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# SMED AS AN INDISPENSABLE PART OF LEAN MANUFACTURING IN THE SMALL AND MEDIUM ENTERPRISES

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***Abstract:*** *Lean allows to simplify and speed up the process while reducing or eliminating waste. This makes Lean concept very useful in solving a problem which is presented here. This paper presents the technique of the Lean concept, opposite to the tradicional approach allows the early market entry of products. The research was conducted in the real company environment, to reduce or eliminate the small stop time loss using the single minute exchange of dies (SMED). The SMED technique which has been only widely used to improve changeover loss has been proven to be an effective approach to also tackle the small stops. This type of the loss wich has been regarded as one of the most difficult losses to be reduced among all the six big the overall equipment effectiveness (OEE) losses. The application of SMED technique in a labeling industry (Trim Ltd Company) completely eliminated the small stop time loss. The OEE is measured before and after the improvements.*

***Keywords:*** *method – time measurement, Lean, small and medium – sized enterprises, labeling industry, SMED, OEE*

## 1. Introduction

The current crisis situation caused by the pandemic COVID-19 and the long-term financial situation on the world market forced many countries to reduce their production budgets. Therefore, companies must focus on simplifying and speeding up the process while reducing or eliminating waste from the process. Implementation of the Lean concept into their operating system may enable the fulfillment of all demands. In order to keep their presence on the market, the companies must adjust their structures to lower prices, increase product quality, short delivery times to satisfy customer requirements in general. At the same time, the companies must also meet the expectations of the current order with cost reduction. Under these conditions and obligations, the Lean production system appeared. The lean concept became an actual topic in management in the late 20th and early 21st century.

There is a wide range of tools and methods in the Lean philosophy, including value stream mapping, Kanban/pull, kaizen, just-in-time, standardized work, simulation, automation (jidoka) total production maintenance, 5S (sort, straighten, shine, standardize and self-discipline), cellular manufacturing, continuous improvement, visual control (andon) Total Quality Management (TQM), poke yoke (Bhamu & Sangwan, 2014).

In addition to these, widely spread and the most used tools in the practice can also be

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singled out (Sezen et al., 2012; Marodin & Saurin, 2013; Psomas & Antony, 2018); workforce involvement in solving problems, concurrent engineering and workforce recognition and reward, lot size reduction, setup time reduction, cross-training and root cause analysis for problem-solving.

The research (Achanga et al., 2013; Zhou, 2012) has shown that Lean production is more present in larger than in companies, i.e. the concentration of methods and tools of the Lean concept is not equally applicable in large and small companies. The basic drawback in the SME sector is the lack of knowledge and education of employees, which is a prerequisite for the successful implementation of Lean in almost all companies. There is neither statistics nor extensive literature indicating the use of Lean production in SMEs in the Republic of Serbia.

The paper will especially analyze the SMED method as a tool of Lean production. This method can especially be applied in eliminating losses occurring in production companies.

## 2. Literature review

During the development of the concept, a large number of authors provided their opinion, theories, and improvements of the concept. The views of the authors who provided their contribution in the area of Lean production will be presented below.

„Lean production is Lean because it uses less from everything compared to mess production: half of the human effort in the factory, half of the production space, half of the investment in tools, half of the engineering hours for development of a new product in half of the time (Womack et al., 1999, p. 11).“ The authors such as Arlbjorn & Freytag (2013); Bhamu & Sangwan (2014); Samuel et al. (2015); Mund et al. (2015) define Lean as a concept expressing an idea, which basically relies on the reduction of waste and increase of the value for the customer.

The authors such as Worley (2004), Hopp & Spearman (2004), Hakue & Moore (2004), Simpson & Pover (2005), Seth & Gupta (2005), Taj & Berro (2006), Narasimhan et al. (2006) define Lean production as a systematic removal of waste from the value flow of the product, i.e. creation of „production without waste“, while the authors Shah & Vard (2007) stated that waste removal is extended out of the organization, i.e. onto the whole supply network.

