STUDY AND IMPLEMENTATION OF SMED METHODOLOGY AND ITS IMPACT IN A PRODUCTION LINE

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Abstract

Due to globalization, the companies are facing an enormous pressure to reduce productive costs, in order to increase its productivity and to face the strong competition of the emergent countries. The SMED is a tool which its aim is the reduction of wastefulness's associates to the productive process.

The SMED methodology was created and applied for the first time in the ends of the fifty decade and since then this methodology has come widely to be spread in sufficiently competitive sectors as it is the case of the automobile industry. Currently the reduction of costs reaches particular importance in sectors with a weak technological component incorporated in the product, and where typically the key purchase factor (of the product) is the price. In such a way, the productive efficiency is a critical success factor for the company. The SMED methodology is a tool that allows companies to get advantages at the level of the productive efficiency, through the reduction of the production costs. Minimizing the setup's time, it allows companies to get two great advantages, to reduce costs of equipment immobilization and allows producing small lots, thus eliminating the costs associates the stock.

The main objective of this thesis is to study the implementation of SMED methodology. It was studied and analyzed the productive system of two distinctive production lines; a line of plastic injection and a line of would brush production. Based on diagnostic’s results, it has been developed solutions and calculated there impacts in the company productivity.
1. Introduction

1.1 Why short setup time?

The need for short setup times is not new; it has been around for quite a while. Indeed, the time between producing the last product of a series, and producing the first product of a new series that meets all quality requirements; has always been considered as a production waste.

More recently, in all types of industries, there is an increased focus on reduction production waste, so the need for short setups is now bigger than ever. The globalization of the market, customization of products, and the continuous effort for better efficiency of the existing production equipment are the main driving forces of this phenomenon. Many companies around the world are implementing lean concepts and customer-pull-based production systems. For these systems, short setup times are a sine qua non (Womack et al. 1992).

There are many reasons to improve setup time, and Van Gourbegen (Goubergen et al. 2002 a) categorizes those reasons in three main groups:

- **Flexibility:** Due to an increasing number of products and product variants that have to be offered to the customer and a decrease of the corresponding order quantities, a company has to be able to react very quickly. If you need to produce small lot sizes, then you need to have short setup time (Shingo, 1985).
- **Bottleneck-capacities:** Especially on these machines, every minute that is lost is wasted. Setups need to be minimized to maximize the capacity available for production.
- **Cost minimization:** Since direct production costs are related to the machine performance, an overall equipment effectiveness (OEE) calculation (Nakkajima, 1988) can easily show the impact of setup reduction on overall machine performance. An overview of other financial benefits of short setup times can be found in Culley (Culley et al. 2003).

1.2. Basic elements of a setup

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. The ‘quality’ of a setup is determined by three key elements: technical aspects of equipment and tools, the organization of the work (‘who does what when’) and the method used (‘how’). All three key elements have to be optimized. The final necessary condition for having a ‘good quality’ setup is the motivation of the people performing the setup, according to Goubergen (Goubergen et al. 2002 a). They are usually production operators or sometimes machine setters from the technical/maintenance department. This motivation is also determined by appropriate training. Even with a perfectly designed machine, made to enable fast setups, and the most efficient method and organization of work, described in a setup instruction, there will be no good setup if the people who have to perform the work do not see the importance of a short setup or are not motivated or trained for
obtaining short setup times. This is illustrated by a global manufacturer of weaving looms, who designed an advanced loom with automatic beam exchange. They had extreme difficulties in selling this equipment, as their main markets were in countries where labor is plentiful and cheap. Setup reduction was viewed there, as a way to destroy employment.

1.3. Setup Reduction by Single Minute Exchange of Dies

Economics changes such as increasing product variety and the use of JIT have raised the value of fast setups. In response, systematic methods have been developed for improving setups. One of those methods originated in Japan and emphasizes shop floor issues, with no use of information technology. It was originally developed for fabrication processes such as auto parts stamping, and has been applied mainly in automotive industries. Shigeo Shingo (1985) developed the more general approach, which he called SMED: Single Minute Exchange of Dies. SMED is a methodology for systematically re-engineering setup processes, and thereby radically reducing their duration, with documented reductions from hours to less than 10 minutes ("single minutes"). The SMED methodology consists of three phases.

In the first phase, setup tasks are differentiated based on whether they can be performed while the machine is running (external tasks) or must be performed while the machine is stopped (internal tasks). For example, when examining the setups for the large body molding presses at Mazda, Shingo (1985) discovered that the presses were shut down while mounting bolts for the new die were being located. Once a setup process is analyzed in this way, it is possible to reschedule many tasks as external activities that are performed while the machine is operating. An example is pre-positioning all dies and tools needed for the next setup while the previous job is still running. Only the remaining internal tasks require the machine to be stopped.

