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Reducing Change-over Time using SMED Process in Automotive Wheel Rim Manufacturing Industry

Shubham Kulkarni
(Department of Mechanical Engineering, Savitribai Phule Pune University, Pune, Maharashtra, India
Email: shubhamkulkarni299@gmail.com)

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Abstract:

The increasing competitiveness in manufacturing unleashed a quest for the improvement of company's productivity through innovations. Process innovation is extensively used to improve the production of a product or to provide a better service the Single Minute Exchange of Die (SMED) is an examples of such process innovation. It is a process-based innovative methodology that involves the separation and conversion of internal setup operations into external ones. The SMED methodology reduce and simplify the setup time during changeover makes it possible to respond to fluctuations in demand and results in lead time reductions as well as the elimination of wastefulness during changeover activities. This paper discusses the SMED concept and methodology for reduction of changeover time in Wheel Rims Manufacture industry. The main objective of research is to provide an insightful case study implementation addressing SMED implementation in Automotive Wheel Rims Manufacture industry located in Pune. In this research the change-over procedure was recorded for 6 months, activities that take up maximum or unnecessary time were identified and measures for reduction of changeover time suggested. It is found that the production rate increased by more than double the earlier production with the use of SMED. The result achieved showed considerable reduction in changeover time could be achieved with SMED.

Keywords — **Changeover time, Lean manufacturing, Productivity, SMED, Kaizen**

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I. INTRODUCTION

In today's global and competitive market, one of the most important aspects for companies is to be capable of producing a wide range of products for high demand. Customers with high demand, look for manufacturers that have the production capabilities to satisfy their needs. Companies with this production power are in constant struggle to compete for more customers. For companies of such calibre to be at the top of the market, by producing quality products at competitive prices, has become one of the biggest challenges for production manufacturing processes. More and more companies try to stay up to date with all the new manufacturing methods and processes to create a more efficient overall production. There are many concepts which can be used by companies and organization to reduce time and cost , eliminate waste and improve the quality of the product like (Continuous Improvement), Value Stream Mapping (VSM), 5S, Total Productive Maintenance (TPM), Just-in-Time (JIT) and Single Minute Exchange of Die (SMED) [1] The literature reveals that there is a lack of empirical research on the application of setup reduction methods in manufacturing

industries and that more research is needed in several SMED areas.

This research put forth the concept of SMED in production process which is aimed to reduce the changeover time as excessive changeovers result in loss of production time with a company located in city of Pune, Maharashtra manufacturing wheels of commercial and car vehicles as a case.

II. LEAN MANUFACTURING PRODUCTION PRACTICE

To deliver a wide range of high quality in quicker response times at reasonable prices industries need a continuous improvement through implementation of lean concepts and customer-pull-based production. Today companies are forced to produce more products at smaller batch sizes which result in more changeovers. In order to produce small quantities of a large diversity of products a rapid changeover capability need to be developed. Set-up reduction initiatives can help in increasing flexibility by conducting more changeovers and reducing lot size. It also increase bottleneck capacities and maximizes the line availability for production as well as minimizes the cost, as production costs are related to equipment effectiveness. [2]

Companies or organizations need to work from customer perspective who consumes a product or a service. As per lean manufacturing production practice the expenditure of resources other than the value for the end customer is wasteful and need elimination. Value is defined as any action or process that a customer would be willing to pay for. A setup can be defined as the elapsed time between the last product A leaving the machine and the first good product B coming out. [3]

The Lean production concept provides a set of tools which help in the identification and steady elimination of "Muda" which is referred as wastefulness, uselessness and futility in a company or organization. Muda contradict value-addition in an operation which is a process that adds value to the product or service that the customer is willing to pay for. [4]

III. CHANGEOVER PROCESS

Changeover time is often defined as the total time required for change from one product to the second product. Total change over time is the lost production which includes ramp down time, setup time and ramp-up time. Ramp down time Run down period is the time between the ends of a batch production till the lot quantity is completed. Setup Time Setup time is the non production time in which change over takes from one part to another. [5]