Holveg's (2007) opinion is that Lean production is a set of five elements, interconnected into a single cycle – the process of product development, the process of managing suppliers, the process of managing customers, and the process of policy for quality insurance of the product during the entire production process. The focus is put on permanent improvement, which enables companies agility to face the market demands and changes of the surrounding of today and tomorrow (Alves et al., 2012). Hallgren & Olhager (2009) pointed up that Lean production is actually a program aiming to increase the efficiency of production operations in an organization. It enables the shortening of delivery time between customer order and product shipment, as well as the cost reduction. In this way, the companies are becoming more competitive in the market (Alukal, 2003). Gamage et al. (2016) observed the Lean production as a social-technical system highlighting its double contents. The author Taj (2005) analysed two important aspects in Lean production: human and non-human. The first aspect deals with teamwork, training of employees, fluctuation of employees, type of organization, and similar. The second aspect puts the accent on the supply chain.

According to Lean philosophy, seven types of unnecessary spending are defined (Al-Najem et al., 2013; Amin & Karim, 2013;

Jasti & Kodali, 2014; Thurer et al., 2016):

1. Overproduction.
2. Unnecessary and excessive stocks of raw materials.
3. Unnecessary movements.
4. Inappropriate processes.
5. Excessive movement (transport).
6. Waiting and
7. Defects of finishing.

Among researchers such as Longoni et al. (2013), Sangvan et al. (2014), Gamage et al. (2016), Jasti & Kodali (2016) there is a common opinion, and it is that Lean production has the same final goal: elimination of all types of waste and activities without additional value in each phase of production of the service process of a production company, as well as the supply chain. „Lean aims to provide superior value for the customers through a holistic optimization of the process, both within the organization and out of it (Psomas & Antony, 2019).

According to the author Koscamis (2015), the Lean system is consisted of three basic elements:

1. Lean way of thinking.
2. Introduction and modification of business processes and
3. Continuity of introducing improvements.

The basic principle is a long-term and continuous improvement of all business processes and relationships with partners, including employees, managers, owners, shareholders, and the social community.

If all the principles of the Lean concept are efficiently implemented and conducted daily by all the employees, such an organization becomes a Lean organization. In contemporary conditions of operating, by identifying and eliminating unnecessary and wasteful activities in a business process, and by directing attention exclusively on what makes the value from the customer's point of view, Lean system of production allows reaching the maximum quality of production processes, in order to establish and maintain the balance between quality and timely satisfaction of customer needs and one's own profitability (Mačužić & Đapan, 2016).

According to Pisić et al. (2018) basic Lean strategies in terms of reducing costs are:

1. Reduction of necessary assets for existing business volume and
2. Increase the business volume for the current level of resources.

The reduction of necessary resources for the existing level of the business volume begins with an approach focused on managing human resources, production equipment, and control.

The increase of the business volume for the current level of resources is achieved by revision of planned and preventative maintenance of the plant and by optimization of the process. With an improved approach to the maintenance, production duration is reduced, and thereby also the inventory and orders can be optimized, which leads to cost reduction at the level of the whole organization.

Lean production is and will be a standard philosophy of production in the 21st century. However, there are certain limitations when speaking of implementation itself demands full devotion of the company, a lot of investment money, and time. Based on previous researches and studies, it was noticed that the implementation of Lean production was more successful in large companies than in small ones (Rose, A.M.N. at el., 2011). Today the competition on market is big, the demand for high-quality products and services is growing, so those small and medium companies are not left much space, except to enter the process of implementing Lean production in order to follow the changes imposed by the market. The advantage of the sector of small and medium companies is that it is a lot easier to enable full devotion of the employees and management when implementing Lean production unlike large organizations (Anthony & Kumar, 2005).

The goal is to establish a system in which the value of the product is increased by eliminating unnecessary activities and waste in production. The SMED method helps in detecting problems and finds ways to make the problems visible. The SMED is one of the methods of Lean production, developed by Shigeo Shingo in 1969. He used the method later in order to shorten the time of print setup in Honsha, one of Toyota factories. The implementation of this method provided unexpectedly good results – the reduction of time set up for printing machine. Shigeo Shingo managed to increase the productivity up to 40% in the heavy industry in Hiroshima. The time of building a ship was reduced from 4 to 2 months (Dillon & Shingo, 1985). In recent years, the SMED method proved to be a successful method, which was proven through several scientific studies. This methodology reports on the issue of time reduction in preparation, replacement, setup of equipment, and which tools are related to the setup (Sousa et al., 2018). In the paper of the author Moreira (2011) after the implementation of the SMED method, a cost reduction of as much as 2% was achieved.

