Single Minute Exchange of Dies (SMED) concept

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Abstract - *To survive in cutthroat competition, industries need to reduce production time and costs in order to improve operating performance and flexibility. Single Minute Exchange of Dies (SMED) mainly focuses on recognition of internal and external activities. Accordingly, this article has as its main objective to review the literature addressing this less studied topic: SMED. This paper covers the literature review of SMED tool and purpose of this literature review is to develop an overview of the conceptual framework of SMED tool. The various industrial applications and the existing articles indicate the relevance of the topic and methodology. Flexibility and responsiveness are main pillars of manufacturing, which is operated by demands of greater product variety and improved quality.*

Key Words: *changeover reduction, SMED concept , FMEA analysis , productivity Improvement, internal and external functions, Quality Tools etc*

1.INTRODUCTION

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 study was originally developed through the study of a die change process. Generally, SMED aims to standardize and simplify the operations. By this means, the need for special skilled workers is also minimized. Since then, the ways to improve and support the SMED technique are considered in the literature. The SMED technique is used as an element of Total Productivity Maintenance and "continuous improvement process" in various studies to reach lean manufacturing .Describes lean enablers which is based on the principles of lean production. Incorporated into an appropriate methodology, lean enablers can be employed to design new factories or deduce measures to improve existing factories.

1.1 SMED concept

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. This rapid changeover is key to reducing production lot sizes and thereby improving flow. SMED is the term used to represent the Single Minute Exchange of Die or setup time that can be counted in a single digit of minutes. SMED is often used interchangeably with "quick changeover". SMED and quick changeover are the practice of reducing the time it takes to change a line or machine from running one product to the next. The need for SMED and quick changeover programs is more popular now than ever due to increased demand for product variability, reduced product life cycles and the need to significantly reduce inventories. This rapid changeover is key to reducing production lot sizes and thereby improving flow. 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").

2. FOCUS ON SMED

The focus on the SMED applications for process industry plants that produce materials like paints, paper products, foods, beverages, personal care items and fiber, and apparel rather than assembled products such as refrigerators, cell phones, or automobiles. It is noted that changeover complexity should be considered in addition to the mechanical and electrical changes when changing to a different product since these industries often need chemistry and physics changes during the process is reaching equilibrium on the new product and specified properties. Describes the improvement of the quick changeover process of a painting line in a wooden frames factory. The application presents the scheduling of the involved setup operations, considering their duration, precedence relations and resources' need, in order to achieve a reduced setup time.

The main focus of the project is to reduce the lead time in a manufacturing process, by analyzing the cycle time for each of the process and identifying the critical process in the manufacturing line. Then identification of value added and non-value added activities in process and to reduce non value added activities to increase the productivity in it.

- To increase the productivity of the industry so that the demands are met.
- To reduce the wastes leading to reduced expenditure.
- To eliminate the bottlenecks in the production line.
- To increase the efficiency of the process by reducing the non-value added activities.

3. OBJECTIVES of SMED:

- ➢ Study the process flow in the production line of a manufacturing.
- ➢ Estimate the cycle time for each manufacturing processes.
- ➢ Create the current state value stream map with the cycle time.
- ➢ Find out the bottleneck in the current state value stream map.
- ➢ Identifying the value added and non-value added activities for the product.
- ➢ Apply lean tools to minimize non value added activities.
- ➢ Create the future state value stream map and compare the benefits.

4. PROCESS OF SMED

1. Observe the current methodology: Current procedures generally recorded on video tape of all the changeover process. It covers the complete changeover from one model to another model.
2. Separate the Internal and External activities: Internal activities are those that can only be performed when the process is stopped, while External activities can be done while the last batch is being produced, or once the next batch has started.
3. Stream line the process of changeover: For each iteration of the above process, a substantial improvement in set-up times should be expected, so it may take several iterations to cross the ten minute line.
4. Continuous Training: After the successful first iteration of SMED application the prime requirement becomes the training of all the operator of the cell. Training has been given by cell champion. See Figure 1.
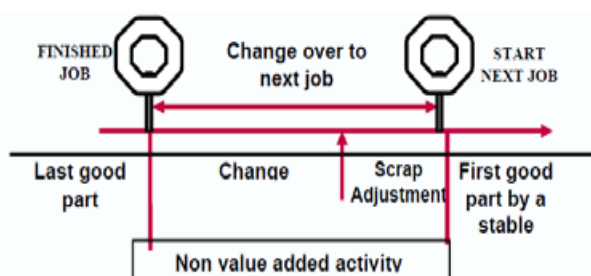

Fig. 1 Representation of change over time

5. The Five S's

The Five S's are some rules for workplace organization which aim to organize each worker's work area for maximum efficiency.

