The Implementation of Single Minute Exchange of Die with 5'S in Machining Processes for reduction of Setup Time

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Abstract:-Nowadays market demand is increasingly time to time and there is no time to waste and also shortage of manpower throughout the world. Reduction in time is direct way to increase the productivity and profit. So there is need to reduce the time by using some new lean methodology. In global industry there is different techniques are used for reduction of time. All of this we use the SMED (Single Minute Exchange of Die) technique for reduction of time. In this paper we describe that how the SMED technique is used and how it helps to reduce the time and increasing the productivity. The SMED technique is implemented on three mechanical pressesmachines and calculated the setup time before and after implemented SMED.

Keyword: - *SMED (Single Minute Exchange of Die), 5'S, Setup Time, Productivity*

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1. Introduction: -

Today's customer needs a good quality product with low price and less time. This is not possible with using conventional methods for manufacturing. This is possible with only using modern techniques and machines as per the requirement of the process. So to complete the requirements, we have used the SMED technique to reduce the time of operation for the existing machines.

1.1. SMED: -

Single-Minute Exchange of Die (SMED) is one of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. 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") [1].SMED methodology applied to prepare an optimal standard procedure for changeover operations on defined machine. However, for small batch manufacturers the issues that led to the change in focus for long run producers have not been present to the same degree. A comparison of results and achievements before and after SMED implementation were done to measure the effectiveness of SMED to reduce cycle time [2].
SMED is one of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. It is also often referred to as Quick Changeover (QCO) [3].The SMED process complete in four steps i.e. combine, elimination, simplification and measure that shown in figure no. 01.

Figure: - 01, SMED Process

1.2. Types of SMED: -

Internal Setup–In this setup the operations that can be carried out when the machine is shut down or off at time of working. An example would be the removal or exchange of a die or drill bit.

External Setup–In this setup the tasks that can be carried out while the machine is in operation or running. An example in this is transportation of a new die or bit to the machine.

Single Minute Exchange of Dies (SMED) mainly focuses on recognition of internal and external activities. It is concerned particularly with transferring internal activities into external ones in as many numbers as possible, by also minimizing the internal ones [15].

1.3. Setup Time: -

Setup time, or changeover time, is defined as the time from completion of the last good part of one lot to completion of the first good part in the next lot. Traditionally, when somebody referred to changeover, they used to refer to mere tooling attachment and detachment operations. Actual changeover, on the other hand, is longer, and comprises all activities required to have the machine ready to produce the new lot [20].

2. Literature Review: -

The Single Minute Exchange of Die (SMED), a process-based innovation originally published in the mid 1980s, involves the separation and conversion of internal setup operations into external ones. Although very important in increasing productivity SMED experiences are not very widespread in Ibero-America [4].

Single-Minute Exchange of Die (SMED) refers to the theory and techniques used for the reduction of equipment setup times. SMED has as its objective to accomplish setup times in less than ten minutes, i.e. a number of minutes expressed by a single digit. Although not all setups can be literally reduced to this time, between one and nine minutes, this is the goal of the SMED methodology (Shingo, 1985).

Dr. Shingo was developing SMED, Mr. Ohno, as the executive managing director of Toyota, was realizing that there was a close connection between the principle aspects of the Toyota Production System and the SMED system. In his pursuit of the ideal production system, he became convinced that drastic reductions in set-up times were essential. This conviction prompted him to demand that his people achieve three minute die changeovers. Fortunately, his demand and Shingo's ideas about the SMED system that were in the back of his mind, coupled with Shingo's keen interest in set-up reductions all came together in a timely manner [5].

The production is limited by similarity of technological processes. That is why it is so important to well design the production lines at the beginning in corporations dealing with mass production [6].

After implementing the SMED methodology, it is possible to defend that simple process-based innovations, as the Separation of internal from external operations and the conversion of internal to external operations, are among the key drivers to productivity improvement [7].

In Shingo's terminology, "single minute" exchange of dies (SMED) refers to setup times less than "10" minutes. Since he typically worked with stamping presses with multi-hour setups, this was a major accomplishment. Our first contribution was to demonstrate the applicability of Shingo's Single Minute Exchange of Dies approach well beyond the situations it was developed for [8].