Huarhua-Machuca et al. (2019) suggested a combination of 5S and SMED for reducing the number of production lacks in companies for the production of electrodes by using the simulation. In this way, the number of defective elements was reduced by 11,23%. SMED is highlighted as an important tool used for reduction of setup and time, which directly influences the factor of availability and OEE index of machines and equipment. SMED method in production may reduce or eliminate the short time of the stoppage. The authors like Van Goubergen & Van Landeghem (2002), Singh & Khanduja (2011) are of the opinion that in the phase of the designing the tool, someone should think about the setup time. Regarding this fact, they gave a suggestion for reducing the time of setting the machines and accompanying equipment up.

The use of the SMED method provides the following results: average time of tools replacement is reduced, machine flexibility is increased due to reduction of tools replacement time, the availability factor is increased and the number of produced components is increased (Haddad et al., 2021). As the method demands results both before and after, we can say that it has its beginning and its end. SMED is a process and for that reason, regular maintenance and upgrading of the SMED method are necessary.

It is important to emphasize that for the implementation it is not necessary to invest large assets in order to achieve the reduction of time for transition from one production batch to another.

### 2.1. The possibility of applying Lean concept in small and medium companies in the Republic of Serbia

The sector of small and medium companies (SME) in the last decade of the 20$^{th}$ century has a significant role in all economies, and thanks to a permanent increase of economic activity, it is has taken its place in transition and developing countries (Kostadinović & Ranđelović Petrović, 2015). The role of SMEs is great in transition countries that face the problems such as high unemployment rate, a deficit of investments, low grade of economic activity, and similar. An important characteristic that contributes to the higher participation of SMEs in the total number of companies is the ability of SMEs to adjust well to new techniques and technologies on the market. The previous decade is characterized by economic growth and development that took place in a direction to realize simultaneously both the growth of personal and public spending. The reason is that changes in personal spending have an impact on the general condition of the national economy (expansion/recession, increase/reduction of unemployment) (Paunović, 2017). By means of market reforms, privatization and inflow of foreign investments, the institutional and material preconditions for stable development are created (Post-crisis model of economic growth and development of Serbia 2011-2020). The researchers (Achanga et al., 2013; Zhou, 2012) have shown that Lean production is more present in large companies, i.e. the concentration of methods and tools of the Lean concept is not equally applicable in large and small companies. The main drawback with the SME sector is the lack of knowledge and education of employees, and that is the prerequisite for a successful implementation of Lean in almost all companies. As it has already been mentioned in the second chapter of this paper, Lean implies the philosophy characterized by less working at the workplace, less production space, fewer investments, less time, and fewer tools and stocks (AL-Najem et al., 2013; Amin & Karim, 2013; Jasti & Kodali, 2014; Thuren et al., 2016).

There are no statistics and extensive literature indicating the use of Lean production in SMEs in the Republic of Serbia. Major changes in the Serbian market occurred with the arrival of some foreign companies, by means of acquisition or direct investments. For example, with the arrival of Japanese company JTI in Senta Japanese philosophy – KAIZEN has been „transferred". Hence, kaizen is a permanent progression. The use of this tool resulted in great changes in Japan so that kaizen management started to be implemented both in American and European companies, and JTI has been using kaizen as a business philosophy since the start of its business operation in Serbia.

The company Pitura that is in the production of paints and varnishes applied the Kaizen philosophy in its business operations and in such a way made a different organization in the way to spend less energy than before its introduction. Pharmaceutical company Hemofarm, now owned by the German company Stada, in its business operation, applies Six Sigma statistical tools and techniques in the production process. In addition to Hemofarm, this method is also used by General Electric. The companies like SMP Automotive, Feka and other companies in the automotive industry design their production and the whole business according to the demands of the Lean concept.

