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Application of SMED in Small Scale Garden Tube Manufacturing Industry

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Abstract - The purpose of this thesis is to implement a new concept of single minute exchange of die to reduce the set-up time of machine. To implement and analysis the benefits of SMED, this concept is implemented in small scale industry Utkarsh Polycool Garden Tube manufacturing industry. The need of this concept is to reduce the internal time and increase the external time. Therefore, in this thesis before and after implementation of single minute exchange of die is calculated. The outcomes are excellent, and the adjustments made in the workplace were rather minor and had little impact on worker comfort. However, the single minute exchange of die technique has made industrial workers much more at ease and has increased productivity.

***Key Words*:** Small Scale industry; Single minute exchange of die, Internal Time, External Time.

1.INTRODUCTION

MADHYA PRADESH state is now growing rapidly in SME's sectors and provides so many helps to them. MADHYA PRADESH state having enough resources but due to the lack of expert knowledge, lack of adoption of industrial good practices, SMEs situated in MADHYA PRADESH are not growing well. Therefore, in this research work with the help of literature survey and experts' opinion and effective tools is find out and applied in one of the SMEs to validate the results and reduce the ideal time and convert it to useful time and convert their business into profitable business. To achieve this 'lean manufacturing methods provide a set up technique known as "single minute exchange of die," this will apply on SMEs to validate the above written benefits.

2. OVERVIEW OF SINGLE MINUTE OF EXCHANGE OF DIE

SMED was developed by Shigeo Shingo in 1950s Japan in response to the emerging needs of increasingly smaller production lot sizes required to meet the required flexibility for customer demand. The SMED technique is used as an element of Total Productivity Maintenance (TPM) and "continuous improvement process" [8]. The phrase "single minute" does not mean that all changeovers and startups should take only one minute, but that they should take less than 10 minutes (in other words, "single-digit minute"). [26]

The origins of SMED technique can be dated back to 1950, when Shigeo Shingo, then management consultant at the Japan Management Association, was asked to eliminate bottlenecks created by three large body-molding presses at Toyo Kogyo's Mazda plant in Hiroshima (JMAC). During this survey Shingo had the first of a series of breakthroughs that would later become famous under the name of SMED. By observing an 800-ton press setup, Shingo realized that "there are two types of setup operation:

• Internal setup – setup operations that can be performed only when the machine is stopped, such as mounting and removing dies.

• External setup – setup operations that can be completed while the machine is running, such as transporting dies to or from storage" (Shingo 1989).

He observed that by performing operations such as organizing and preparing the bolts externally, it was possible to reduce the setup time by 50 percent.

3. LITERATURE REVIEW

In this research work the main aim is to find out an effective, simple, easy to understand and most economic industrial tool, which will increase the productivity, profitability, customer satisfaction, and improve work culture. To achieve above, following steps are taken:

I. Examine literature related to small scale manufacturing industry work on lean manufacturing.

II. Direct interview with the small-scale industry owner and understand their work culture and methodology.

III. Discuss the literature and interview with the academician related to our work.

The literature survey also contents the research paper related to implementation of SMED in SMEs. From the literature survey its clear to understand that to implement SMED following steps need to follow:

I. Separate internal from external setup operations

II. Convert internal to external setup

III. Standardize function, not shape

IV. Use functional clamps or eliminate fasteners altogether

V. Use intermediate jigs

VI. Adopt parallel operations

VII. Eliminate adjustments

VIII. Mechanization.

3. Aim and Benefits of the Research Work

The goal of this study is to minimize internal time and convert most of the internal time to external time to reduce setup time to a single digit minute. By using this strategy, SMEs can decrease waste and idle time while increasing customer satisfaction through on-time delivery. If SMEs meet the mentioned goals, their productivity and profit can increase dramatically. All it takes is a small adjustment to the economy and working procedures to make this happen. In Madhya Pradesh lots of SMEs are working but most of them are not much aware about the general industrial tools like VCM (value chain map), SMED (single minute exchange of die), preventive maintenance, 5S and OEE (overall equipment effectiveness) etc. because these industries are mainly engaging in completion of projects and not observe the area of improvement by just focusing the cost area like man cost, machine maintenance cost and wastage cost. But not adopt an effective industrial method to improvise them.

To validate above in this research a case study company “Utkarsh Polycool garden tube Manufacturing Industry” has selected and this is a manufacturing company making PVC garden tube with size of Ø ½ inch, Ø ¾ inch, and 1 Ø inch. This industry is come under small scale industry but it belongs to manufacturing company using extruder machine has the implementation of any industrial tool can be apply in other kind of manufacturing industry. but this industry has only one manufacturing machine for production.