For small batch manufacturers the issues that led to the change in focus for long run producers have not been present to the same degree. SMED methodology applied to prepare an optimal standard procedure for changeover operations on defined machine. A Comparison of results and achievements before and after SMED implementation were made to measure the effectiveness of SMED to reduce cycle time. Hence, not only is it imperative to focus on reducing the amount of productive time that is lost when a machine is being set, but also to eliminate errors, with the application of poka- yoke principles to the setting equipment and procedures [10].

The SMED method has been improved by additional procedures simultaneously applying the 5S method. With this method application has resulted in the following improvements: average tool exchange time periodis decreased, machine flexibility is raised due to reduced tool exchanges in controlled time period increasing in this way different parts production possibilities [11].

SMED is a process and not merely a program because a program has a beginning and an end. Therefore, constant sustaining and improvements through SMED must be continuously implemented [12].

SMED if implemented properly can help in reducing sources of waste in systematic way [13].

SMED methodology was applied to prepare an optimal standard procedure for changeover operations on defined machine. Ergonomics and safety issues were also taken into consideration during setups. Since an ergonomic workplace makes operations easier for the operators, simple however crucial changes are suggested [15].

In the current business scenario with emerging global competition and rising customer expectation, providing lowcost and high quality products is a winning mantra. These high expectations can be met through low cost automation andby keeping low operational cost.Minimizing the operation cost can be achieved by improving operational indicators likedelivery, quality, performance of machine etc. [16].

The success of any study or a study lies on the proper selection of an appropriate strategy and right methodology. Also it is essential to have a systematic procedure to approach the problem. The right approach towards the problem will increase the

confidence level of the organization. Without one, the solutions may be ineffective and may lead to some painful consequences [17].

It is important to note the methodology developed by Shingo SMED as well as the derived approach proposed don't have a strict, application and it is fundamental to adapt them to the reality of the companies to be successful implemented and that is essential to mixed up functional and structural changes into implementation entails. As we have shown most of thetimes is not necessary to make big investments to achieve reduced changeover times if weexamine well the existing resources and reorganized them to be more effective [18].

SMED helps to reduce machine setup times by eliminating wastes and unnecessary setup processes and also helps to improve current setup processes and manufacturing flexibility [19].

SMED philosophy was adopted to investigate the setup operations. It primarily consisted of analyzing the external and internal setup activities in terms of their need (i.e. preparation, replacement or adjustment), time taken and the way these could be reduced, simplified or eliminated [21].

3. Summary of Literature Review: -

Manufacturing Time and cost is important key to success of each industry, so we need to reduce the manufacturing time and cost of industry. The lean manufacturing has given the good result to reduce the manufacturing time and cost of industry. The lean manufacturing has different types of technique according to our requirement in industry. The SMED and 5'S of TPM technique has been best practice to reduce the setup time of machine and increase the productivity and it is easiest technique to implement in any machine in industry.

4. Implementation of SMED in Mechanical Press Machine in Gill Agro Industry: -

4.1. Introduction:

Gill Agro Industry situated in Punjab state and it manufacturing different types of agriculture machine since 1976. In this industry we see that there is need to implement lean manufacturing in Industry. We see that in there have lot of time waste in changeover the die and tool in mechanical press machine. There have been three mechanical press machines, 25 tones, 50 tones and 150 tons respectively.

4.2. Problem Formulation:-

To find the problems at time of changeover in mechanical press machine first made the fishbone or cause and effect diagram of high setup time of mechanical press machine that shown in figure no. 02. In this figure shows the causes of high setup time due to Manpower, Method, Machine and Equipment's. With the help of we have found out the root causes of this high setup time and easily resolve by the implementation of SMED technique.

4.3. Methodology: -

After we study the different sources we found the procedure to implement the SMED technique with 5'S, its procedure is shown in figure no. 03, in which in which first we use 5'S technique and then classify the internal and external set up to convert internal to external setup and streamlining all aspects of setup operation.

