Productivity Improvement through Single Minute Exchange of Die (SMED) Technique

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Abstract- To stand up in today's highly competitive world, the manufacturers need to find a way to reduce the production time. Elimination of the wastes can improve the productivity of the company. By making use of the lean manufacturing tools the company can remain in competition and they can survive in modern world. The main objective of this project is to reduce the setup time of the Gear Hobbing Machine by 20 – 25 % through Single Minute Exchange of Die (SMED) Technique and thereby improving the productivity. The work is carried out at a gear manufacturing company. Careful observation is done while changeover or setup and maximum possible internal activities have been converted to the external activities and then some of the activities were made parallel, hence saving a considerable amount of time.

Index Terms- SMED, Setup Time, Internal and External Activities, Lean tools

I. INTRODUCTION

The high variety and low quantity parts is major scenario of the present production system. Due to the smaller production quantities and high variety parts, the setup time tends to increases which in turn decrease the productivity. Companies are these days focusing on to reduce the setup time and to remain in the competition [1]. Quick changeover or the setup plays a vital role in the lean manufacturing. Changeover or the setup reduction is one and same which deal with eliminating the non value adding activities during the setup [1]. Eliminating the non value adding activities will increase the productivity. To face today's competitive environment, the manufacturers should adopt a method where the non value adding activities should be eliminated. Many of the firms are going for the SMED method which is quite simple and results obtained are well satisfying. Flexibility and Responsiveness are the two main pillars of manufacturing, which is operated by the demand of the products variety and quality [2].

II. SINGLE MINUTE EXCHANGE OF DIE (SMED) TECHNIQUE

SMED was developed by the Shiego Shingo in 1985 in Japan. Due to the increasing demand of the smaller lot sizes and to meet the required flexibility of the customer, shingo proposed a method called as Single Minute Exchange of Die which states that the changeover should take one minute or more precisely less than ten minutes [2]. Single Minute Exchange of Die is related to setup reduction and is main objective is to reduce the time to a single digit value. This will help the organization to minimize the level of inventory and effective utilization of the equipments [3]. As we can observe that the product life cycle of the products is reducing, and demand for variable products is increasing, the need for SMED feels compulsory in any organization. The analysis of the SMED has to begin with the details of the process and the time study. If any internal activity cannot be eliminated or converted then it has to be combined or simplified or replace if possible. Here the major concern is to identify the activities which are being done and then to separate it. There are two kinds of activities which are involved in the setup or the changeover [4].

Internal Activities: These are the activities which can be done after stopping the machine [2]. Example, Removal of the Fixture or the tool etc
External Activities: These are the activities which can be done when machine is still on [2]. Example, bringing the next Fixture or the Cutter when the machine is still on
Value added activities: The time spent on activities that add value to an item from the customer's perspective. These are the activities that effectively change the form and function of a raw material into good or service that the customer is willing to pay for [4].
Non Value Added Activities: The time spent on activities that add cost but no value to an item from the customer's perspective. These are the activities that the customer is generally not willing to pay for [4].

III. OBJECTIVE OF THE PRESENT WORK

The aim of the project is to study the existing setup operation thoroughly and observe each and every activity which is done by the operator. Single Minute Exchange of Dies (SMED) is the tool and technique of the lean manufacturing which is adopted and applied at this area. This technique will help company to eliminate the wastes during the setup or the changeover of the machine which will help the company to improve the productivity. The objective of the project is to reduce the Setup time of the Gear Hobbing Machine by 20-25% through the Single Minute Exchange of Dies (SMED) Technique.

IV. METHODOLOGY

The method followed to implement the SMED Technique is,

1) Review the Literature about the Single minute Exchange of Die (SMED) by referring Journal papers, books etc.
2) A detailed study of operation and existing setup changeover is done.
3) Internal and External activities are identified from the setup operation.
4) Separation of Internal and External activities is done carefully.
5) Now the Internal activities are converted to the External Activities.
6) Some of the activities are made parallel wherever possible.
7) The optimization of the activities, confirming the results and standardizing the operations is done.

V. PROCEDURE AND DATA COLLECTION

A. Data Collection

The data has been collected by observing the current situation and analyzed. It is found out that there is several non value adding activities happening during the setup operation. As we can see that the less time in tool change will improve the productivity of the company [5]. Based on the actual production, data was collected and recorded and the time taken was measured using the stop watch. Subsequently, a statistical bar chart can be drawn to monitor and analyze the problem [6].