4. Problem Statement

Through a review of the literature and process observation at the "Utkarsh Polycool PVC garden Tube Manufacturing industry," it was discovered that the operator was not keeping track of the amount of time needed to set up the machine and that a significant amount of time was wasted on transportation and tool searches. Therefore, the main issues find out in the implementation of SMED are as follows in “Utkarsh Polycool PVC garden Tube Manufacturing industry”:

i. The industry lacks accurate machinery setup time calculations.

ii. The extruder area is not systematic and far away from raw material and tool room area due to which tool and different size dies transportation require extra time and effort.

iii. The industry lacks the necessary understanding of the “single minute exchange of die.”

The research challenge and the area where SMED implementation will provide a solution are both accurately defined by the above points. The SMED implementation procedure is provided in the upcoming research methodology chapter along with a solution strategy.

5. Research Methodology & Structure

The test presentation also enables quick recognition of the test flow diagram. The all steps of the methodology are as follows:

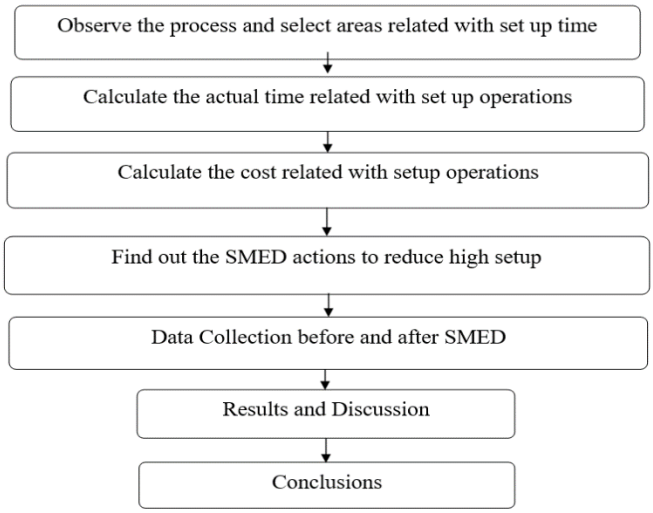


Fig. 4.1 FLOW CHART OF RESEARCH METHODOLOGY

Figure-1

6. Data Collection

The research technique states that every step of the garden tube manufacturing process is observed, from the very beginning to the completion of the final product. A stop watch is used to measure and record all time-consuming procedures sequentially. Before SMED is implemented, the time records of the processes are written down in a table. In this industry, Ø ½ inch, Ø ¾ inch, and 1 Ø inch PVC garden tubes are produced by a single extrusion machine. The data collection steps are given below are as follows:

I. **STEP ONE:** In this first step present setup time is observe and record for all the diameter size. To perform recording time mobile stop watch is used. For recording a table is prepared of three columns in which first column denote serial number, second column denote setup process name, third column denote net time in minute and fourth column denote total time in minute.

Serial Number	Setup Process Name	Net Time (minute)	Total Time (minute)
1	Start & Heating of Extruder Machine for Ø 1/2 Size	120	120
2	Fill Raw Material (HDPE) in 04 buckets 25 Kg Each	40	120
3	Fill oil and color in two different buckets	15	120
4	Wait for Heating	65	120
5	Put Raw Material in Extruder Hopper	10	130
6	Extrusion Start/Cooling & Trifling	60	190
7	Packaging	80	270
8	Die set for next size Ø ¾	20	20
9	Same Procedure is adopting for size Ø ¾ excluding heating of extruder machine		

Table 4.1 Example Setup Time (Before SMED)

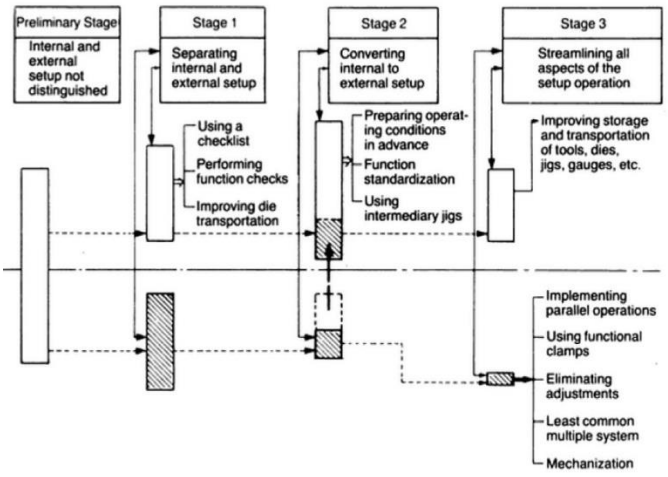
II. **STEP TWO:** In this second step internal and external activities are note down and separated. Because our aim is to convert internal time to external time. For this work a table is prepared in which internal and external activities are written in different column along with time consume.

