

A Survey on Reduction of Setup Time for Various Manufacturing Processes using SMED

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ABSTRACT: Process time for any manufacturing process is very important aspect as far as profit of that industry is concerned. Less process time will lead to more production and timely dispatch of orders to the customers. Slow changeover time will act as bottlenecks. And bottlenecks will lead to stalls in production, overstock of supply and loss of customers. Machine setup time is the major part of process time. There are many tools to reduce the time required for the machine setup. This paper deals with the literature review about the use of tools to reduce setup time and thereby reduce the cycle time for manufacturing processes. It covers different aspects of machine setup time such as internal activities and external activities. Any type of industry can apply this tool called Single Minute Exchange of Dies to reduce setup time and remain in ever growing competition.

KEYWORDS: Setup time, SMED, Internal and External activities

I. INTRODUCTION

Increasing competition leads manufacturing industries to be more flexible and versatile. This results in the requirement of different types of setups for variety of products. Hence it is required to change the setup time to time. It takes time to change the settings and machine setup and hence increase overall production time. Set up time may be defined as time elapsed between machining or manufacturing of last component of one type and first component of the next type. It requires to change the machine setup when product to be manufactured is changed. As compared to total production time, setup time takes less share. But reducing non value added time is always beneficial. Reduced setup time leads to reduced production time, less chances of bottlenecks, timely dispatch of orders and satisfied customers.

Lean manufacturing is used to point out the waste and eliminate it with continuous improvement. Under lean manufacturing there are many tools and techniques such as 5S, SMED, KAIZEN, etc. that can be applied by industries to improve their production and minimize the waste. There are different tools which are used to reduce setup time. SMED is one of them. SMED (Single Minute Exchange of Dies) is the concept of reducing the changeover time or setup time. It reduces the time taken for changing over from one size to another, or from one type of product to another. It does not mean to finish all the setup in just one minute but to reduce setup time to a single minute i.e. less than 10 min. There is one more technique similar to SMED which is OTED (One Touch Exchange of Dies) tells that setup should take place in less than 100 seconds. Die is the tool used to do setup.

The main purpose of setup reduction is minimizing down time of a machine. It will be helpful in increasing flexibility of a company, enhance the capacity of company, and also boost the overall output. When it is time to change the setup, operator moves around to change the tooling from one type of part to the another. Meanwhile machine is in idle position. And the time wasted for doing this cannot be restored. Setup time is the combination of value added and non-value added activities, internal and external activities.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

There are some basic steps to be followed while implementing SMED. First we have to observe the current methodology. From this methodology we have to distinguish internal and external activities. Internal activities are those which can be performed only when machine is no working, and external activities can be performed while last batch of previous type of product is being produced. In this we can get the tools required for the setup while previous production is still not completed. Now more the external activities less will be the time required for setup. So we have to convert internal activities into external activities. After that we have to simplify the remaining internal activities. Now streamline the activities which are performed externally so that they go hand in hand with internal activities. Record the changes and document the new procedure. On repeating this procedure we can get improvement each time. Literature study about SMED has been focused on the implementation of this tool in different manufacturing sectors. People have studied and also implemented this tool to observe the consequences of application of SMED under different circumstances. This paper covers the study of literature related to the techniques available for reduction of changeover time.

II. LITERATURE REVIEW

A. Manufacturing Industries

Raikar [1] in his case study emphasises on implementation of SMED in manufacturing industry. According to him best results are possible through teamwork, proper planning and simple modifications. He carried out study in an automotive industry. He has shown need to overcome bottlenecks and run the process more effectively. He achieved the project objective by reducing process time to 24.5% and resulted in increase in productivity. Figure 1 shows reduction in setup time after the implementation of SMED. Before implementation time required for setup was 339 seconds and after the time was reduced to 256 seconds. So the time saving achieved is of 83 seconds.