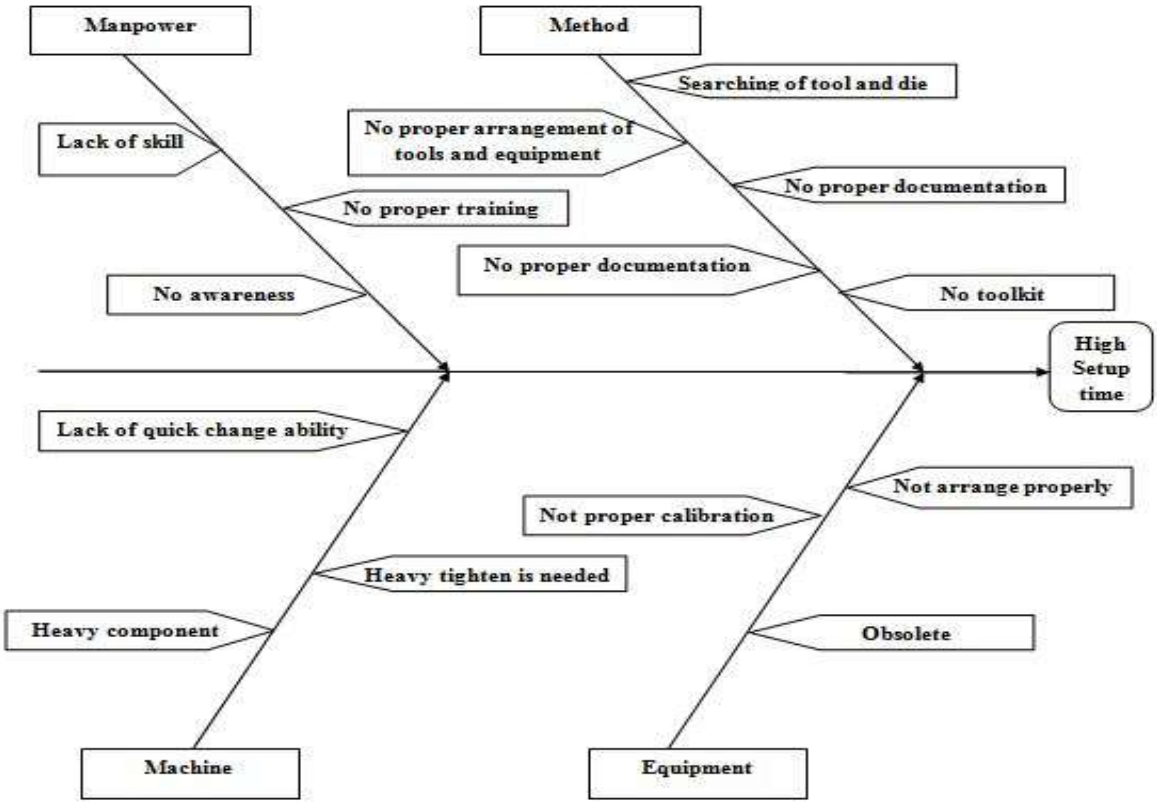

Figure: - 02, Fishbone diagram of high setup time of mechanical press machine

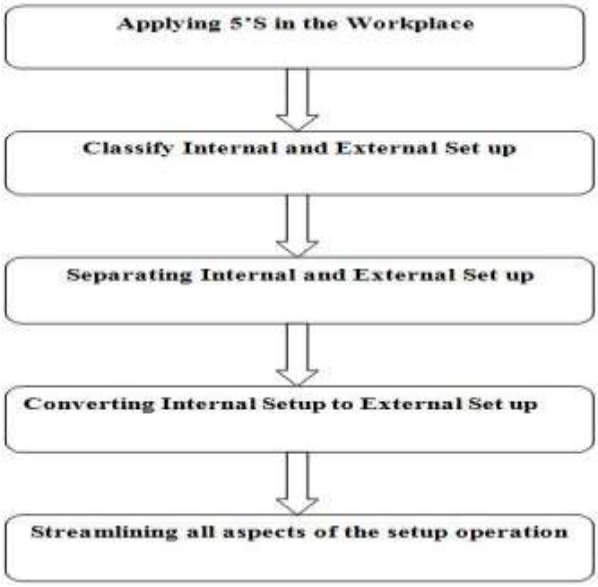

Figure: - 03, Procedure to Implement the SMED

4.4. Step by Step procedure to implement the SMED in Mechanical Presses Machine: -

Step 1: -

In this step we have implemented the 5'S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) technique in the workplace. In which we have separated out the unnecessary and necessary tools and equipment in the workplace and proper arrange and locate the necessary tools and equipments in near place of the machines and also used the trolley for some tools and equipments to easily carry this tools and eequipments. In this step we have also clean the workplace and machine to increase the morale of employees. The arrangement of some die and tools near of machine were shown in figure no. 04.

Figure No. 04, Arrangement and locate of tools and dies in near of the machine

Step 02: -

In this step we have classify the Internal and External set up by using the Internal and External Set up sheet as shown in figure no. 05, in which shows the name items and type of set up and also shows the what items or process would you convert from Internal and External Set up with its reasons. In this step we have also study the overall condition of workplace and machines to implement the SMED.

Internal and External Setup Sheet

Sr. No. _____ Date: _____

Name of Employee: _____ Name of Department: _____

Name of machine: _____

Name of Setup (Internal or External): _____

Which items or process would you convert from Internal to External Setup?

_____

_____

Why?

_____

_____

Signature

Figure: - 05, Internal and External Setup Sheet

Step 03: -

In this step we have separate the internal and external setup sheet to specify the setup process and it is easy to use at time of setup of machine.

Step 04: -

In this step we have try to convert most process or items from internal to external setup. It helps to reduce the setup time of machine.

Step 05: -

