1:16:00				
18	Setting length of cut	31:55:00	2:04:00				
19	Increasing carrier height	34:02:	2:07:00				
20	First pc loading in mandrel	34:51:00	0:49:00				
21	Cycle ON	37:16:00	2:25:00				
22	Comp stuck while unloading	40:10:00	2:54:00				
23	Size checking (not OK)	41:10:00	1:00:00				
24	Reloading and setting the size	43:22:00	2:12:00				
25	Checking size (OK)	43:42:00	0:20:00				
26	Given to std. room for L&P checking (LP and OK)	55:39:00	11:57:00				
27	Lifting table for L&P correction	58:00:00	2:21:00				
28	Cycle ON Idle	60:20:00	2:20:00				
29	Cycle ON with component	61:21:00	1:01:00				
30	Given to std. room for L&P checking (L&P not OK)	80:33:00	19:12:00				
31	Setting helix angle lead correction	84:40:00	4:07:00				
32	Cycle ON Idle	85:36:00	0:56:00				

CHANGEOVER OPERATIONS ANALYSIS CHART							
TOTAL MINUTES 92.45		DEPT. PRODUCTION		DESCRIPTION OF CHANGEOVER From MODEL 808 to 809			
		MACHINE(S) SHAVING		SET-UP PERSONNEL Vishesh			
NO.	CHANGEOVER ELEMENTS	RUNNING TIME	ELEMENT TIME (sec.)	CHANGEOVER CATEGORIES			IMPROVEMENT PLAN
				INTERNAL	EXTERNAL	WASTE	
33	Cycle ON with component	86:27:00	0:51:00				
34	Given to std. room for L&P checking (L&P OK)	92:45:00	6:18:00				

Table 1.
Changeover sheet.

Activity No.	Waste Activities	Time in Sec (2650 Sec)
3	Cleaning cutter housing face	15
16	Checking component centre	32
17	Setting depth for 0809	76
19	Increasing carrier height	127
22	Component stuck while unloading	174
27	Lifting table for L&P correction	141
28	Cycle ON Idle	140
29	Cycle ON with component	61
30	Given to std. room for L&P checking (L&P not OK)	1152
31	Setting helix angle lead correction	247
32	Cycle ON Idle	56
33	Cycle ON with component	51
34	Given to std. room for L&P checking (L&P OK)	378

Table 2.
Identified waste activities.

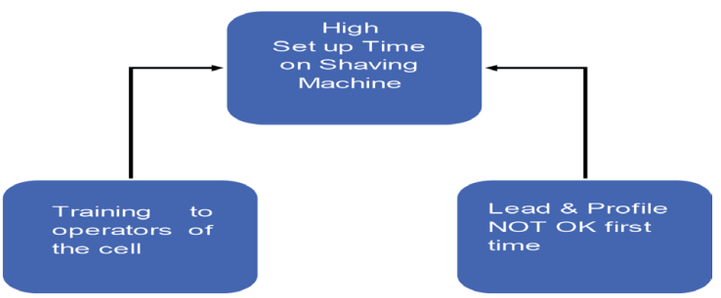


Figure 6.
Major causes of high setup time.

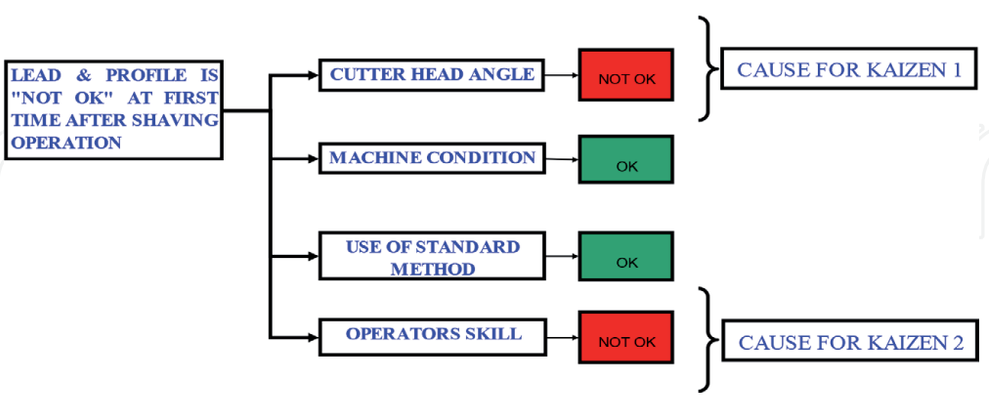
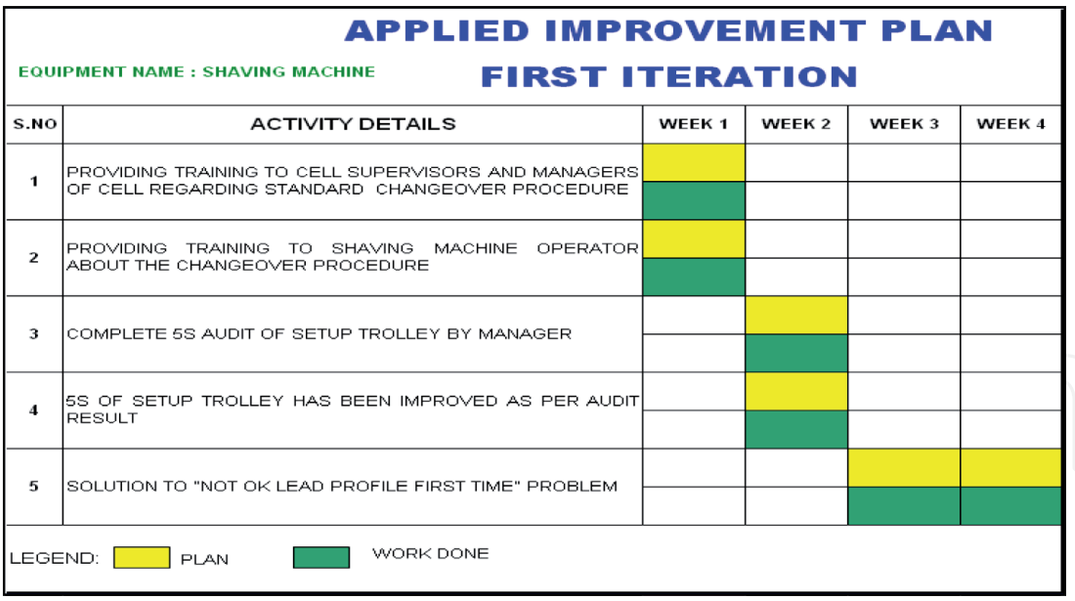