In the second phase, technical modifications enable some of the remaining internal tasks to be done externally (Trovinger et al. 2005). Modifications can include changes to the design of machines, processes, and even products, but these changes are usually small, inexpensive, and highly targeted (Goubergen et al. 2002 b).

In the final phase of SMED, all tasks of the machine setup, both internal and external, are streamlined to make them faster and more (labor) efficient. Internal setup improvements give labor savings and less machine downtime. External task improvement does not directly improve downtime, but frees operators for other activities, as Trovinger (Trovinger et al. 2005) demonstrate. The methods used for streamlining include industrial engineering and process re-engineering: look at all the activities that go on, omit the non-essential, and design faster ways to do the essential. Typical changes include replacing general tooling, fixtures, and adjustment mechanisms with customized equivalents that require little or no adjustment; using color coding and spatial layout to make items easier to find and harder to make errors with; using floating workers who assist machine operators with each setup; pre-stationing or preloading raw materials for the next batch. “Fool proofing” is used to prevent errors, to make them obvious
when they occur, or to reduce their effects (Culley et al. 2003). A variety of good practice-oriented material has been written about SMED in different industries, such as Trovinger (Trovinger et al. 2005), and Modarress (Modarress et al. 2005). Analytic and comparative articles are rarer. (McIntosh et al. 2007) Looks at the economic costs and benefits of different types of SMED activity. (Min et al 2007) examine a concrete plant and argue that a number of cultural, procedural, and managerial barriers must be overcome before SMED can be implemented. Scott (Scott et al. 2001) also said that continuous education is essential for a good implementation of SMED methodology. (Goubergen et al. 2002 a) generalize a list of “design rules” from 60 projects. The unit of analysis in these studies is always a single machine setup — the wider impacts of the speed up are not examined.

2. Results

2.1 Diagnosis Methodology

To consider solutions that result in time improvements during setups it was necessary to collect working material on the existing situation in the productive system.

To analyze all the waste existing on the production system some instruments had been used, such as:

- Visual inspection
- Study of the methods and the times
- Collection of data of the informatics system
- Interviews

Visual inspection

The application of this method was based in such a way on filming carried through during the accomplishment of setups as well as for physical presence in loco. The analyzed aspects had been the following ones:

- Used procedures;
- Communication between operators;
- Functions of each operator and its behavior in relation to its function;
- Capacity and motivation to effect its task;
- Difficulties felt for the operators;
- Coordination it enters all the departments of the company, either the administration, the production, the production manager, the department of quality and the logistic one

Study the methods and the times

This stage had as objective two main points, first to identify and to classify all the operations and second to get values to characterize and quantified the same operations.
In the first point the different setups had been divided in groups; the main factor of classification was the operations that its procedure had.

After the identification and classification of all the operations that belonged to the used procedure in the format changes had been measured the times for chronograph.

**Interviews**

The carried through interviews had developed it some hierarchic levels. Interviews with the responsible administrator for the production had been developed and still interviews with the responsible ones for the middle management of the company. Interviews with the responsible ones for the maintenance had been become still full filled, which are the operators who carry through all the setups. Still some informal contacts with the operators of the machines had been developed.

**Collection of data on the informatics system**

The resource to the data of the company had as goal to acquire a rule of work, since it was possible to get times of production and setup for each order of finished production already. It was possible to analyze some interesting data, that in another way would be sufficiently difficult due to impossibility to remain all constantly in the company during the laboring time.

**2.2 Diagnosis Results**

To give an example of the phases above, it was chosen to tell the activities that had been carried through the line of household filling.

After the diagnosis phase it had been reached results that had served of base to consider improvements in setups. In such a way, the several groups of setups as well as the delayed average time in each one are presented in Table 1. In this table it is also possible to observe the maximum and minimum times delayed in each one of the different types.

<table>
<thead>
<tr>
<th>Type of setup</th>
<th>Average Time</th>
<th>Minimum Time</th>
<th>Maximum Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Car” Setup</td>
<td>15:38:01</td>
<td>11:46:40</td>
<td>19:07:01</td>
</tr>
<tr>
<td>“Color” Setup</td>
<td>3:13:18</td>
<td>0:00:42</td>
<td>12:19:21</td>
</tr>
</tbody>
</table>

After collected all the data it was possible to study and to reach two results: the variability of the delayed time was very high; another evidenced fact was that 57% of the time that delayed setup was due to disorganization. This delayed time had absence of the work place as the main cause
of the variability of the times, even so it has been identified other factors, such as it has more than one setup carried through at the same time.

Table 2 - Table with the percentage of the average times of which setups stages

<table>
<thead>
<tr>
<th>Type of setup</th>
<th>Machine Operator</th>
<th>Maintenance Operator</th>
<th>Waiting Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Car” Setup</td>
<td>1%</td>
<td>52%</td>
<td>47%</td>
</tr>
<tr>
<td>“Base” Setup</td>
<td>2%</td>
<td>57%</td>
<td>41%</td>
</tr>
<tr>
<td>“Material” Setup</td>
<td>3%</td>
<td>83%</td>
<td>14%</td>
</tr>
<tr>
<td>“Color” Setup</td>
<td>6%</td>
<td>94%</td>
<td>1%</td>
</tr>
</tbody>
</table>

It is important to relate that the lost time due to internal disorganization and to the lack of communication between departments is common to all the different types of setup. In the injection line also analyzed, the lost time was not so raised.