In this step we have streamlining all aspects of setup operation. This step also include the basic improvement of internal and external setup in machine and developing different methods of complete the tasks in easier, faster and safely ways. We have also checklist the improvement in setup operation after the implemented the SMED and search the causes of repeated activities and unnecessary physical damaged and trying to remove or reduce them. In this step there is need to better planning activity to successful implementation. We also suggested the some points to reduce the setup time that shown below.

- Avoid the use adjustable tool in workplace
- Select the tool you needed at workplace.
- Minimize the bolt length and split the thread and using one turn fastener.

- Use checklist operating procedure.
- Increases the number of equipments used in workplace.

5. Data collection and analysis the Set up time for comparison between before SMED and after SMED: -

After the SMED implementation in three mechanical press machines we calculated the setup time before and after SMED implementation. The Table no. 01, 02 and 03 are shown the setup time and save time of mechanical press machine (25 tones, 50 tones and 150 tones) before SMED implementation and after SMED implementation. In the Table no. 04 shows the total setup time and save time of three machines before SMED implementation.

Table No. 01, Set up time of 25 tones Mechanical Press machine (Before and after SMED Implementation)

Sr. No.	Activity/Process	Time (Minute) Before SMED	Improvement Idea	Time (Minute) After SMED	Time Saving
1.	Open nut and bolt to remove the last tool from the machine	08	Simplification	06	02
2.	Open nut and bolt to remove the Die from the machine	08	Simplification	07	01
3.	Search the next tool for machine	02	Implement 5'S, Convert Internal to external Setup	00	02
4.	Search for spanner and other equipments	03	Implement 5'S, Convert Internal to external Setup	00	03
5.	Search the next die for machine	03	Implement 5'S, Convert Internal to external Setup	00	03
6.	Tighten the nut and bolt to adjusts the tool on machine	12	Simplification and using Poka-Yoka	08	04
7.	Place and Tighten the nut and bolt to adjust the die on machine	18	Simplification and using Poka-Yoka	15	03
	Total Time	54		36	18

Table No. 02, Set up time of 50 tones Mechanical Press machine (Before and after SMED Implementation)

