The Application of Single Minute Exchange of Die in the Production Process Improvement

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This paper concerns Single Minute Exchange of Die (SMED) which is one of lean tools applied for reduction of change over time on machines. It is a review paper on the basis of the literature collected from three electronic databases: Elsevier Science, Springer and E-resources from the library of Poznan University of Technology. The retrieved articles were screened following the inclusion/exclusion criteria. After applying the literature selection criteria 40 articles published between the years 2000-2017 were chosen. These papers were classified on the basis of the year of publication, the journal title, the main issue, tools and methods, type and also location. Their analysis revealed that SMED was applied in various range of enterprises in order to reduce time of setups and eliminate unnecessary activities which have no value for the process. It was also a useful tool for production process improvement as it may support lean tools in order to increase the process efficiency. The vast majority of papers was published in European countries. However, the increasing number of publications in recent years may suggest the increase of interest in this subject in different areas.

Keywords: lean, process improvement, Single Minute Exchange of Die.

1. INTRODUCTION

Nowadays, the quickly changing environment forces companies to increase their competitiveness using various methods and tools which are helpful in quality improvement. They have to offer the best possible products and service to develop and improve their market position. In order to achieve that, it is possible to implement Lean Manufacturing which is an innovative concept of business management, used especially in the restructuring process. It is a management methodology that creates such a work culture in an organization which makes all employees interested in a constant reduction of costs, improving the quality level and shortening the cycle of delivery. This concept emphasizes the elimination of wastes such as overproduction, motion, waiting, transportation, inventory, defects, over-processing, not-utilized talent and unsafe or ergonomic working conditions. It originates from the practice in a Japanese company Toyota whose international expansion and excellent economic results have led to the popularization of this conception (Wyrwicka, Zasada, 2014; Wyrwicka & Mrugalska, 2017). According to Womack and Jones (1990) the implementation of Lean Manufacturing should be based on the following principles:

- definition of value-added activities from the customer point of view,
- organization of all value-added activities according to value stream,
- establishment of smooth and continuous flow of values through the value stream,
- implementation of a system which enables value stream to react to customers’ needs,
- continuous improvement (Koch, 2011).

It is often used with other methods and tools, such as 5S, Total Production Maintenance (TPM), Single Minute Exchange of Die (SMED) or standardization, in order to improve the process efficiency and eliminate unneeded activities (Mrugalska et al., 2019).

Over the last few years SMED is getting more and more popular in production companies from different industries. It is a relatively low-cost and
commonly available method which may bring many profits to enterprises. It has to be reduced only to one single digit of minutes, but any changes in decreasing the time will have a positive impact on the process improvement. The idea is to define external and internal activities during process of setups, eliminate external ones and then focus of minimizing the internal ones (Shingo, 2017; Robinson, 2017).

SMED is a method used to reduce the time needed for changeovers and setups of the machines. Single minute means that the time needed for a setup is with a single digit. However, it may be sometimes impossible to shorten the time to less than 10 minutes, it was noticed that each application of SMED results in very big shortening and simplifying of the process. According to Shigeo Shingo, SMED is the most effective method to achieve a Just-In-Time production (Shingo, 2017). The effectiveness of this method was proven many times, especially in a manufacturing sector while reducing the time needed for changeover from hours to minutes (Grzybowska & Gajdzik, 2012; Moreira & Garcez, 2013).

SMED is based on a simple division of every operation connected with an internal and external changeover. The internal changeovers are all the activities that have to be performed when the machine is switched off, for example replacement drill chuck, while external changeovers are these activities which may be performed before stopping the machine or after the restart of the process for the changeover on the production to a new product type. The analysis and the process of shortening the changeover usually start from an internal changeover. It may be observed that a bigger amount of improvements can be performed in the phase of preparation for a changeover as well as during a test run. The very first step is about recording the changeover to deeply analyze the whole process and make a specific documentation. The analysis should be performed in a group of specialists in the organization, such as a machine operator, manager of the department, Lean Management group member, health and safety manager etc. (Ulutas, 2011).

The most important benefits of shortening changeover time by using the SMED method are:

- reducing inventory levels and raw materials, work in progress and finished products,
- higher productivity of changeover machines and processes,
- raising the standards of organization at the work station during changeover by of process and all equipment,
- improving financial liquidity by shortening the time the product passing through the organization,

According to Shingo, setup procedures are varied depending on the type of operations and equipment. However, general rules of a setup process consist of:

- Preparation – it is important to ensure that all components are in the correct places and prepared for the process.
- Removing tools and parts – before starting to produce the next lot, all unnecessary tools and parts have to be removed.
- Settings and measurement – it is essential to measure all production operations such are dimensioning, measuring temperature in order to run the production process.
- Checking – this step will be easier if settings and measurements were performed in a correct way (Shingo, 1985; 2017).

