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# Optimization of Wood Processing Setup Using the SMED Method

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***Abstract*— In a world of continuous market development and increasingly demanding customer needs, aligning production processes is crucial. Applying the SMED (Single Minute Exchange of Die) method is essential as a fundamental tool within the Toyota Production System philosophy to directly address demands for reducing production time. The SMED method enables tool changeovers within short time frames, minimizing downtime and facilitating the production of various items. Thus, this method further enhances a company's flexibility and productivity. This research aims to reduce tool changeover time in the door frame processing process, which involves five technological operations requiring three tool changes.**

***Keywords*— SMED, Kaizen, Lean, Flexibility, Efficiency**

## I. Introduction

Companies are constantly under pressure in today's global business environment due to rapid technological changes and fierce competition. Customers, aware of the advantages of the modern market, demand swift deliveries and flawless reliability in delivery services [1]. This demanding spectrum of needs places companies before a complex challenge: increasing production variability while reducing activities that do not add value to the products while maintaining production continuity [2]. This paradox underscores the importance of the tool changeover process in production. Thus, companies face a dilemma - whether to minimise the total number of tool changes or reduce the duration of the changes themselves [3].

When analysing losses within companies, the time spent on tool changeovers is often considered one of the most significant forms of unnecessary time loss [4]. Reducing the duration of this process directly leads to cost reduction [5]. One effective way to address this issue is transitioning to producing smaller batches while concurrently applying Lean manufacturing principles to increase productivity and maintain low costs [6]. On the other hand, lengthy and complicated tool changes often drive companies to avoid changeovers, resulting in the production of large batches [7].

All these reasons indicate the need to reduce the time required for tool changeovers, which is achievable through implementing a quick changeover system [8]. One of the most efficient tools for implementing this system is the SMED method (Single Minute Exchange of Die) [9]. This method, through gradual changes in the organization of the changeover process, standardization of procedures, application of special tools, and technical modifications of machinery allows for a radical reduction in the time needed for tool changeovers, reducing it from several hours to just a few minutes [10].

## II. Changeover

In modern manufacturing, particularly within Lean production practices, there is a drive to reduce production waste, meet customer demands in desired quantities, and just-in-time delivery to gain a competitive edge in the market [11]. The key to achieving these goals is increasing flexibility by producing smaller batches [12]. However, such an approach typically leads to frequent system changes known as "Changeover."

Changeover involves the time (Setup time) required to perform a series of activities necessary when transitioning from one technological operation/process to another, including tool or equipment change [13]. These activities involve machine stoppages, cleaning, tool replacement, adjustments, testing, and achieving high product quality. All these activities can be categorised as external and internal. External setup activities can be performed while the system is running, whereas internal setup activities can only be conducted when the system is stopped [14].

It's important to note that these activities are often considered unnecessary losses as they do not contribute value to the product but significantly increase overall production costs [15]. Hence, optimising them to reduce the time required for execution is crucial. For this purpose, applying appropriate methods, such as the SMED method, is key.

## III. SMED method

SMED is a powerful technique that reduces the time required for tool changeovers to less than ten minutes [16].



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The development of the SMED technique began in 1950 under the guidance of Shigeo Shingo, a prominent expert in kaizen, at Mazda in Hiroshima. The first concrete results of implementing SMED appeared in Toyota in Nagoya in 1969, and it wasn't until 1985 that the SMED method emerged in Western countries [17].

The SMED method aims to reduce the time needed for tool changeovers and setups to decrease machine downtime, loss of time, and production costs [18]. This approach results in increased flexibility and efficiency in production, which is crucial for optimising time in manufacturing processes [19]. SMED is particularly beneficial for producing different parts and in cases of frequent tool changes in smaller batch production.

The expected outcomes of applying the SMED method are reflected in economic benefits such as increased production capacity and improved ergonomic conditions, standardisation, team strengthening, and workload balancing [20]. Developing this technique enables quick and efficient tool changeovers, easing the work for production workers.