Work Station	6728
Part Name	Output Shaft
Operation	Hobbing
Cycle time	680

The details of the activities performed by the operator and corresponding time taken are tabulated. Tooling required during the setup is also enlisted and whether the operator is performing internal or external activity is also tabulated. The activities which are marked have chosen for converting the internal activity to External activity.

Table 1 shows the details of the Activities performed and corresponding time consumed

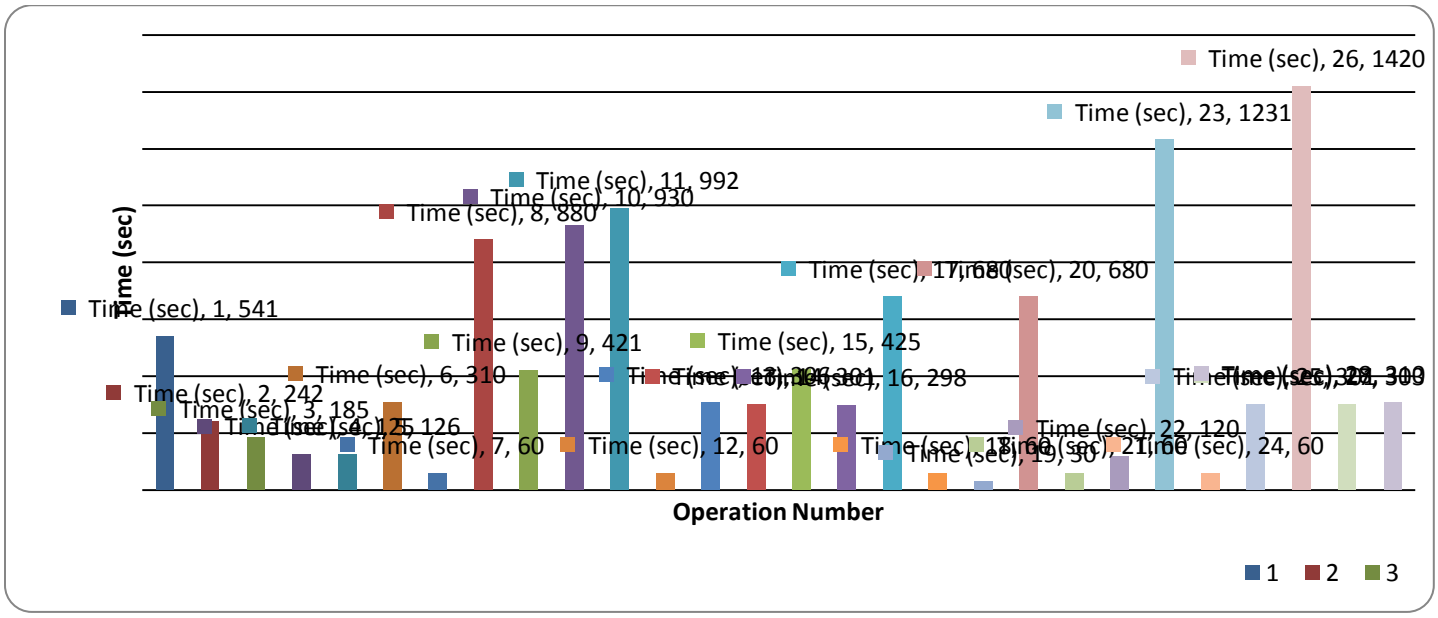
Opn No	Process Steps	Time Taken(sec)	Tools Required	Type of activity
1	Operator writes the LOC and takes the Sign of Q/C inspector	541	LOC book, Pen, Carbon paper	Internal Activity
2	Operator goes to the control plan table and picks up the required control plan chart	242	Control plan chart	Internal Activity
3	He brings the Required tools from the tool rack	185	Hammer, Spanner, Allen key, Al rod,	Internal Activity
4	Now he removes the Hob , Cleans it and kept just beside	125	Allen key, Al rod, Hammer	Internal Activity
5	He remove the Fixture now and cleans it	126	Allen key, Al rod, Hammer	Internal Activity