S.NO.	INTERNAL ACTIVITY	INTERNAL ACTIVITY TIME	EXTERNAL ACTIVITY	EXTERNAL ACTIVITY TIME
1	Die Setting for Extrusion	20 Minutes	Fill Raw Material (HDPE) in 04 buckets 25 Kg Each	No Time (in between Start & Heating of Extruder Machine)
2	Start & Heating of Extruder Machine	120 Minutes	Fill oil and color in two different buckets	No Time (in between Start & Heating of Extruder Machine)
3			Put Raw Material in Extruder Hopper	10 Minutes
4			Extrusion Start/Cooling & Trifling	60 Minutes
5	Extruder Machine Set for Next Size Ø ¾	20 Minutes	PACKAGING	80 Minutes

Table 4.2 Internal & External Activity Time (Before SMED)

III. **STEP THREE:** After second step next step is to find out the best possible method or approach to convert internal time to external time and try to minimize the internal time by adopting best method of working by adjusting the right sequence of work through which SMED will achieve.

IV. **STEP FOUR:** In this step above three steps are streamline as per time, man, machine, and money.



7.IDENTIFICATION OF CRITICAL AREA OF SET UP TIME

Based on the SMED 08 concept following critical were observed on observation time:

i. Extruder machine require 120 minutes of heating before start production hence in between the worker prepare raw material but they can prepare raw material for 100 Kg (only one lot size) production only. After that they are engaging in production process because industry have one supervisor and three helpers.

ii. The production planning is done based on market demand and according to it every size is manufactured but this kind of planning increase the internal time.

iii. Raw material and tools are not placed as per production planning. Hence carrying and travel time increase the internal time.

iv. Ergonomics and working area of industry are not well managed.

v. Tools and techniques are not effectively used by worker.

8. OBSERVATION & SUGGESTIONS OF MACHINE SET-UP PROCESS

For the application of SMED in the industry a whole week production process is observed and time is noted for every process after that as per SMED 8 techniques suggestions given to industry owner and owner agree with the technique implementation in the industry for one week. After that before and after SMED application time comparison is done. The suggestions are given below:

i. **Activity:** The first suggestion is given that at the time of machine heating all 03 helpers prepare raw materials not only for one lot but for three lots i.e. two helpers prepare raw materials (HDPE) for 12 buckets and one helper fill oil and color in 06 buckets.

Suggestion: This suggestion converts the 65 minutes wait for heating internal time to external time because in between these two lots is also fill in bucket for next 200 Kg production.

ii. **Activity:** The raw material stocks are placed 60 feet away from the extruder machine and because of that it takes 15 minutes to carry and place raw material near the machine for one lot. Therefore, for four lots production require 60 minutes time for carry and place raw material.

Suggestion: To reduce this internal time a suitable small area is selected to kept near the extruder machine, which is helpful for reducing raw material transport time from raw yard to extruder machine area.

iii. **Activity:** After completion of the production of one size, die is again set to produce next size, which has taken 20 minutes internal time. By the observation it is found that the L-key is used for die set take more time because of short length and more effort required to tight the die nuts.

Suggestion: A one-foot hollow pipe having internal diameter equal to L-key outer side. This arrangement provides the leverage effect and because of it less power require to set die for next size production.

iv. **Activity:** The production planning is done by company on the experience basis that the Ø ¾ inch diameter size garden tube has more demand from the market side rather than other two size (Ø ½ inch, Ø 1 inch). Therefore, industry follow 50:50 ratio, it means in a full day working first three a half hour (03 hour 30 minutes) used to produce Ø ¾ inch size and second half

(03 hour 30 minutes) for next size (Ø ½ inch). Second day same procedure is adopted but in second half other size (Ø 1 inch) is produce. This production planning is adding the die setting internal time and the enough lot is not produced in one day to sell.

Suggestion: The industry do not have proper forecasting of the demand because as per the dealer requirement they supply the garden tube but to meet the demand some time require to manufacture because of that delivery require some time and this will affect the reputation of the industry.