From all the stated, it can be concluded that the presence of the Lean concept in SME in the Republic of Serbia is still weak in domestic companies, while with the arrival of foreign companies (especially in the area of the automotive industry) there has been a significant shift in the use of the Lean philosophy in our region.

## 3. SMED method

In the literature, there are different classifications of waste causes, i.e. wastes are encountered in the sense of listing seven, eight, or even nine different types. Although very similar, these classifications deserve special attention. According to the widest accepted approach one can speak about seven types (seven types were also identified in Toyota Production System by Shigeo Shingo) of wastes (Hines & Taylor, 2000): overproduction, unnecessary and excessive inventory, unnecessary transportation, overprocessing, excessive movement, waiting and defects of finishing. In order to enable the smooth running of production, it is necessary to allow optimal running of all activities in the production process. Among Lean tools mentioned in the first chapter of the paper, the Single Minute Exchange of Dies matrix (SMED) can be an efficient method for reducing excessive stocks, the time necessary for changing tools in the production process, setup of machines, the transition from one production batch to another, etc. SMED methodology puts the focus on the possibility of reducing the time during preparation, setup and work of machines, as well as the time of transition from one type of production to another. The primary purpose of SMED methodology is to define internal and external activities. All activity settings that do not disturb directly the equipment and that can be performed without interrupting the production, are defined as external activities. Actions implying certain stoppages in the work of equipment are defined as internal activities. When these two activities have correctly separated the reduction of machine setup time occurs. According to the author Shingo, the transition from one production batch to another should take place in one-digit time (less than 10 minutes). Techniques for achieving one-digit time for transition are applied in production areas in order to shorten and standardize the stoppages between two batches by applying various tools and techniques. The researchers in this area (Jebaraj Benjamin, Murugaiah & Srikemaladevi Marathamuthu, 2013) have singled out the SMED method as the concept that can be applied for resolving various types of losses in the production process. However, this paper will try to show the successful use of SMED method and other types of losses in the Lean production environment.

The authors Gouberneg & Vandeghem (2002) are of the opinion that quick replacement of tools is very important in the production process as it allows the production of a wider assortment of products within a shorter time interval. Five principles for quick replacement are the following (Jebaraj Benjamin, Murugaiah & Srikamaladevi Marathamuthu, 2013):

- Differentiation of internal setup elements from external setup elements.
- Separation of internal elements as possible into external ones.
- Simplification of the remaining internal elements.
- Simplification of the external elements.

Well-organized production and maintenance of total production (TPM) rely on the use of the OEE concept (Overall Equipment Effectiveness). OEE concept includes the so-called, six big losses (failure, setups, small stoppages, speed reduction, the impossibility of movement and discarding production), which can be classified into three areas- availability, performances and quality.

### 3.1. Overall Equipment Effectiveness

Measuring production performance, all the deficiencies that may occur in the production process would be identified and eliminated. The advantages of measuring performance can be summarized in a few theses (Maskell & Baggaley, 2004):

- Measuring production performance is focused on the issues related to the Lean system of production, by directing the employees to the realization of company goals.
- Managers and executives receive the right information at the right time in a form they can easily understand and use.
- The procedure of collecting data and reports is quick, simple, and relevant.
- Measures that are applied are directly developed from the business strategy of the company and serve for motivating employees towards realization on that strategy.

The task of employees in the production sector is to satisfy the daily needs of customers. In order to identify the problems disturbing their work, certain measures that follow the Lean goals of the company can be used. One of them is OEE. It measures the capability of the machine to produce a product unit of demanded quality within a defined term in order to secure customer loyalty. This indicator was presented by Nakajima (1988), in the context of Total Quality Management as a key indicator on equipment/machine working characteristics. The concept of OEE is a method serving for improvement of business performance, whereby the main focus is on achieving quality, productivity, and availability of equipment and reduction of all activities without values in the Lean production environment (Nelson Raja & Kannan, 2010), One of the main goals of OEE concept is the reduction or elimination of so-called six big losses. OEE represents a complex indicator obtained as a product of the following three factors (Gonzalez, 2017):