6	He goes to Fixture stand and brings the required fixture and height block	310	Height block	Internal Activity
7	Fixing the height block and tightening it	60	Height block	Internal Activity
8	Now he is fixing the required fixture and star washer, checking R/O , bringing the Extension	880	Hammer, Spanner, Allen key, Al rod,	Internal Activity
9	Now he brought the Work piece from vendor store	421	Work piece	Internal Activity
10	Once again he setting the Height block and checking the R/O of height block	930	Allen key, Al rod, Hammer	Internal Activity
11	Loaded work piece and setting the De burr tool	992	De burr tool	Internal Activity
12	Kept back unnecessary tools	60	Al rod , Allen key	Internal Activity
13	He goes to the consumable store and returns the previous hob and issues the required one	306	Hob	Internal Activity
14	Keeps the hob on hob arbor stand and checks the R/O	301	Spanner, Allen key	Internal Activity
15	He cleans the hob gripper and fixes the hob and checks the R/O	425	Cotton, Allen key, Al rod	Internal Activity
16	Operator Programming according to control Plan chart	298	Control plan chart	Internal Activity
17	Hobbing Starts	680	Nil	External Activity
18	He Checks the Diameter over the pin (DOP) - not okay	60	Micrometer, rubber band	Internal Activity
19	Once again he runs the program with some adjustments	30	Control plan chart	Internal Activity
20	Hobbing Starts	680	Nil	External Activity
21	Checks the DOP and finds satisfactory	60	Micrometer, rubber band	Internal Activity
22	Removes the work piece and cleans it	120	Cotton	Internal Activity
23	Now Operator goes to the graph test-waiting	1231	Work piece, control plan	Internal Activity
24	Operator finds the graph satisfactory	60	Graph paper	Internal Activity
25	Goes to the Q/C inspector and takes sign	301	Graph paper	Internal Activity
26	Operator hob 2 more parts and waits for the line Quality inspector	1420	Nil	External Activity
27	Quality inspector checks and okays it	303	Micrometer , pins, rubber	Internal Activity

28	Operator writes the FOC and Takes sign of Q/C head, production Starts	310	FOC book, Pen	Internal Activity

B. Analysis of the present situation

The collected details from the above setup are analyzed; from the chart below we can see that.