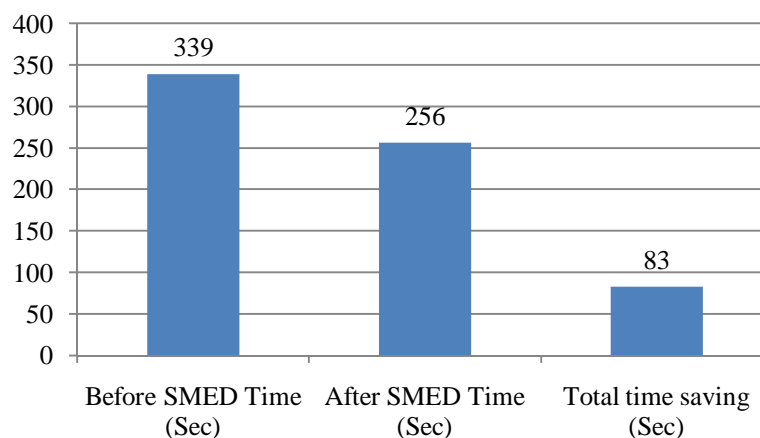


Fig. 1 Comparison before and after SMED [1]

He listed down all the operations and the time required for those operations while setup is being changed. After that it comes to know about the idle time for worker and idle time for machine. This clears the scope for reducing setup time. Also he separated internal and external activities. Then he suggested simple ideas to be implemented for each activity. After implementation of those ideas time for each activity was recorded. And then he compared the time before SMED and after SMED. He concluded that it is beneficial to focus on reducing changeover time as well as to eliminate the errors by implementing tools like poka yoke. This elimination of waste improves productivity, reduces the cost and thereby satisfies customer.

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Vol. 6, Issue 5, May 2017

According to Ferradas and Salonities [2] sort changeover time is always beneficial in manufacturing industries. In their study they have presented tailored methodology that have been used specially for automotive industry. Validation of proposed method was done by implementation of proposed tool on welding cell for a period of four months. In this study they found that in addition to SMED, appropriate strategy and preparatory activities are important factors for success. By implementing SMED, company has achieved 33% reduction on changeover time which we can observe in figure 2. To overcome the shortcomings they have developed a four stage model. Those four include strategic, preparatory, implementation and control. They have also followed basic strategy of SMED. They listed all the activities carried out while setup. Then internal and external activities are separated. After that internal activities are converted to external activities, non value added and unnecessary activities are eliminated.

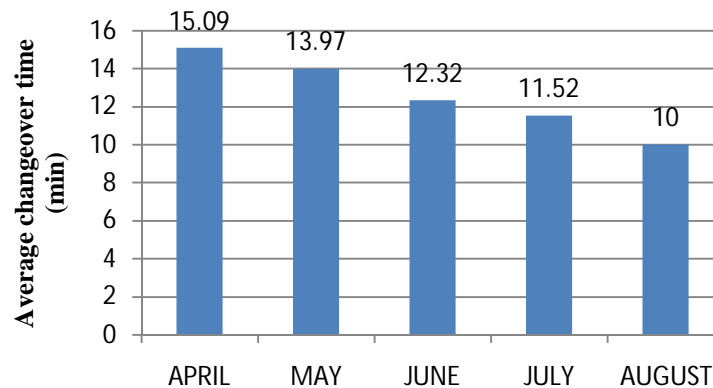


Fig. 2 Changeover time reduction since the beginning of project [2]

Concluding their work, tailored SMED implementation, literature review and collection of best practices helped to incorporate the changes in setup.

Assaf and Haddad [3] carried out performance improvement in an aluminium profile extrusion production system using single minute exchange of dies (SMED) methodology. The company in which they worked has an extrusion line that works in batches and frequently needs changing of dies. Their work clearly shows how this methodology is applicable to any manufacturing industry and how much it can be beneficial for the factory. Results shows that implementation of SMED can result in the saving in the range of 5% to 15%. The work was carried out in four steps, internal and external setup not separated, Separate two types of activities, convert internal into external setup and finally rationalize internal and external setup. Company they worked is one of the main Aluminium companies in West Bank in Palestine. Checklists were used to list down all the activities related to the setup. Movements of operator were observed. All this helped to take the record of movements, timings, distance travelled by operator while doing setup. This further helped to identify flaws in the process. After evaluation of setup process it is concluded that up to 15% improvement is possible which can save 60 thousand dollars per year. Further in this field process called One Touch Exchange of dies is trending now a days and which is a big challenge ahead of industries. But this is achievable through advanced automation and the use of industrial robots.