1. **Sort** – Sort what is needed and what is not needed so that the things that are frequently needed are available nearby and as easy to find as possible. Things which are less often used or not needed should be relocated or discarded.
2. **Straighten** – Arrange essential things in order for easy access. The objective is to minimize the amount of motion required in order for workers to do their jobs.
3. **Scrub or Shine** – Keep machines and work areas clean so as to eliminate problems associated with un-cleanliness. In some industries, airborne dust is among the causes of poor product surface or color contamination. To be more aware of dust, some companies paint their working places in light colors and use a high level of lighting.
4. **Stabilize or Standardize** – Make the first 3 S's a routine practice by implementing clear procedures for sorting, straightening and scrubbing.
5. **Sustain** – Promote, communicate and train in the 5 S's to ensure that it is part of the company's corporate culture. This might include assigning a team to be responsible for supervising compliance with the 5 S's.

6. SMED Terms

- **Adjustment Waste:** Any activities that would cause the machine to cycle in a   sample or trial mode which could create a part that must be inspected and then possible scrapped or reworked (Rubrich & Watson, 2004).
- **Internal Setup:** That part of the setup which must be done while the machine is shut down, for example, removing or attaching dies (Rubrich & Watson, 2004).
- **External Setup:** That part of the setup which can be done while the machine is still running, for example, preparing a die to be used for the next run (Rubrich & Watson, 2004).
- **Batch:** A quantity of items that are processed together (Marchwinski & Shook, 2003).
- **Downtime:** Production time lost due to planned and unplanned stoppages. Planned downtime includes scheduled stoppages for such activities as shift start up, production meetings, changeovers to produce other products and scheduled maintenance. Unplanned   downtime includes stoppages for breakdowns, machine adjustments,

material shortages and absenteeism (Marchwinski & Shook, 2003).

- **Changeover:** The process of switching from the production of one product or part number to another in a machine or a series of linked machines by changing parts, dies, molds or fixtures, also called a set-up. Changeover time is measured as the time elapsed between the last piece in the run just completed until the first good piece from the process after the changeover (Marchwinski & Shook, 2003).

- **Die Set:** This is the tooling that is removed and replaced in a punch press during a changeover. A die set consists of a set of male punches and female dies which, when pressed together either creates a hole in the work piece or forms the work piece creating features desired by the customer.

- **Waste:** Any activity that consumes resources but creates no value for the customer (Marchwinski & Shook, 2003).

- **Lean Production:** A system of production that makes and delivers just what is needed, just when it is needed and just in the amount needed. Lean manufacturing aims for the total elimination of all waste to achieve the best possible quality, lowest possible cost and use of resources, and the lowest possible production and delivery lead times (Marchwinski & Shook, 2003).

- **Value Stream Map:** A diagram that defines each step of the material an   information flow needed from initial order of a good or service through delivery (Marchwinski & Shook, 2003).

- **Lot:** A quantity of items that are processed together (Krajewski & Ritzman, 2007).

- **Value Added Activities:** The time spent on activities that add value to an item from the customer's perspective. These are activities that effectively change the form and function of a raw material into a good or service that the customer is willing to pay for (Marchwin ski & Shook, 2003).

- **Non-Value Added Activities:** The time spent on activities that add costs but no value to an item from the customer's perspective. These are activities that the customer is generally not willing to pay for (Marchwinski & Shook, 2003).

- **Shingo, Shigeo (1909-1990):** A consultant to Toyota who made key contributions to the development of the Toyota Production System, especially quick changeovers, SMED and standardized work (Marchwinski & Shook, 2003). the target of reducing changeover times to a single digit, or less than 10 minutes (Marchwinski & Shook, 2003)

- **Punch Press:** A machine tool used to work materials (typically steel) by changing the shape of the raw material. Material shape is changed through application of direct pressure which forces the material to change shape. The function of the punch press is to hold the die set and apply the motion and pressure required to perform value added operations to raw materials.

- **Setup Waste, Internal:** Alignment activities required to remove and install tools, for example, the time associated with using a fork truck to maneuver the old tool out and the new tool in while setting up a press (Rubrich & Watson, 2004).

- **Setup:** The process of switching from the production of one product or part number to another in a machine or a series of linked machines by changing parts, dies, molds or fixtures, also called a set-up. Changeover time is measured as the time elapsed between the last piece in the run just completed until the first good piece from the process after the changeover (Marchwinski & Shook, 2003).