### A. *Implementation of the SMED method*

To properly implement the SMED method in the manufacturing process, it is necessary to go through four main steps (Figure 1) [21]:

1) *Observation of the tool changeover process*: The first step in applying the SMED method involves thoroughly analysing the existing system. This includes carefully observing the tool changeover process and communicating with operators to understand the process better. It's also important to document all the steps required during the tool changeover, including measuring the time needed for each activity.

2) *Separation of internal and external activities*: After a detailed analysis of the tool changeover process, the next step is precisely distinguishing activities as internal (performed while the machine is stopped) and external (which can be done while the machine is running). Identifying the total duration of internal and external activities is also essential.

3) *Transformation of internal activities into external activities:* In this step, there's a transformation of internal activities to determine if there are internal activities that could be transformed into external ones, i.e., those performed while the machine is running.

4) *Optimization of internal and external activities:* The final step focuses on improving the tool changeover process to reduce the time required to perform internal and external activities. This may involve eliminating unnecessary steps or activities during tool changeovers, optimising human aspects through better preparation and work organisation, technological changes within the process, and introducing automation, machine and tool redesign.

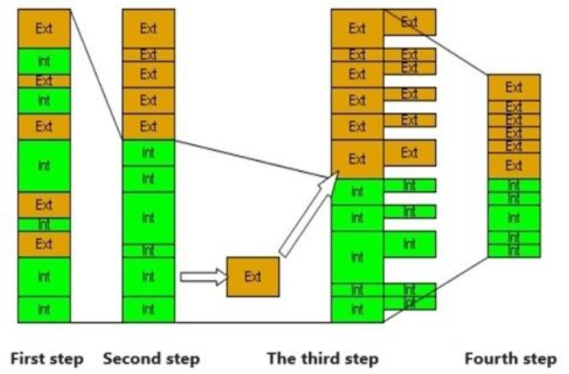


Fig. 1 Steps in implementing SMED [22]

## IV. Application of SMED method in an interior door manufacturing company

In a manufacturing company specialising in interior door production, an issue has been identified during tool changeovers in the door frame processing, particularly in individualised production with small batches. The door frame processing on the milling machine involves five technological operations, requiring three different tools to be changed. Specific problems during tool changeovers include extended time for replacements and adjustments. Additionally, deviations from prescribed values frequently occur while setting the tools to specific depths and penetration heights into the material. These combined challenges result in production halts, time loss, and additional costs, reducing the company's flexibility and efficiency. One approach to address this problem is implementing the SMED method, which is executed through four key steps.

### A. *Observation of tool changeover process*

After a detailed observation and analysis of the tool changeover process, all activities necessary for tool changeovers in each technological operation were documented, including the time required for each activity. The results are visually represented by creating a Gantt chart, as shown in Figure 2.

### B. *Separation of internal and external activities*

In the second step of this process, it is crucial to carefully and accurately distinguish internal from external activities. The results of activity separation and their durations are clearly depicted in the Gantt chart shown in Figure 3. This diagram provides a comprehensive overview of internal and external activities, allowing for a better understanding of the tool changeover process and identifying potential areas for transformation and optimisation.

### C. *Transformation of internal activities into external activities*

Considering these tool changeovers are crucial for door frame processing, they must be performed when the machine is stopped, constituting internal activities.

This is primarily for the safety of workers at that workstation and because these activities cannot be performed while the machine is operational. Consequently, few activities can be transformed into external ones. One such activity, after transformation, is "Removing old tools and auxiliary equipment," as depicted in the Gantt chart illustrated in Figure 4.