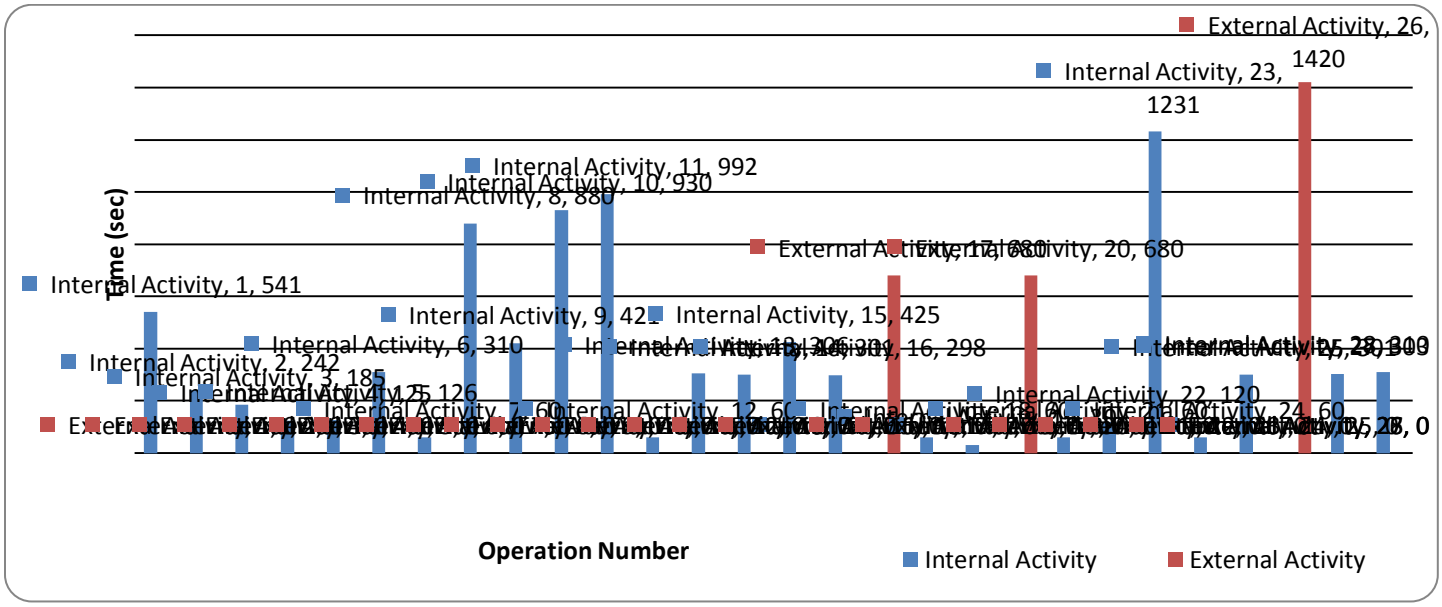


From the above chart,

- Setting up of the new fixture during the setup takes 7.76% of the total time loss
- Fixing of the height block consumes 8.20% of overall time loss, and
- Setting up the De burr tools takes 8.75% of the total time loss

So from the above data, there are many areas in the setup where I could reduce the time and improve the productivity. From the above chart there are various activities which were performing as internal activities only so there is the scope that I can convert it to the external activity and thereby reducing the setup time.

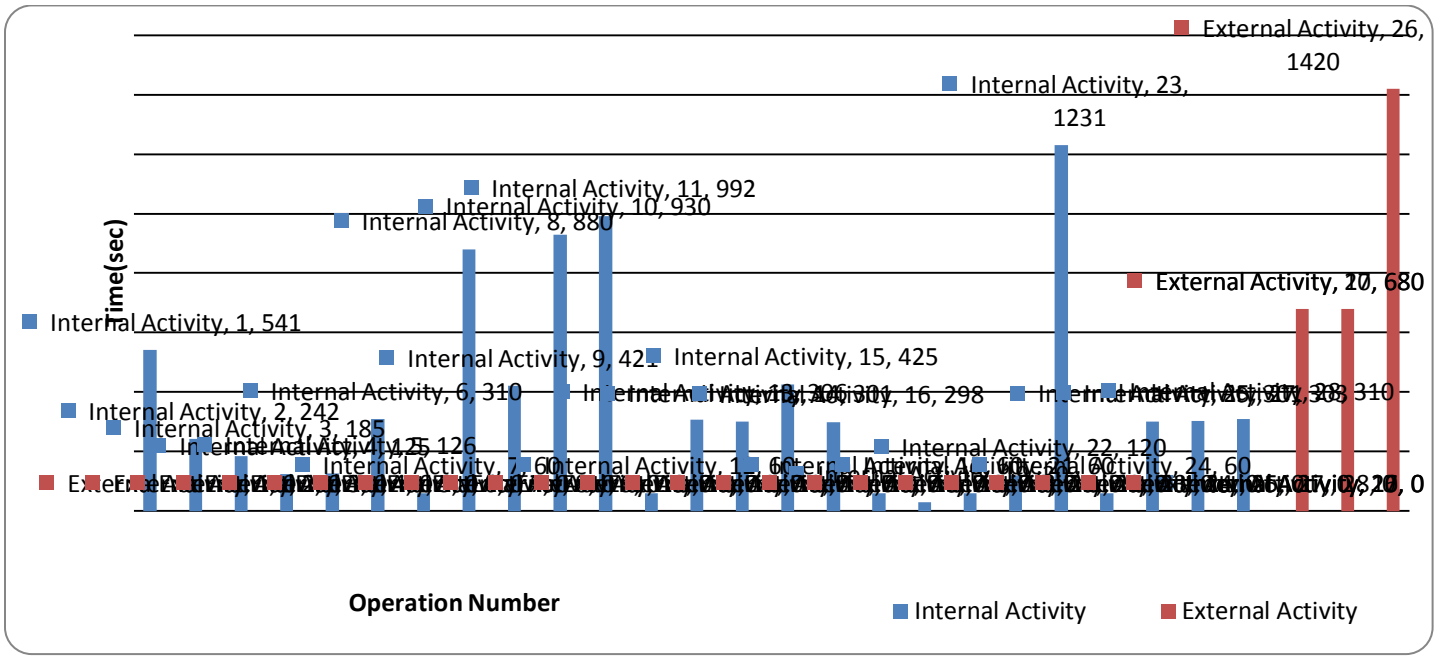
C. Identification of Internal and External Activities



From the above chart it can be seen that only three activities are external and the rest 25 activities are internal. My aim is convert as many as possible internal activity to external activity so that maximum time can be saved and productivity can be improved.