- **Setup Waste, External:** Activities such as searching, locating or moving jigs, tools, bolts, clamps, fasteners, gauges or instructions in the setup area (Rubrich & Watson, 2003).

7. SMED Implementation in CNC machine Fixture

In CNC machine comparison between old fixture and new fixture after the implementing of SMED concept.

Fig 2. CNC machine
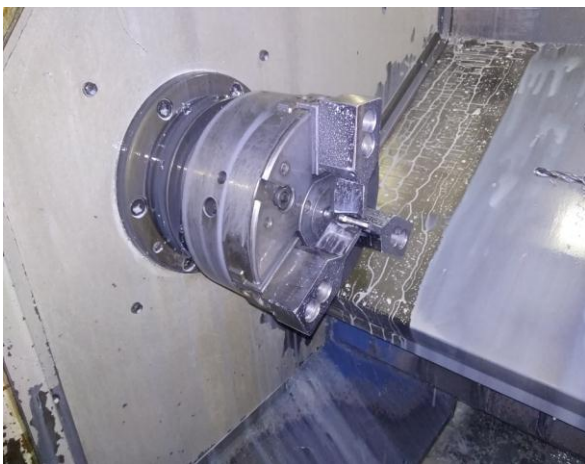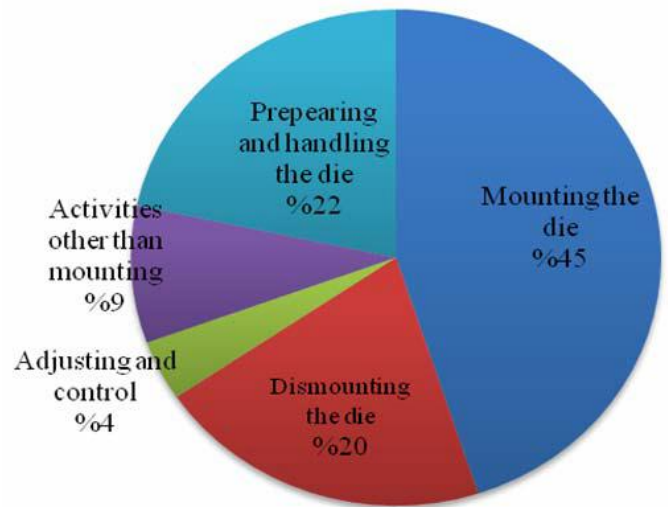
Fig 3. Fixture mount on CNC machine

Fig 4. Old fixture

8. APPLICATION of SMED

This application aims to optimize machine utilization, enabling small lot sizes, reducing production times, reducing the time that machine does not operate. Also, shortening preparation and machine adjustment times and reducing stocks. The facility in concern manufactures Styrofoam products that are used to support mainly for refrigerators during packing and handling. The injection presses in the facility are also capable of producing other products by utilizing the dies that are designed for automotive parts and construction sites. High product variation forces the company to make changeovers frequently.

1. Analyzing setup time

A video recorder was used to analyze how setup tasks are executed in the current case. Then, based on the activities, total time is analyzed. A pie chart is drawn where the percent of task times are stated in Fig. 5.

Fig.5. Current percent of setup steps

2. Eliminating inefficient time

Eliminating the time that may be wasted during searching required equipment's is important. Therefore, a list of materials and equipment's that is being used during setup is made. Also, forms are designed to enable that they are available and properly working when needed.

3. Standardization

In the final step, the improvement studies were reported and checklists were formed. The causes for recursive activities were determined as much as possible and act plans to eliminate them were provided. Finally, the setup tasks will no longer be unpredictable time delays by use of the precise time records. Therefore, better planning activities will lead to better customer satisfaction. The education and skill levels of the workers are also an important issue that needs to be considered during standardization.

9. CONCLUSION

In this study, 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. One of the major problems more setup time was identified and then study about the fixture design. Literature survey related to single minute exchange of dies (SMED) was carried out.

Further studies in the facility may include 5S and Kaizen studies for internal setup. Alternative ways to shorten internal setups can be searched in detail. In order to eliminate adjustment steps, trial and errors should be minimized. Settings must be used for changeover operations instead of adjustments. Therefore, a design of experiments study can be done to determine parameters of the machine. It should be kept in mind that successful implementation of

new production methods requires sustainability and permanent solutions and the key of sustainability is the standardization of that optimal solution.

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