Azizi and Manoharan [4] designed an efficient value stream mapping (VSM) to improve the productivity in small medium enterprise (SME) by eliminating non value added activities. A case study was selected for implementation, PCB production as it is the major part in smart tag. They first analysed wastes in production at start. And after analysis plan was to use Kaizen activity with Single Minute Exchange of dies for process improvement. To identify current VSM (value stream mapping) it is necessary to have information about flow of material and information in PCB assembly line, transferring the collected data, inventory, WIP, etc. In SMED separation of internal and external activities is done and some of the internal activities are converted into external activities. Time required for activities before and after implementation of SMED was recorded. This study has shown that implementation of VSM in PCB assembly line reduces wastes that affected its productivity. That waste also include high changeover time during

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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insertion process of PCB assembly line. Improvement suggested was based on SMED and Kaizen technique. Machine setup time was found to be reduced from 145 seconds to 54 seconds.

Abraham et al. [5] carried out setup time reduction with the help of SMED technique in a stamping production line. To remain in cutthroat competition industries are opting for the options like lean manufacturing, TPM, TQM etc. According to them utilization of sources is dependent on the capability of industry to change and manage the change. A press shop which is used for the production of hose pumps required reduction in process time and improvement in productivity. Hence it was selected for the project. Objective was to reduce setup time from 7 hr to 2 hr.

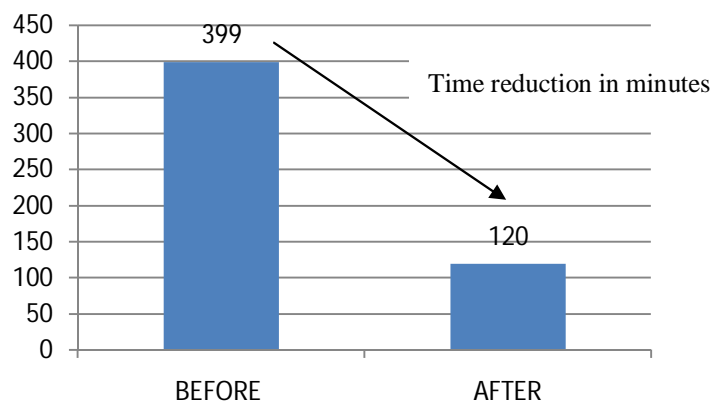


Fig. 3 Graph after implementation of SMED [5]

But this objective was to achieve with minimum investment. First the problem statement was defined. Then present literature was done to know the current status of the work that is carried out in similar fields. After that a step by step plan was prepared. According to the plan data collection was done which helped to identify bottlenecks. Analysis carried out also included detailed time study. This helped to plan the changes required in the current system. Time study was carried out for 9 months. Bottleneck was then identified. Internal and external activities were separated. And the next step was to improve internal and external activities. This implementation helped to improve setup time for BMS machine as shown in figure 3. The setup time for each setup drastically came down.

Costa et al. [6] carried out industrial application of SMED methodology and other lean production tool. This work is about improvement in the setup process of a mechanical press machine. The work was carried out during the period of five months. SMED along with other lean production tools such as 5S, visual management etc were applied to reduce the setup time. WIP and distances travelled by worker was also on target for improvement. Main objectives of this project are to reduce setup time along with standardise setup activities and to increase production flexibility. They prepared a nine step methodology to suggest and implement improvement solutions. Three main reasons for reducing setup time were flexibility, bottleneck capacity and cost minimization.

Palanisamy and Siddiqui [7] carried out reduction in changeover time and improvement in productivity by implementing conventional SMED method along with MES for better production planning and control. Most of the companies follow this tool called SMED but fail to implement it. This requires a systematic implementation and still it is not a best tool to reduce setup time in all circumstances and situations. In their study SMED was implemented along with MES specially for automotive supplier. Now a day's customer requires short delivery time and a high delivery reliability. The best method to tackle this is to have small lot size and therefore a shortest possible change over time. In conclusion, they have proposed a new approach for setup time reduction with MES to overcome the drawbacks of available. After implementation of the methods the changeover time was reduced by 69% and this resulted in increase of production by 18.86%.