After discussion and observation with industry owner its decided that the production is done based on one size production in one day. It means a whole day machine is set for one size by which in one day 500 Kg (10000 feet) garden tube is manufactured for selected size.

v. **Activity:** After 100 ft garden tube is cut by automatic saw, trifling chute roll the garden tube make it bundle. The bundle of garden tube is wrap by worker manually by plastic sheet and tapping it but if the worker wraps the plastic sheet loosely it will unwrap in the handling and transport time. Therefore, for wrap it tightly work need extra time. One bundle takes four minutes to completely wrap and tape, total 80 minutes require to wrap 20 bundles.

Suggestion: To wrap the garden tube bundle tightly in short time a hand-hot air blower is used by which only two turns of plastic sheet require instead of four turns by hand wrapping. Therefore, hand hot air blower reduces the packaging time by two minutes. It means only 40 minutes require to wrap the 20 bundles.

9. CONVERSION OF INTERNAL TIME TO EXTERNAL TIME AS PER SUGGESTIONS

In the observation process, total four activities are identified for the implementation of single minute exchange of die and as per SMED technique suggestions given and implement. The suggested activities are observed for twelve days. After the observation following conversion from internal to external time is recorded:

After the observation following conversion from internal to external time is recorded:

S. NO.	Substitution Process	Procedure	Before SMED (min)	New Procedure used	After SMED (min)	Time Save (min)
1	Die Setting	Manual	20	one-foot hollow pipe attaches with L-Key	10	10
2	Start & Heating of Extruder Machine	Automatic	120	Nil	120	0
3	03 Helper Fill Raw Material (HDPE) in 04 buckets 25 Kg Each	Manual	40	External	40	00
4	02 Helper Fill oil and color in two different buckets	Manual	15	External	15	00
5	Wait for Heating	Automatic	65 (Idle Time)	02 Lots of raw material of 200 Kg Prepare	External-00	65
6	Put Raw Material in Extruder Hopper	Manual	10	Nil	10	00
7	Extrusion Start/Cooling & Trifling	Automatic	60	Nil	60	00
8	PACKAGING	Manual	80	Hand Hot Air Blower is used for Tight wrapping	40	40
9	Extruder Machine Set for Next Size Ø ¾	Manual	20	one-foot hollow pipe Fix with L-Key	10	10
	TOTAL TIME (In Minutes)		**430 Minutes**		**305 Minutes**	**125 Minutes**

Table 5.1: Activity Time Table Before and After SMED

As we can see from above table that the total time before SMED is 430 minutes and by using new procedure as suggested by research work, it has been converted into 305 minutes. Total 125 minutes save by adopting new procedures.

10. INTERNAL & EXTERNAL TIME AFTER SMED

Additional activities are divided into internal and external categories. External ones are performed, when machines are in operation, and internal ones are performed, when machines that have stopped.

The identification of single minute exchange of die to implement area are given below in tables:

S. NO.	Activities	Category	
		External	Internal
1	Die Setting for Extrusion		Internal
2	Start & Heating of Extruder Machine		Internal
3	Fill Raw Material (HDPE) in 04 buckets 25 Kg Each	External	

4	Wait for Heating		Internal
5	Fill oil and color in two different buckets	External	
6	Put Raw Material in Extruder Hopper	External	
7	Extrusion Start/Cooling & Trifling	External	
8	PACKAGING	External	
9	Extruder Machine Set for Next Size Ø ¾		Internal

Table 5.2: Internal & External Activities Before SMED

S.NO.	Activities	Category	
		External	Internal
1	Die Setting for Extrusion		Internal
2	Start & Heating of Extruder Machine		Internal
3	Fill Raw Material (HDPE) in 04 buckets 25 Kg Each	External	
4	Wait for Heating	External	
5	Fill oil and color in two different buckets	External	
6	Put Raw Material in Extruder Hopper	External	
7	Extrusion Start/Cooling & Trifling	External	
8	PACKAGING	External	
9	Extruder Machine Set for Next Size Ø ¾	Activity removes	

Table 5.3: Internal & External Activities After SMED

The time taken before SMED by main activities are:

S.NO.	Name of Activities	Time Taken (Minutes)
1	Die Setting	20
2	Wait for Heating	65
3	Packaging	80
4	Extruder Machine Set for Next Size Ø ¾	20
TOTAL		**185**

Table 5.4: Time Taken Before SMED

The activities changed and technique used as per SMED are given below:

S.NO.	Activities	Activity Type	Activity Type Change	Technique Used
1	Die Setting	Internal	Nil	one-foot hollow pipe attaches with L-Key
2	Wait for Heating	Internal	External	02 Lots of raw material of 200 Kg Prepare
3	PACKAGING	External	External	Hand Hot Air Blower is used for Tight wrapping

Table 5.5: Activities Changed and Technique Used As Per SMED

This table details the transitions between internal and external activities as well as several time-saving methods.