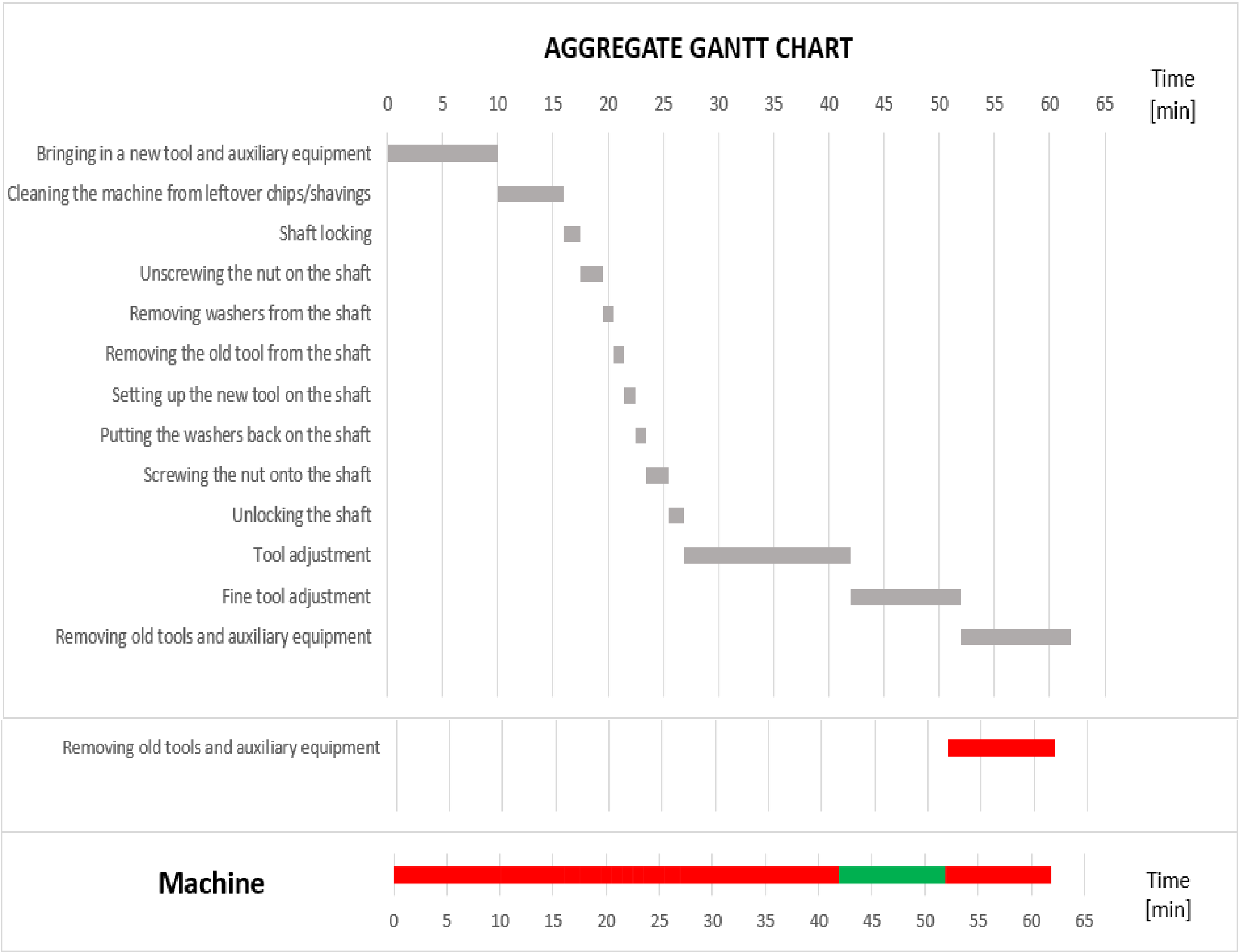


Fig. 3 The aggregated Gantt chart of internal and external activities

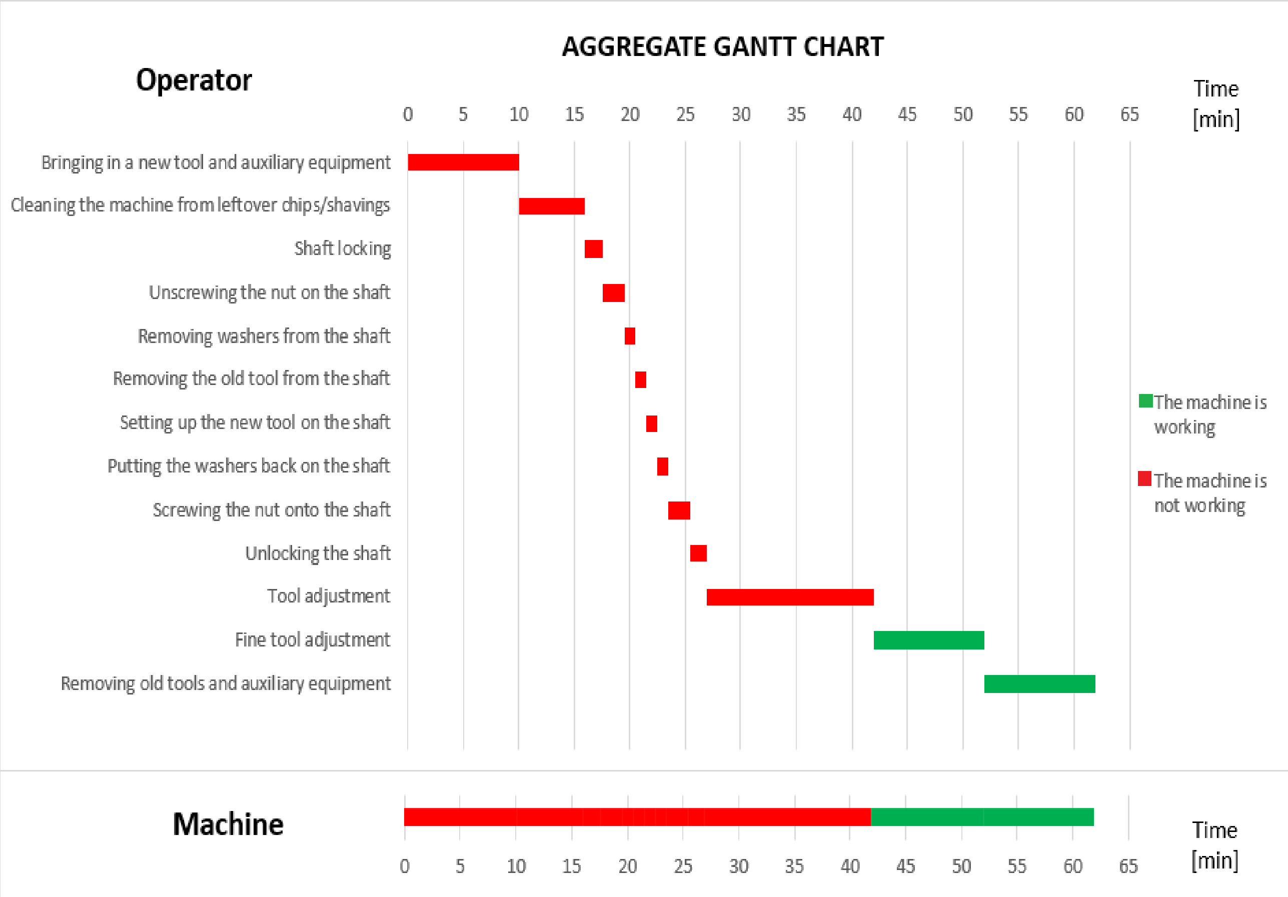


Fig. 4 The aggregated Gantt chart of transforming internal into external activities

## *D. Optimization of internal and external activities*

In the end, in the final step of detailed analysis, the following internal activities were identified that couldn't be transformed into external ones but could be significantly accelerated. Regarding external activities, a way to expedite their execution was found, and some were even eliminated.