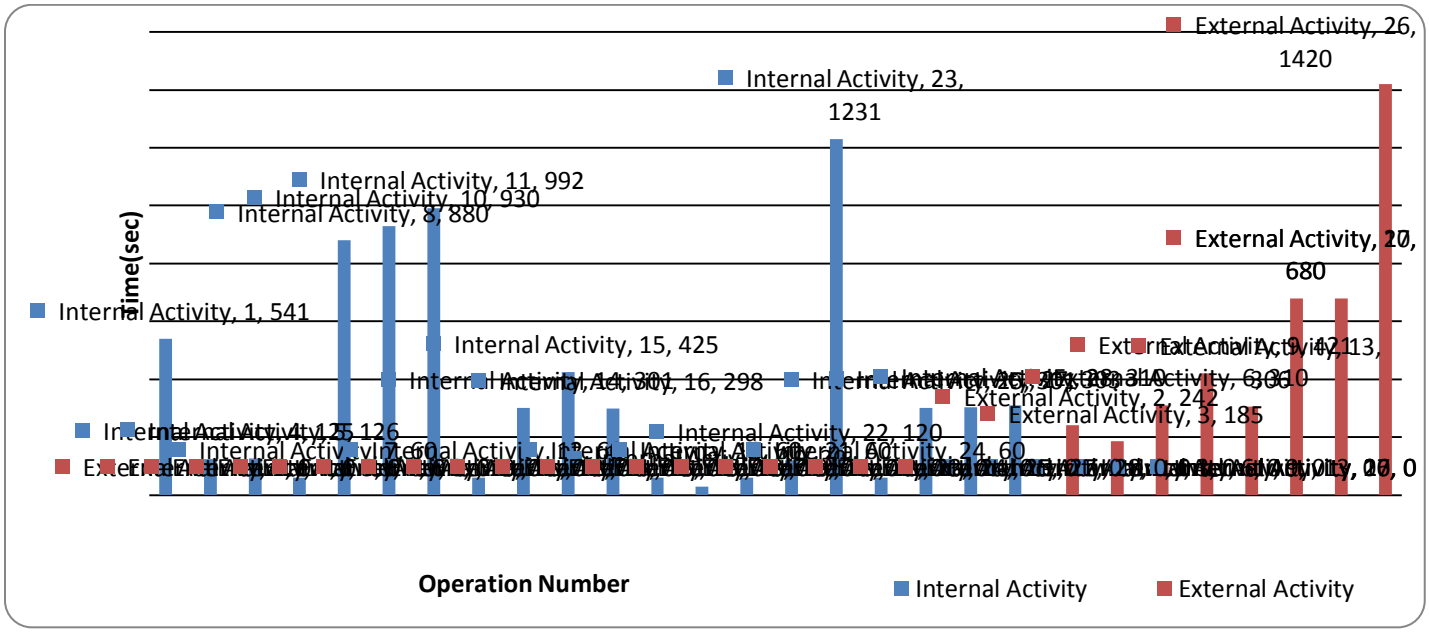
D. Separating Internal and External Activities

After analyzing the present situation in the setup, internal and external activities are identified and now separated as show in the figure. The blue color column indicates the internal activities whereas red color indicates External activities.



Here the three external activities (17, 20 and 26) were separated. Now I can see the clear picture of the activities that where they stand and how much time they consume. From the above table 1 activities need to convert are marked and thus it has to be changed to external. The next step will elaborate that.

E. Conversion on Internal Activities to External Activities



Five activities (2, 3, 6, 9, and 13) were successfully converted to the external activities and thus time 24.4 min is saved. Table 2 shows the details below.