S.NO.	Activity	Time Before SMED	Time After SMED	Time Saved
1	Die Setting	20 Minutes	10 Minutes	10 Minutes
2	PACKAGING	80 Minutes	40 Minutes	40 Minutes
	Total	**100 Minutes**	**50 Minutes**	**50 Minutes**

Table 5.6: Activities Time Before & After SMED

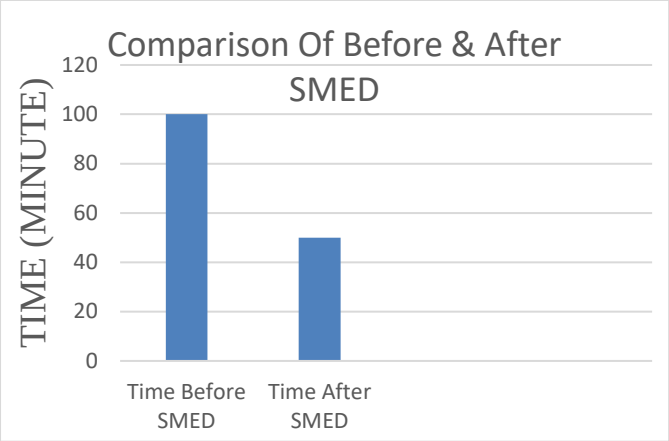


Figure: 5.1 Time Comparison Before & After SMED

It is clearly seen from the above graph that the SMED implementation reduce the activity time by 50 minutes. By the using of adopt parallel operation method total 65 minutes time is also save because this 65-minute worker become idle and by SMED technique in these 65 minutes worker involve in the new lot preparation. Hence total 115 minutes save in a single day. The extruder machine produces 100 Kg Garden tube in one hour, so we can understand that the industry can manufacture 200 Kg extra garden tube by implementing SMED.

11.RESULTS FROM SMED OF MACHINE BEFORE AND AFTER SMED IMPLEMENTATION

By implementing the SMED in polycool garden tube manufacturing industry following results were received:

i. Before single minute exchange of die (SMED) implementation industry have total 09 activities in which 05 external activities and 04 internal activities. After implementation of SMED one activity reduce by adopt parallel operation of SMED and one external activity increase. Therefore, after SMED total 06 external activity and 02 internal activity.

ii. Before SMED 65 minutes waste for wait for heating of machine (internal activity) which is converted into external activity by preparing raw materials for two lots in between wait for heating time.

iii. Before SMED, die setting require 20 minutes because normal size L-key is used by which machine operator is take time to die set but by SMED mechanization concept L-key is attached in a one-foot hollow pipe due to this machine operator can set die easily and time reduce by 10 minutes.

iv. Before SMED, packaging is done by hand wrapping of plastic film on the 100 ft bundle. By using SMED mechanization technique hand hot air blower is used for tight wrapping of plastic cover. By this method total 40 minutes save.

The key finding is that the company Polycool Garden Tube Manufacturing was able to remove wastefulness and non-added value operations by using SMED approaches. Additionally, the extruder machine's setup time was lowered from 430 minutes to 305 minutes, and other associated activities took less time further shortened from 20 to 10 minutes for setup.

The use of SMED techniques and the shifting of some internal tasks into external tasks led to a notable daily gain in productivity of 125 minutes, or 200 kg, as well as higher profit.

12. CONCLUSION

SMEs must use all available decision support tools to augment production planning for increased productivity to attain "manufacturing excellence. In today's dynamic and competitive climate, productivity and profitability should be the primary indices of sustainability. Therefore, methods such as SMED have enormous potential to shorten product cycle times and boost competitiveness. SMED is essential to raising the industrial sector's performance. The market is calling for more personalized items these days, which puts pressure on manufacturers to lower the cost of their products to compete in the fiercely competitive market. Therefore, businesses need to be able to produce a wide range of goods quickly, and as a result, they need to have the capacity for considerably more frequent die changes to minimize setup time. Almost all manufacturing organizations prioritize increasing productivity, maintaining operational availability, and improving the overall efficiency of the production line. Industries need to develop ways to cut setup times, get rid of unproductive and non-value-adding operations, and turn idle setup time into regular production time to compete in today's competitive global market. Setup time Manufacturers must endeavor to streamline their operations by implementing lean production strategies like SMED to meet these goals. impact prices, capacity, downtime, and product quality. Extended setup times might result in lower productivity and output rates. The garden tube extruder machine was chosen for this study to minimize setup time. The extruder machine's setup time was lowered from 430 minutes to 305 minutes.

13. ACKNOWLEDGEMENT

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