To prevent these problems it was considered to delegate in a person the function to co-ordinate and supervise all the procedure of setups, also the communication between the different departments involved in the setups procedures.

To prevent the stopping of equipment while another equipment is in the setup procedure. This solution is reached through better planning of the production. To place the information about the next setups as time and machine to avoid lost time because miss information, as well as a bigger accompaniment of setups on the part of the administration.

Finally it had been proposed to give extra money to motivate the employees; and create the idea that the realization of setups more quickly as possible is as important as to produce well and fast.

2.3 Proposals Solutions

To give an example of the developed solutions, it was chosen to tell the activities that had been developed in the improvement of “Base” setup.

To develop proposals that allowed diminishing the time of setup was opt by the creation of several solutions. In first place was created Solution 0. Solution 0 is not more than the current situation of the company but without all wastefulness’s caused for the several problems with the organization. Followed by Solution 1, that it is an evolution of Solution 0, which it is reached by remove all the external operations that are carried through to setups. The following step passed for creating Solution 2. This stage was created by reducing the time of the internal operations. Finally Solution 3 was reached, that passed for reducing the time of the external operations.
Solution 1

Solution 1 passed for introducing small changes to the procedure of setups. Previously the operator of the equipment after finishing the production; carried through small tasks near the equipment. These tasks consisted of the fulfilling of documentation and the cleanliness of the surround area before the intervention of the responsible operator for setups. The solution proposal passes by the accomplishment the procedure of the machine operator while the responsible operator for setups carries through its work.

Solution 2

Solution 2 passed for the alteration of some components of the equipment. In the diagnosis phase it was observed that it had vary tasks that delayed time sufficiently. These tasks were related with the squeezes. The squeezes are parts that have as function to fix the material. The reason for the time excess was the existence of many screws. This new part of the equipment would be a junction of the bases of the squeezes, with the squeezes properly said. With this junction of the related parts it is possible to eliminate four screws. In all equipment it was possible to eliminated twenty four screws.

Solution 3

Solution 3 consisted for the creation of check lists and check tables. One of the solutions proposals passed for the division of the some products in groups. Each group of products is produced appealing to a tool specifies. In such a way time is prevented that could be expense in other activities.

Impacts

The impacts achieved with the proposal solutions application allow reducing the time of setup substantially. It is possible to observe these same impacts Table 3. In Figure 1 it is possible to see the impacts on production. It had been calculated the production for the period of three months.

Table 3 - Table with the foreseen times after the application of the proposals solutions

<table>
<thead>
<tr>
<th></th>
<th>Diagnosis</th>
<th>Solution 0</th>
<th>Solution 1</th>
<th>Solution 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>7:45:28</td>
<td>1:42:00</td>
<td>1:34:00</td>
<td>0:32:00</td>
</tr>
</tbody>
</table>
3 Conclusions

The program of improvement displayed here appeared of the necessity of a company to improve its productive performance. This work told the stages that had been used in a project of application of method SMED. The steps of application of the methodology used had been described and in the end the gotten profits had been established. The gotten improvements had been and disclosed an important return on the investment made for the company. One gives credit that the method can be talked back in the company.

Concerning the gotten results, it was possible to conclude that the biggest wastefulness it must to the organization lack. This imperfection has several reasons, such as: (i) lack of communication between the diverse departments and lack of control of setups on the part of the management; (ii) the employees does not have a correct thought, for these people is more important to produce that to carry through one setup more quickly as possible; (iii) it lacks of someone with capacities to manage the production.

The current advantages of the improvement program are many, amongst them can be cited some chance for the company: (i) to know its system more at great length productive, (ii) to correct practical procedures and that they can assist the production to get a superior performance, (iii) based in one a specialized diagnosis more, to direct future actions in benefit of the best employees, (iv) to get improvements in different areas of performance, to increase its competitiveness. It is essential that the company gives to continuity to the actions initiated in this project, allowing that the actions undertaken during the project they are incorporated as practical common and routine. This will go to increase the confidence of the collaborators how much to the objectives of the company, improving the relationship between the parts. The
measure that the project will be extended to other lines of production, one becomes important to establish a accompaniment routine. This accompaniment aims to consolidate the use of the implemented techniques, to create instruments for the human resources and to redefine new ways of acting.

References


Goubergen, D.V., Landeghemb, H.V., 2002. Role and responsibility of the equipment design engineer in the set-up reduction effort. IIE SOLUTIONS 2001 Conference organized by the Institute of Industrial Engineers, in Dallas, TX.