Table 2 shows the details of the activities converted and corresponding time saved

Operation Number	Activity	Previously Activity	Planned Activity	Time Saving (sec)
2	Operator goes to the control plan table and picks up the required control plan chart	Internal	External	242
3	He brings the Required tools from the tool rack	Internal	External	185
6	He goes to Fixture stand and brings the required fixture and height block	Internal	External	310
9	Now he brought the Work piece from vendor store	Internal	External	421
13	He goes to the consumable store and returns the previous hob and issues the required one	Internal	External	306
Total Time Saved				1464

From the careful observation, I sorted out five internal activities which can be converted to the external one. These activities were performed as Internal. For example, operator had a habit of bringing all the required tools when the machine is turned off. Work piece also he used bring during the off period of machine. It was same for all activities like bringing the required fixture, Hob or Control plan chart. Here I can save time and that add up to the improvement of the productivity. From the above table it can be seen that 1464 seconds (24.4 minute) is saved. 13% time is saved from overall setup time.

F. Parallelism of Present Activities

In the present scenario, the operator was all the activities and but he has some lack of skills and ideas. Each activity was doing at a time and he was unaware that he could perform those activities parallel also. I combined some of the activities which can be made parallel and those activities are feasible also. The table 3 below shows the details about the activities combined and corresponding time saved.

Sl No	Activities done parallel	Time consumed (Before Parallelism)	Times consumed (After parallelism)
1	LOC and Sign of Q/C + Control plan chart + tools back	968	420
2	Brings Fixture + brings Height block	370	195
3	Graph Test satisfactory + Q/c Sign	361	205
4	FOC book + unnecessary tools	370	200
	Total Time	2069	1020
Time Saved after Parallelism = 2069 - 1020 = 1049 sec			

From the parallelism of actvities, a total of 17.48 minutes have been saved and it will add up to the time saved. 22.18% setup time reduction is obtained.

VI. RESULTS AND DISCUSSION

After converting the possible internal activities to external activities and then making some of the possible activities into parallelism, a setup time reduction of 22.18% is seen which is well in the range of 20 – 25 %. The following column charts shows the comparison in setup time before and after SMED.