OEE = Availability × Performance × Quality

*Availability – A,* is a function of working time and loss of stoppage. It is obtained by relating the time period in which the machine actually operates to the total time during which the machine should be in operation (Araújo et al., 2017):

$$(A) = \frac{Operating\ Time}{Plan\ Production\ Time}$$

*Performance - P*, are the function of net working time and the loss of speed. It is obtained relating the real capacity to the ideal capacity of the machine (Costa, Silva & Campilho, 2017):

$$(P) = \frac{Net\ Operating\ Time}{Operating\ Time}$$

*Quality – Q,* are the function of fully operative time and loss of quality (Costa et al., 2018):

$$(Q) = \frac{Fully\ Productive\ Time}{Net\ Operating\ Time}$$

OEE represents an excellent indicator for measuring achieved improvement compared to the initial state of the company process. OEE actually represents a key indicator of machine performance, as well as the indicator of employees' performance who are responsible for the sustainability of the process (Haddad et al., 2021). For that reason, the accent is put on downtime, which has a direct impact on the availability, efficiency, and quality of the product.

In order to achieve maximum availability, it is necessary to identify basic causes of stoppage, reduce them or fully eliminate them. The availability can be denoted as the most significant, most important index in calculating OEE. If the production system is not available, it is not possible to produce any production unit, while a possible number of units stays the same. In that way, the performance significantly falls. The quality of produced units is also a significant index of OEE. Defective products influence the reduction of the OEE index.

## 4. Case Study

In order to display effects and research the possibility of applying the presented SMED model was implemented and examined in the real-time environment. The case study was conducted in the company Trim Ltd from Jagodina and in cooperation with the production manager, which, among other things, deals with the production of thermal transfer ribbons for printing and labels in rolls, from different types of paper. Thermal-transfer ribbons are used for printing on labels, by means of thermal transfer printers. Depending on the media on which is printed, ribbons can be of different quality. The labels in the roll are mainly used for logistic labeling, barcoding of products, warehouse marking, and similar.

By expanding its business to the production of stickers and ribbons, the company Trim Ltd encountered a number of difficulties and it was necessary to begin improvements that include organization of production plant, reduction of losses, regulation of information flows, the control of production quality, creation of standard operational procedures and work instructions. Certain elements of given improvements are possible to be improved by means of the SMED concept. Identification and elimination of necessary activities in the production process aim to direct the attention to what makes the value from the customer's point of view.

The production process takes place in the following way: raw material for the production of ribbons and labels comes into the shape of jumbo paper rolls, i.e. the ribbons that are placed on the machine for cutting ribbons, i.e. cutting the labels. The prerequisite for serious production is a certain level of stocks of one and another. Before the introduction of the Lean concept and SMED method, the raw material was stored in the part of the business space that did not meet standards for storing raw materials.

Trim's operational team applies Lean tools and the most failure models and effects analysis (FMEA). In the industry of producing labels and ribbons, reaching the level of 70% is considered an easier goal. On the other side, each improvement above 70% demands a more detailed analysis of three big losses: availability, productivity, and quality.

As Pareto rule 80:20 means that 80% of all identified problems could be easily overcome, on the other side, 20% of the problems are difficult to remove. This 20% is related to defining six big losses of OEE, which are not easy to be reduced or eliminated (Jabaraj Benjamin, Murugaiah & Srikamaladevi Marathamuthu, 2013).

One of the greatest challenges for the company Trim in relation to competitors is to reduce its production costs. The focus is put on the loss of time that occurs during process change, then stoppages of machine work during packing of raw materials, etc. The authors of the paper, together with the team that lead the production, have worked on reduction, i.e. elimination of time losses during small stoppages of the process of producing labels and ribbons. The specificity of Trim's production, unlike other productions, is that the machines do not throw out pieces as a finished product, but run meters.

The goal of this study was to:

- Reduce or fully eliminate losses occurring during stoppage of machine work and
- Improvement of OEE.