Sr. No.	Activity/Process	Time (Minute) Before SMED	Improvement Idea	Time (Minute) After SMED	Time Saving
1.	Open nut and bolt to remove the last tool from the machine	10	Simplification	07	03
2.	Open nut and bolt to remove the Die from the machine	10	Simplification	08	02
3.	Search the next tool for machine	02	Implement 5'S, Convert Internal to external Setup	00	02
4.	Search for spanner and other equipments	03	Implement 5'S, Convert Internal to external Setup	00	03
5.	Search the next die for machine	03	Implement 5'S, Convert Internal to external Setup	00	03
6.	Tighten the nut and bolt to adjusts the tool on machine	10	Simplification and using Poka-Yoka	08	02
7.	Place and Tighten the nut and bolt to adjust the die on machine	20	Simplification and using Poka-Yoka	15	05
	Total Time	58		38	20

Table No. 03, Set up time of 150 tones Mechanical Press machine (Before and after SMED Implementation)

Sr. No.	Activity/Process	Time (Minute) Before SMED	Improvement Idea	Time (Minute) Before SMED	Time Saving

1.	Open nut and bolt to remove the last tool from the machine	**30**	Simplification	**24**	**06**
2.	Open nut and bolt to remove the Die from the machine	**30**	Simplification	**26**	**04**
3.	Search the next tool for machine	**02**	Implement 5'S, Convert Internal to external Setup	**00**	**02**
4.	Search for spanner and other equipments	**03**	Implement 5'S, Convert Internal to external Setup	**00**	**03**
5.	Search the next die for machine	**03**	Implement 5'S, Convert Internal to external Setup	**00**	**03**
6.	Tighten the nut and bolt to adjusts the tool on machine	**40**	Simplification and using Poka-Yoka	**32**	**08**
7.	Place and Tighten the nut and bolt to adjust the die on machine	**45**	Simplification and using Poka-Yoka	**40**	**05**
	Total Time	**153**		**122**	**31**

Table No. 04, Total setup time of three Mechanical Press machine (Before and after SMED Implementation)

Sr. No.	**Mechanical Press machine**	**Total Time (Minute) Before SMED**	**Total Time (Minute) After SMED**	**Total Time Saving**
1.	**25 tones**	**54**	**36**	**18**
2.	**50 tones**	**58**	**38**	**20**
3.	**150 tones**	**153**	**122**	**31**
Total time of three machine		**265**	**196**	**69**

In figure no. 06 shows that the graphical representation of setup time of mechanical press machine (25 tones, 50 tones and 150 tones) before SMED implementation and after SMED implementation.

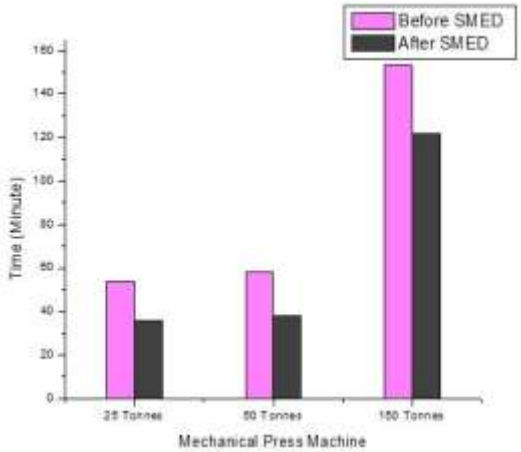

Figure No. 06, Graphical representation of Total setup time of three Mechanical Press machine (Before and after SMED Implementation)

6. Conclusion: -

The implemented SMED technique has given the good result for the reduction of setup time.This study has proved that reduce setup time with eliminating no value adding at time of changeover. In this paper we have implemented the SMED technique with the 5'S implemented in three mechanical press machines (25 tones, 50 tones and 150 tones) and its workplace. We calculated the setup time of change the tool and die in the machine before and after implemented the SMED technique. After calculated the data we found that total setup time of three mechanical press machine before SMED implemented was 265 minutes and after SMED implemented was 196 minutes, then we have saved in setup time was 69 minutes. We concluded that SMED technique has been helpful for setup time reduction and it direct causes to increase the productivity of industry and also 5'S technique has been helpful to given better arrangement and aesthetic look and enhance workers morale.

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