Companies strive to minimize and, if possible completely eliminate changeover time which is essentially the time required to 'set' the machine. Even though more companies are applying setup time reduction methods today, the reduction in setup time is not a new concept. Ford in 1926 was practicing lean manufacturing and just-in-time production and reducing changeover times at least 20 years before Toyota and other Japanese companies. [6] The need for shorter changeover times has been increased from the last decade across all industries. Customers require short delivery times and a high delivery reliability. The best way to overcome this problem is to produce small lot size in most economic and efficient way. Research established that there is a direct relationship between lot sizes and setup times. The shorter the changeover time, the smaller the lot size; therefore, it can be produced in an efficient way.[7]

IV. SMED CONCEPT

The origins of SMED technique can be dated back to 1950, when Shigeo Shingo who was working as 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). Shingo found out a series of breakthroughs that would later become famous under the name of SMED. [8]

SMED is the term used to represent the Single Minute Exchange of Die or setup time that can be calculated in a single digit of minutes. [9] 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 cycle and the need to significantly reduce inventories. [10] The catchphrase "single minute" does not represent that all conversions and start-ups have to take only one minute, but that they would take less than 10 minutes (in other words, "single digit minute") [11]

The relation between SMED and equipment design is also correlated and it indicated that SMED is suitable not only for manufacturing improvement but also for equipment development. SMED tool has been successfully used in the pine factory and empirically the result was reduction in setup time from 45 min to 15 min and underlines the importance of lean in the application of Information Technology to manufacturing. New modified improvement framework for lean implementation has also been proposed and lean implementation has been divided it in to "waves" and put the SMED tool in second wave amongst overall four waves. Shingo states that "SMED can be applied in any factory to any machine". Work regarding the application of design changes to the changeover process and the balancing of production lines using the set up minimization. [10]

The SMED method was generally used to reduce changeover process time which has been promoted by many lean managers and academics. This concept is perceived as the best way to reduce industrial changeover times. Research established the benefits and saving by eliminating or reducing wastefulness and non added value tasks and activities using SMED method. It has been found that implementation of SMED can save about 2% of the company's sales volume (360,000 €). [12] As per Shah the techniques for implementing SMED are as follows :

- Separate internal from external setup operations
- Convert internal to external setup
- Standardize function ,not shape
- Eliminate fasteners altogether
- Use intermediate jigs
- Adopt parallel operations
- Eliminate adjustments
- Mechanization

V. SETUP REDUCTION

The basic idea of SMED is to reduce the setup time on a machine. There are two types of setups: internal and external. [8]

- **Internal setup activities** are those that can be carried out only while the machine is stopped.
- **External setup activities** are those that can be done while the machine is running.

The basic idea is to make as many activities as possible from internal to external and also concluded that setup reduction is a tool which is universally applicable.

Setup Reduction Time at a Batch Manufacturing Plant by Mario A. Aguilar in which SMED is also used as a tool to improve flexibility and the greatest benefit from reduction in changeover time is the ability to produce parts in smaller batches. The relation between SMED and equipment design is also correlated and it indicated that SMED is suitable not only for manufacturing improvement but also for equipment development. SMED tool has been successfully used in the pine factory and empirically the result was reduction in setup time from 45 min to 15 min and underlines the importance of lean in the application of Information Technology to manufacturing. New modified improvement framework for lean implementation has also been proposed and lean implementation has been divided it in to "waves" and put the SMED tool in second wave amongst overall four waves. Shingo states that "SMED can be applied in any factory to any machine". Work regarding the application of design changes to the changeover process and the balancing of production lines using the set up minimization.

Prompt response and flexibility towards the demands of customers is an important aspect for success of an organization. Generally poor design of equipment need more time to complete a task where continuous process improvement and SMED (single minute exchange of dies) can play a major role to sort out this situation. [13] Application of Shingo methodology increases manufacturing

capacity with an improvement in equipment flexibility that allows working with smaller batch sizes, eliminating waiting by creating a flow of materials and ultimately achieves cost reduction. For different products changeover complexity, mechanical and electrical changes should be considered as many industries require chemical and physical changes during the process . [14] It has been stated that a reduction of machine setup time using the SMED method is economical, but has only limited effects. The design of a new machine is expensive, but the new setup time will be very short. Taking into account both costs and setup time, it is most efficient for the company to select the SMED method and to make improvements to the machines. [15]

VI. METHODOLOGY

Data for this research was obtained from an Automotive Wheel Rim Manufacturing Industry. The change-over procedure was recorded from the start using a camcorder over a period of 6 months. Recordings were done for the seven machines individually where the obvious faults were pointed out and listed on an immediate basis. The readings were taken individually for all the 7 machines in the disc line. The procedure for observations and synthesis has been outlined by giving example of the readings taken for the machine 800T-1, which is the first machine in the disc line and performs the operations of Blanking and First Forming. Firstly all the activities involved in change-over procedure (65mins) were identified and separated out as Internal and External activities. This is followed by converting Internal Activities to External activities and eliminating unnecessary activities. Activities that take up maximum or unnecessary time were then identified.