The first phase of the SMED method – to observe and measure the total time loss. The collected data were used in order to provide solutions for overcoming small stoppages in the production of blank white labels in a roll. Also, quick replacement of tools is a prerequisite when speaking of optimization of production time, and it is especially important with the production of products in small batches with frequent changes of tools. Until the suggestion of the authors to implement the SMED method into production, when setting up the operation of the machine, the time of preparation and unpacking was not sufficiently taken into account. By using the SMED method in the company Trim Ltd. it is possible to achieve the following savings in production:

- It is not necessary that the employees in production perform the replacement of tools,
- Reduction of product inventory, because it is possible to react quicker,
- By saving time planning of other improvements in production can be achieved, and
- Saving in time contributes to a larger volume of production.

The authors performed recordings of a few process changes, then stoppages of machine work during packing of raw material. The results of recordings were entered into so-called “recording lists”. Based on those lists, the documentation was created and analysis of activities was performed, i.e. loss of time that occurs during the production of blank white labels. The analysis has shown the following:

- Tool change place is not ready, i.e. unexpected stoppages during replacement itself occur (additional tool, pliers, etc.),

- Transport means is often busy, so that the time of replacement is unnecessarily increased (fork-lift is at the moment used for some other activity),
- Certain means of work are missing, such as hand crane, auxiliary trolley, etc.,
- Replacement of tool is performed by only one operator on the machine,
- The tool necessary for the production process itself is physically distant, which leads to unnecessary loss of time.

The improvements have been achieved thanks to the introduction of a hand crane and auxiliary trolley, which provided the saving time in performing activities, such as toll replacement, placement and removal of paper, and replacement of roll. The production cycle itself has increased thanks to the use of more quality raw materials. Table 1 displays the results after the implementation of the SMED method.

**Table 1.** Overall Equipment Effectiveness (before SMED implementation)

| | | | | | |
|---|---|---|---|---|---|
| Production Data | | | | | |
| *Shift Length* | 8 | Hours = | 480 | Minutes | |
| *Short Breaks* | 1 | Breaks @ | 15 | Minutes Each = | 15 |
| *Meal Break* | 1 | Breaks @ | 30 | Minutes Each = | 30 |
| *Down Time* | 50 | Minutes | | | |
| *Ideal Run Rate* | 45 | mPM (m' Per Minute) | | | |
| *Total m'* | 13,480 | m' | | | |
| *Reject m'* | 150 | m' | | | |
| Support Variable | Calculation | | | | Result |
| *Planned Production Time* | Shift Length – Breaks | | | | 435 |
| *Operating Time* | Planned Production Time - Down Time | | | | 385 |
| *Good m'* | Total m' - Reject m' | | | | 13,330 |
| OEE Factor | Calculation | | | | My OEE% |
| *Availability* | Operating Time / Planned Production Time | | | | 88.51% |
| *Performance* | (Total Pieces / Operation Time) / Ideal Run Rate | | | | 77.81% |
| *Quality* | Good m' / Total m' | | | | 98.89% |
| ***OEE*** | Availability x Performance x Quality | | | | **68.10%** |

All five SMED steps performed during small stoppages, such as “toolreplacement”, “removal/placement of roll from/on the machine”, “establishment of the regime of painting and cutting”, “introduction of paper into the machine” and “replacement of roll” and it has been improved thanks to the implementation of SMED (Table 3). The table describes the activities of the operator in the one shift, whereby due to different work tasks there is tool change during a shift. This saved total of 16 minutes of time loss, i.e. during these 16 minutes the production line was stopped, and now it was turned into the work of the machine itself. The following data have been collected based on the observation method (Table 1). It represents data for the calculation of OEE. Based on the observation table (Table 3) time loss in 50min. The line for production of blank white labels in roll works at the ideal speed of 45 meters per minute (Mpm).

It works 5 days per week and it was planned to stop each weekend for the maintenance. During a shift, two breaks are defined:

1. the first break for breakfast, in the duration of 30 min and
2. the second break, afternoon break in the duration of 15 min.

Total, each day 150 running meters (m') fall off due to various lacks in quality. OEE production line of blank white labels in a roll with a certain time loss is calculated in the following way.