Ram et al. [8] studied industrial benefits of SMED methodology on a high speed press in a punching machine. They improved the setup process of a mechanical press machine in a metal-mechanic area of an elevators company. The

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Vol. 6, Issue 5, May 2017

work was carried out for a period of five months. SMED methodology was applied to reduce the setup time observed at the beginning of the project. On conclusion we can say that SMED when implemented in a systematic way can help in reducing sources of wastes.

Joshi and Naik [9] presented a case study on an implementation of SMED in a small scale industry. According to them better results are possible through team work, good order, planning and simple modifications. This study was carried out in an automotive industry. Result shows that this study achieved 30% of cost reduction and 97seconds reduction in setup time.

B. Tools other than SMED

Kumar et al [10] carried out cycle time reduction of a truck body assembly using lean principles. When an industry is looking for improvement in productivity, efficiency and customer responsiveness. They have calculated the takt time for the assembly line based on the main operations and strategy of company. Then time for each operation is noted and from all this collected data it is analysed that there is a large difference in work content and the time taken by each worker. So there requires application of line balancing. Cycle time was reduced from 90 min to 37.5 min after the application of line balancing. This study also helped to detect waste time and eliminate it step by step.

Saraswat et al. [11] carried out reduction of work in process inventory and production lead time in a bearing industry using Value Stream Mapping (VSM) tool. Lean principles and techniques were implemented and suggested and also a future state map was created . Total lead time was found to be reduced from 7.3 days to 3.8 days. The WIP at each work station is also found to be reduced. The production lead time was also reduced from 409 seconds to 344 seconds.

C. Other than Manufacturing industries

Bajpai [12] implemented SMED methodology in a garment industry to reduce changeover time. Outsourcing of products has increased demand for variety of products, and this increases requirement of frequent changeover in setup. To remain in cutthroat competition garment industries are now adopting tools like 5S, Kaizen, Poka Yoke, DMAIC and SMED. Due to requirement of different styles in garments change of setup is frequent and takes more changeover time. So there is a loss of time and manpower in changing style.

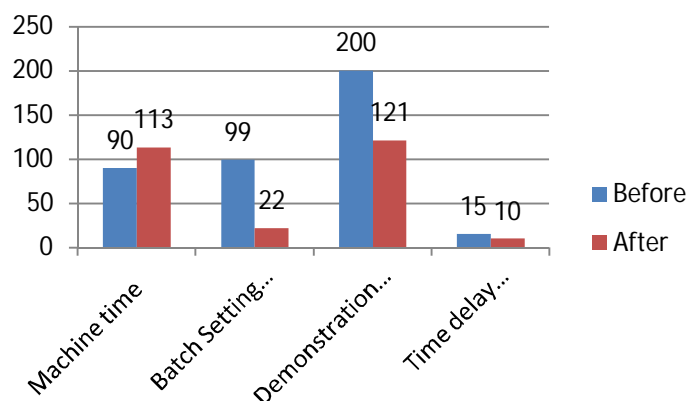


Fig. 4 Elemental breakdown of changeover before and after SMED [12]

This paper gives focus on implementation of SMED in garment industry. All activities required while setup change are listed and distributed in internal and external activities. Then it is tried to convert internal activities to external one. VSM i.e. Value stream mapping will further increase in productivity. Figure 4 shows elemental breakdown of changeover before and after implementation of SMED.

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III. CONCLUSION

Setup time contributes much higher in total production time. Hence it has to be as minimum as possible. Tools like SMED serves the purpose. Single Minute Exchange of Dies helps to reduce changeover time to a single digit i.e. less than 10 minutes. It is possible to reduce setup time in any type of industry by systematic implementation of this tool. Moving ahead of SMED, industries now a day's adopting advanced tools like One Touch Exchange of Dies (OTED). This gives better results than SMED, but requires automation and use of industrial robots. SMED is implemented in simple steps. All the steps that are required while change of setup are listed with the time required. Internal and External activities are separated. It is required to convert internal activities into external activities. The main reason behind this is external activities can be done while production from previous batch is still going on. The machine need not be stopped. But to perform internal activities it is required to stop the machine. Hence it will save much time if we convert internal activities to external activities. SMED along with other tools like poka yoke, 5S will definitely have tremendous effect on the process time as well as the quality of the product.

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