- The internal activity labelled "Bringing new tools and auxiliary equipment"/"Bringing auxiliary equipment" previously required significant time due to poor organisation of processing tools and auxiliary equipment. "Shadow tool boards" were introduced (Figure 5), where all necessary tools and auxiliary equipment were neatly arranged. Implementing these boards also significantly increased the external activity of "Removing old tools and auxiliary equipment"/"Removing auxiliary equipment."
- For performing internal activities marked as "Unscrewing nut on the shaft" and "Screwing nut on the shaft," the shift was made from a regular wrench (Figure 6) to a socket wrench (Figure 7), reducing the time required for these activities
- Internal activities labelled as "Removing washers from the shaft" and "Returning washers to the shaft" previously took more time, which was reduced by using a bushing (Figure 9) instead of several washers (Figure 10).
- The internal activity labelled as "Tool adjustment" was enhanced by applying Visual Management (Figure 11) instead of using templates (Figure 10), enabling precise tool adjustment and avoiding the need for additional external activity "Fine tool adjustment."

Implementing all the aforementioned changes reduced the overall internal time from 51.92 minutes to 33.5 minutes, while the total external time was reduced from 10 to 5 minutes.


Fig. 5 Shadow tool board


Fig. 6 Regular wrench

Fig. 7 Socket wrench

Fig. 8 Washers

Fig. 9 Bushing

Fig. 10 Tool adjustment using a template

Fig. 11 Tool adjustment by width and height

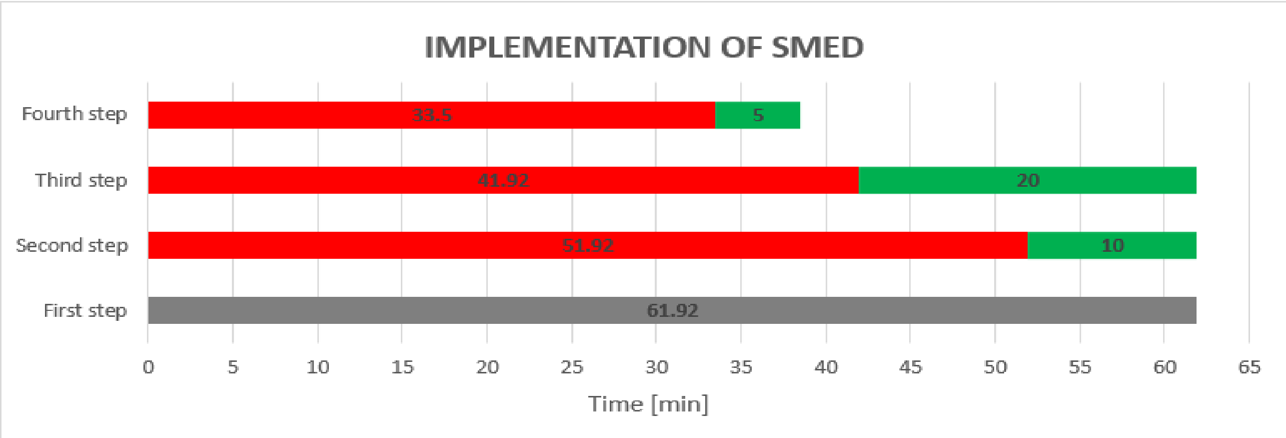


Fig. 12 Stages of implementing SMED in a company producing interior door

## V. Conclusions

By implementing the SMED method in the interior door manufacturing company, a significant reduction in changeover time by 23.42 minutes was achieved, representing an impressive decline of 37.82% compared to the original tool change time, as illustrated in Figure 12. This substantial decrease was achieved by modifying seven different activities in the tool changeover process. Besides confirming that the application of the SMED method can bring significant time savings in tool changeovers, it also clearly indicates that the SMED method is a crucial tool for companies like the one mentioned in this case study facing frequent and lengthy tool changeovers in the production process. Applying the SMED method also enabled precise tool adjustments to specific depths and penetration heights into the material, reducing deviations from prescribed values. These improvements contribute to greater precision and product quality.

From an economic perspective, the achieved time savings in changeover time can be utilised for additional production, resulting in increased production capacities for the company. This increased production capacity can be measured through additional revenues generated by product sales. In summary, implementing the SMED method brings significant financial savings, shortens changeover durations, and streamlines the existing company activities.


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