Figure 7.
Analysis of the major causes.

Kaizen 2: As shown in **Figure 7**, the poor operator skill of setup change procedure is responsible factor for the cause of this Kaizen. To solve this issue following improvement activities has been done:

a. One operator is made in charge of setup changeover and he has been given rigorous training for standardized operating procedure for the setup changeover and provided with written documents.



APPLIED IMPROVEMENT PLAN

FIRST ITERATION

EQUIPMENT NAME : SHAVING MACHINE

S.NO	ACTIVITY DETAILS	WEEK 1	WEEK 2	WEEK 3	WEEK 4
1	PROVIDING TRAINING TO CELL SUPERVISORS AND MANAGERS OF CELL REGARDING STANDARD CHANGEOVER PROCEDURE				
2	PROVIDING TRAINING TO SHAVING MACHINE OPERATOR ABOUT THE CHANGEOVER PROCEDURE				
3	COMPLETE 5S AUDIT OF SETUP TROLLEY BY MANAGER				
4	5S OF SETUP TROLLEY HAS BEEN IMPROVED AS PER AUDIT RESULT				
5	SOLUTION TO "NOT OK LEAD PROFILE FIRST TIME" PROBLEM				

LEGEND: PLAN WORK DONE

Figure 8.
Improvement plan and its implementation.

b. In charge of setup changeover has been provided with a complete Setup trolley with rearranged 5S.

c. A skill matrix is being developed for each operator so that each operator of the cell would be capable to perform setup changeover as per the standard operating procedure.

6. Conclusion

In true sense, SMED is a classical tool of lean manufacturing. As described above there are some apparent benefits for any industry by implementing a SMED tool.

1. It automatically creates lot of extra capacity in any sale our industry this provides a platform for any industry to produce more items that means effective utilization of resources.

2. Since during implementation of SMED always a restricted procedure is adopted and that creates a trust building even among operators and workers.

3. Since the "5S" methodology is the basis for any lean tool implementation and SMED demand high level of 5S implementation. In this way it provides platform for any industry to adopt other advance lean tools such as Kanban, Value Stream Mapping etc.

In this way SMED is used for not only setup time reduction but also having secondary benefits as mentioned above. SMED is more powerful if any industry and applies it with the integration of other lean tools.

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References

[1] Bajpai JD. SMED (single-minute exchange of die) methodology in garment manufacturing industry: Case study in reducing style change over time. InProceedings of the 5th International & 26th All India Manufacturing Technology, Design and Research Conference (AIMTDR 2014), Guwahati, India 2014 Dec (Vol. 1214).

[2] Raikar NA. Reduction in Setup Time by SMED Methodology: A Case Study. International Journal of Latest Trends in Engineering and Technology. 2015;5(4):56-60.

[3] Desai M, Rawani A. Productivity Improvement of Shaping Division of an automobile industry by using single minute exchange of die (SMED) methodology. ARPN Journal of Engineering and Applied Sciences. 2017;12(8).

[4] Ulutas B. An application of SMED Methodology, World Academy of Science. Eng Tech. 2011;55:100-3.

[5] Winatie A, Maharani BP, Riksa VH, Hasibuan S. Increasing Time Efficiency of Change over Process on Solid Product using SMED (Single Minute Exchange of Dies) Method in Pharmaceutical Industry.