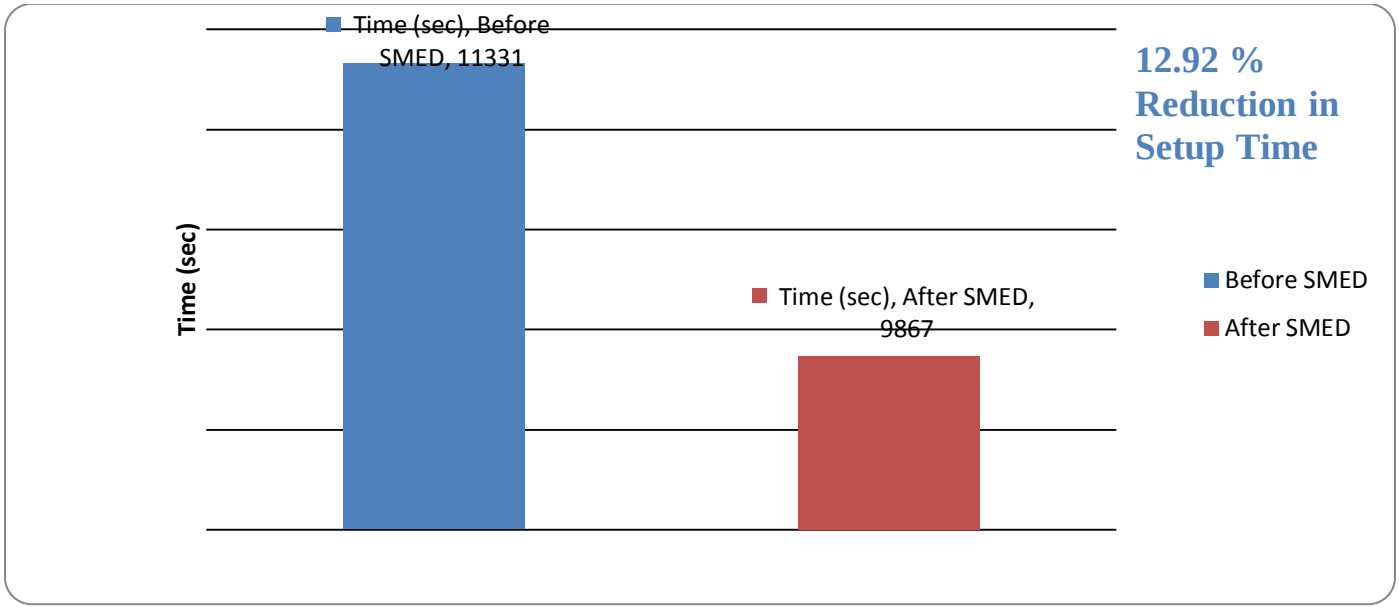


Figure 5 shows the comparison in setup time before and after SMED

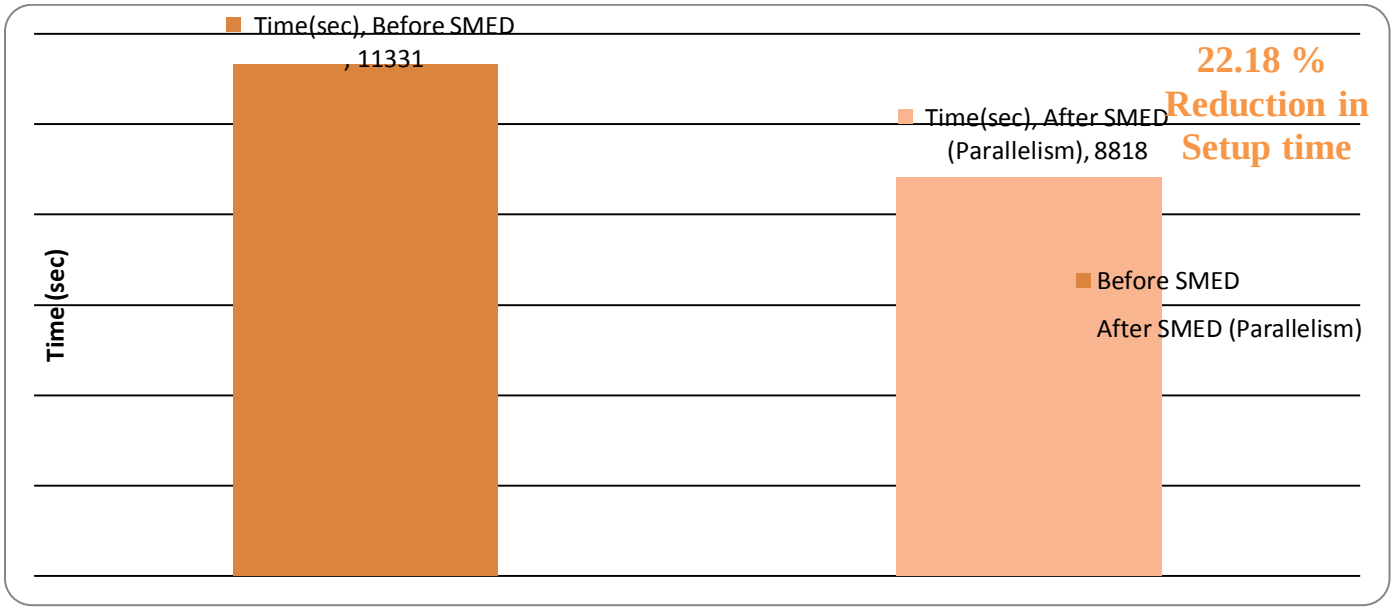


Figure 6 shows the comparison in setup time before and after SMED (some of the activities made parallel)

Table 4 Details of the result obtained

Objective	Time taken before SMED (min)	Time taken after SMED (min)	Time Saved (min)	Percentage Reduction (%)	Cycle time (min)
To reduce the Setup time of the Hobbing machine (6728) to 20 - 25%	188.85	146.96	41.9	22.18	11.3

VII. CONCLUSION

Implementation of the lean principles in any process will bring good results to any industry. Huge results can be achieved by elimination of non value adding activities. If these principles are applied in all department of the organization they will bring considerably good results. SMED methodology is applied to prepare a standard operating procedure for the changeover operation on particular machines. A comparison of results achieved before and after SMED implementation was made. In the objective, 22.18% of the setup time is reduced (41.9 min) and the corresponding cycle time of that machine is 11.33 min which implies that 41.9 / 11.33 = 3.7 parts can be produced in the time saved. The elimination of the wastes improves the productivity which in turn delights the customer and helps the organization to move towards their vision and goals. I conclude that by implementing the SMED technique, Productivity can be achieved and wastes can be eliminated.

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