By implementing SMED method it is possible to impact the reduction of time loss that occurs in this production line.

After the improvement (measured by stopwatch in production of blank white labels) that are shown in Table 3 and in Chart 1, the time was saved. After the implementation of the SMED method, the reduction of time loss of 16 minutes occurs. Now the time loss is 34 min.

By saving in unnecessary time loss the production time is increased after improvement of OEE production line of lank white labels, , is calculatd in fhe following way (Table 2).

**Table 2.** Overall Equipment Effectiveness (after SMED implementation)

| Production Data | | | | | |
|---|---|---|---|---|---|
| *Shift Length* | 8 | Hours = | 480 | Minutes | |
| *Short Breaks* | 1 | Breaks @ | 15 | Minutes Each = | 15 |
| *Meal Break* | 1 | Breaks @ | 30 | Minutes Each = | 30 |
| *Down Time* | 34 | Minutes | | | |
| *Ideal Run Rate* | 45 | mPM (m' Per Minute) | | | |
| *Total m'* | 14,035 | m' | | | |
| *Reject m'* | 150 | m' | | | |
| Support Variable | Calculation | | | | Result |
| *Planned Production Time* | Shift Length – Breaks | | | | 435 |
| *Operating Time* | Planned Production Time - Down Time | | | | 401 |
| *Good m'* | Total m' - Reject m' | | | | 13,885 |
| OEE Factor | Calculation | | | | My OEE% |
| *Availability* | Operating Time / Planned Production Time | | | | 92.18% |
| *Performance* | (Total Pieces / Operation Time) / Ideal Run Rate | | | | 77.78% |
| *Quality* | Good m' / Total m' | | | | 98.93% |
| ***OEE*** | Availability x Performance x Quality | | | | **70.93%** |

Before the implementation of SMED method, OEE coefficient was 68,10%, and after implementation 70,93%. Full improvement of OEE after elimination of unnecessary stoppages is:70,93% - 68,10% = 2,83%. After the improvement, the machine for the production of white labels in roll did not report any stoppages. The improvement of OEE of 2,83% is a significant achievement for the company Trim Ltd. in reaching the world class manufacturing coefficient of 85%. In order to reach an improvement above 70%, an additional analysis of the production process is necessary and it represents a big challenge for achievement. The company Trim Ltd is aware that for achieving the coefficient above 70% of OEE a long-term improvement is necessary. Regarding this, the company enters various projects for the improvement of production work. As the SMED method proved to be an efficient technique in eliminating small stoppages in the process of producing white labels in a roll, the next direction of Trim Ltd would be to attempt to eliminate all other problems in the production of labels by implementing SMED.

**Table 3.** Small stop time saved upon implementation of improvements

| Description of existing steps | Time of existing step (before SMED) (minutes) | Time after implementation SMED (minutes) | Time reduced (minutes) |
|---|---|---|---|
| Tool replacement | 0:14:00 | 0:10:00 | 0:04:00 |
| Removal/placement of roll from/on the machine | 0:14:00 | 0:10:00 | 0:04:00 |
| Establishing the regime of painting and cutting | 0:17:00 | 0:11:00 | 0:06:00 |
| Introduction of paper into the machine | 0:02:00 | 0:02:00 | 0:00:00 |
| Roll replacement | 0:03:00 | 0:01:00 | 0:02:00 |
| **Total (minutes):** | **0:50:00** | **0:34:00** | **0:16:00** |