VII. DATA ANALYSIS

Analysis included viewing of all the recordings, minutely analyzing every step to note exactly what steps were involved in each process. This also included checking the movement of each worker and analysing ways in which it can be done better. The parameter involved in change-over time reduction and the timings were noted and parameter involved in change-over time reduction and the timings were noted and average of these timings was found out. The activities coming under the 80% time were targeted and suitable solutions for the same were listed out. Pre-requisites for all these solutions were listed and meted out. Feasibility and cost analysis for the same solutions were carried out.

VIII. RESULTS AND DISCUSSION

In the month of October changes were made in Cushion pin sorting system and Tool clamping – bolt tightening and loosening marking. Amongst these, the cushion pin sorting brought about a major change by reducing change-over time per machine by around 10 minutes. The tool marking implementation also reduced changeover times per machine by around 5 minutes. This should give a cumulative reduction of around 15 minutes. But the cumulative results are lesser than 15 minutes due to some unavoidable delays between the changeovers of different machines. These changes brought reduction of around 11.5 minutes in the average changeover time from September. The implementations done in November were the most important as they helped reduce the setup time by a huge margin. They were Support plate for sliding tool from 110T-2 to 110T-1 and Tool loading and unloading on both sides of the machine. Amongst these, the tool loading and unloading on both sides has reduced the changeover times by around 12-15 minutes per machine. The support plate attached between the two 110T machines has drastically reduced both, the time as well as the efforts required to enable changeover on them. The changeover time in this month was reduced by 12.71 minutes since October. The changes made in December were Loader arm fixed height stopper, Wheels for material handling conveyors and Tray for die loader arm near machine. Out of these 3, the most helpful was fabricating the tray near each machine i.e. in the conveyor system. It brought about a change of around 7-8 minutes per machine. A cumulative reduction of about 5.4 minutes was recorded for the month of December. Month wise comparison of change over times are shown in Table 1 and Fig 2

Month	C/O time	No. of C/O	Avg. in min.
July	1118	17	65.76
August	997	15	66.47
September	1113	18	61.83
October	906	18	50.33
November	602	16	37.62
December	631	20	31.55

Table 1 Month wise changeover time

Source: Author.

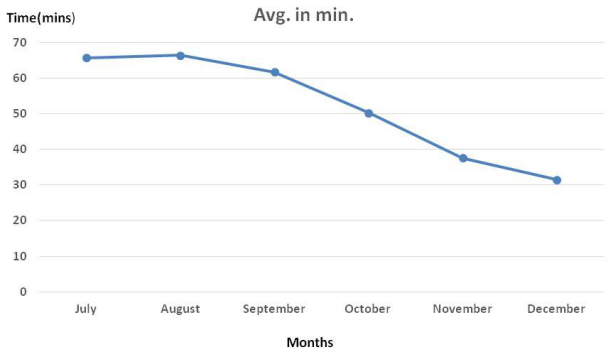

Fig. 2 Graph for month wise changeover time

IX. CONCLUSION

This research identified that the overall changeover time has reduced from an average of 65.76 minutes in July 2015 to an average of 29.6 minutes in December 2015. A total reduction of 36 minutes is observed which can serve the purpose of increasing productivity and flexibility in operation. It has been found that the production rate has increased by about 120 % which is more than double the earlier production. This results in smaller production lots being produced along with higher flexibility in product change. Also, customer demands can be met earlier resulting in higher customer satisfaction. This research provided an understanding of the critical success factors and main barriers for setup reduction in traditional companies. An insight into certain design for changeover rules and the role of equipment design engineer to design an effective setup method presented. It has been demonstrated that relationships between setup reduction investments-setup costs are more complex than generally assumed and that significant benefits can be achieved by prioritizing setup reduction investments in an effective manner.

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