2. THE SCOPE OF THE RESEARCH AND THE METHODOLOGY

In order to perform the review of the SMED method used in practice, the articles from the years 2000-2017 have been chosen. They were found in the following databases:

- Elsevier Science
- Springer
- E-resources from library of Poznan University of Technology

In these international databases there may be found articles published in different languages, however, for the purpose of the analysis only papers in English have been chosen. The selection has been made on the basis of the relevant topic found by keywords. The keywords, which were
used in order to find related articles, were the following:

- SMED
- Single Minute Exchange of Die
- SMED methodology
- SMED method
- SMED in production enterprises
- Lean manufacturing
- Lean tools
- Process improvement
- Process development

The main criterion taken into consideration while choosing the papers was utility and practical application of the method in enterprises and different areas of businesses. They contain scientific topics from various branches, such as engineering, management, economics and others.

3. LITERATURE ANALYSIS

The analyzed papers were classified according to the year of publication and journal title, main issue contained in the article, tools and methods, type and location (Table 1). They were ordered in a chronological way. Most of them were published in European countries, but there are also some from Asia and South America. They presented case studies, however some of them were based on questionnaires or interviews. The main issue concerned the SMED method implemented in enterprises referred to reduction of the changeover time. This method was also combined with other lean tools such as Just in Time or 5S.

The analysed papers were published between the years 2000-2017, however it is worth to emphasise that the number of them has been growing recently. It appeared that 50% of articles were released in the last two years (2016-2017). They mainly (26 papers) represented the state of art in European countries and 14 papers were from other regions, mostly from South America. It shows the world-wide application of this method. In 28 articles SMED was also combined with other lean management tools such as Pareto diagram, Six Sigma, Kaizen or QFD. The papers mainly discussed case studies in particular regions, and rarely interviews or questionnaires were applied in companies.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Journal Title</th>
<th>Main issue</th>
<th>Tools &amp; methods</th>
<th>Type</th>
<th>Location</th>
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<tr>
<td>Władysiak (2007)</td>
<td>Archives of Foundry Engineering</td>
<td>Applying SMED method on casting machines</td>
<td>SMED, Kanban</td>
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<td>McIntosh et al. (2007)</td>
<td>IEEE Transactions of Engineering Management</td>
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<td>Simoes, Tenera (2010)</td>
<td>Management and Control of Production Logistics</td>
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<td>SMED</td>
<td>Case study</td>
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<tr>
<td>Dhake, Rajebhosale (2013)</td>
<td>International Journal of Lean Thinking</td>
<td>Practical application of SMED on printing machine</td>
<td>SMED</td>
<td>Case study</td>
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<tr>
<td>Authors</td>
<td>Journal</td>
<td>Title</td>
<td>SMED Related Tools</td>
<td>Type</td>
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<td>Ferradas, Salonitis (2013)</td>
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<tr>
<td>Teran-Somohano, Smith (2013)</td>
<td>2013 IEEE Congress on Evolutionary Computation June 20-23, Cancún, México</td>
<td>Application of SMED in automotive industry using metaheuristic algorithm</td>
<td>SMED, lean manufacturing</td>
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<td>Jeziernski, Janerka (2013)</td>
<td>Archives of Metallurgy and Material</td>
<td>Research about using lean manufacturing tools in manufacturing enterprises</td>
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<td>Questionnaire, research</td>
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<tr>
<td>Hashemzadehet al. (2014)</td>
<td>Management Science Letters</td>
<td>Factors influencing SMED implementation in plastic injection industry</td>
<td>SMED, VIKOR</td>
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<td>Azizi, Manoharan (2015)</td>
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<td>Mendez et al. (2015)</td>
<td>IFAC – Conference Paper Archive</td>
<td>Methodology of SMED and JIT</td>
<td>Just in Time, SMED, Kanban</td>
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<td>Alhuraishet al. (2015)</td>
<td>Materials of IESM Conference, October 2015, Seville, Spain</td>
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<td>Filla (2016)</td>
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<td>Dombrowski et al. (2016)</td>
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<td>Przegład górniczy</td>
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<td>Case study</td>
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<tr>
<td>Diaz-Reza et al. (2016)</td>
<td>Sustainability 2016, 8, 1237; doi:10.3390/su8121237</td>
<td>Research in 373 Mexican companies about SMED implementation</td>
<td>SMED, lean manufacturing</td>
<td>Questionnaire, research</td>
<td>Mexico</td>
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<td>Gadeet al. (2016)</td>
<td>International Journal of Scientific &amp; Technology</td>
<td>SMED implementation at the automobile workshop</td>
<td>SMED</td>
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<tr>
<td>Lozano et al. (2017)</td>
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4. CONCLUSIONS

In spite of the fact that the SMED methodology was developed in the previous century, the interest in its practical applications has been growing recently. It results from the fact that its implementation has a positive impact on the whole organization as it allows reducing the changeover time, and improving the production process. The analysis of the literature also allowed indicating its applications with other methods and tools which support mainly Lean Manufacturing.

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