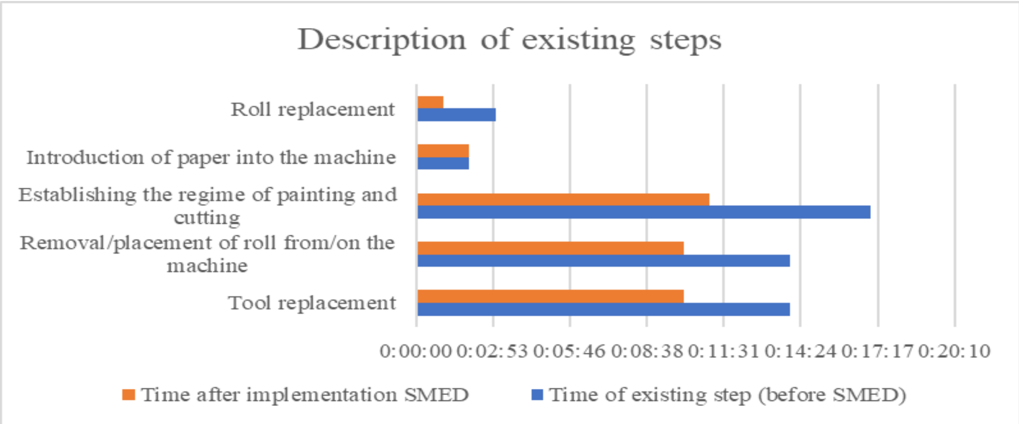


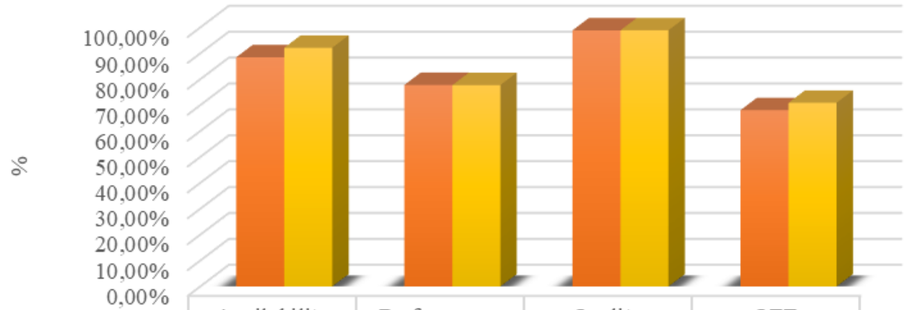

**Chart 1**. Description of the production phases

Success of implementing SMED method in the company Trim that influenced the increase of the value of OEE coefficient by 2,83% can be graphically displayed as in the Chart 2.

By applying SMED method in the company Trim Ltd, the following improvements have been achieved:

- The stoppage time of the machine work was reduced from 50 minutes to 34 minutes.
- The productivity increased because in the time saving of 16 minutes the production can normally run.
- The flexibility of production was increased – tool change is done quicker during a shift.
- The OEE value was increased by 2,83% after SMED implementation and

Working environment of production is more organized.




| | Availability | Performance | Quality | OEE |
|---|---|---|---|---|
| Before SMED | 88,51% | 77,81% | 98,89% | 68,10% |
| After SMED | 92,18% | 77,78% | 98,93% | 70,93% |

**Chart 2.** Description of the production phases

## 5. Conclusion

Identifying and preventing the appearance of lack or loss and their efficient and effective removal will reduce working load and process costs. The answers to stated problems can be found in the Lean concept. Taking into account the available literature it can be said that it is a synthesis and upgrade of management in the most important elements of organizational system. All stated improvements in work can be done in the way that suits us if started immediately of the moment will be waited when the solutions will be imposed and the entire system would have to adjust to the imposed solutions. This paper, had a task to indicate this fact. First, by the implementation of the SMED technique in the improvement of resolving small OEE stoppages during activities of setup and change, the unnecessary time was reduced as well as the duration of the production cycle was increased. Saved time for small stoppages after implementing SMED of 16 minutes, influenced the increase of the production cycle. i.e. the increase of running meters per minute. This study shows the use of the SMED technique in resolving problems of losses during small stoppages, i.e. “six big losses” of OEE. The improvement of activity after implementation of SMED also resulted in the OEE improvement by 2,83%. In the company Trim Ltd, the SMED was used to reduce time loss during machine work. However, the SMED can also be extended for eliminating other losses defined in the category “six big losses”. In the literature, there is a small number of sources covering the use and development of the OEE coefficient in production. This study provided a detailed display of applying the OEE in a real production environment. The paper opens the possibility of using the SMED technique for resolving other OEE losses in the Lean organizations, especially in the sector of small and medium companies.

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