THE STUDY OF EXTENDED SINGLE MINUTE EXCHANGE OF DIE (SMED) METHOD IN 1200 TONNAGE TANDEM PRESS LINE FOR OPERATION IMPROVEMENT

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ABSTRACT

Single-Minute Exchange of Die (SMED) is a popular method used to optimize the die change processing time. The purpose of this study is to identify on how to reduce setup time by using Extended SMED in automotive stamping line. An actual case study at an automotive company in Malaysia was conducted based on parts supply failure cases. The observations, assessments and standard manufacturing implementation were carried out during the study. WITNESS simulation software was used in this study to identify the critical processes and also enable the validation of actual output based on the production planning. The result of the particular 1200 tonnage press line which produced six parts in one shift of operation with small lot size design has been identified and improved. The outstanding improvement based on the Extended SMED compares to conventional SMED approach shows a decreasing changeover time from an average of 20.13 minute to 9.35 minute which is 53 % reduction.

Keywords: Single minute of exchange of dies (SMED), Lean tools, Witness Simulation Software, Automotive, Stamping

1 INTRODUCTION

1.1 BACKGROUND OF STUDY

Single Minute Exchange of Dies (SMED) methodology has been at the forefront of changeover improvement activities since in the mid-1980s by Japanese inventor, namely Shigeo Shingo. The SMED methodology, which emphasizes that improvement should be sought primarily by re-arranging changeover elements into external time. The method has been widely acclaimed and has been extensively assimilated into research and industrial practices. To date, this method is still popular and well accepted in automotive industry [1]. The researchers and industry practitioners around the world are highly respected the system that has been published by Shigeo Shingo in handling problematic change-over activities. The SMED methodology has been widely adopted by many industries to improve manufacturing practice as mentioned in literature surveys [2]. Faster changeover performance, particularly by allowing responsive small batch manufacturing, is

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acknowledged as a cornerstone of JIT (just-in-time) manufacturing, lean/agile manufacturing and `world-class' manufacturing [3].

This paper considers the SMED methodology as the basis of study in order to explore the opportunity for improvement. There are often important opportunities for improvement to changeover performance at all stages of initiatives, which the conventional SMED methodology does not consider [4]. These opportunities include those that feature the application of design or surrounding factors, notably in its effect either to reduce the duration of existing changeover tasks or to eliminate them altogether. This study focuses on the Extended SMED, which is using simulation software method in order to provide improvement for current production set-up. Witness simulation software will analyze and will provide a comparison of improved process. It will become the opportunity to be a basis for future operation setup.

1.2 THE SMED'S CONVENTIONAL APPROACH.

The SMED system is a theory and set of techniques that make it possible to perform equipment setup and changeover operations in fewer than 10 min. SMED improves changeover process and provides a changeover time reduction up to 90% with moderate investments. Changeover operation is the preparation or after adjustment that is performed once before and once after each lot is processed. Shingo divides the changeover operation into two parts; internal setup and external setup [5]. Internal setup is a setup operation that can be done only when the machine is shut down (attaching or removing the dies). External setup is a setup operation that can be done when the machine is still running. These operations can be performed either before or after the machine is shut down [6]. For example getting the equipment ready for the setup operation before the machine is shut down.The process of SMED is illustrated as in Figure 1.

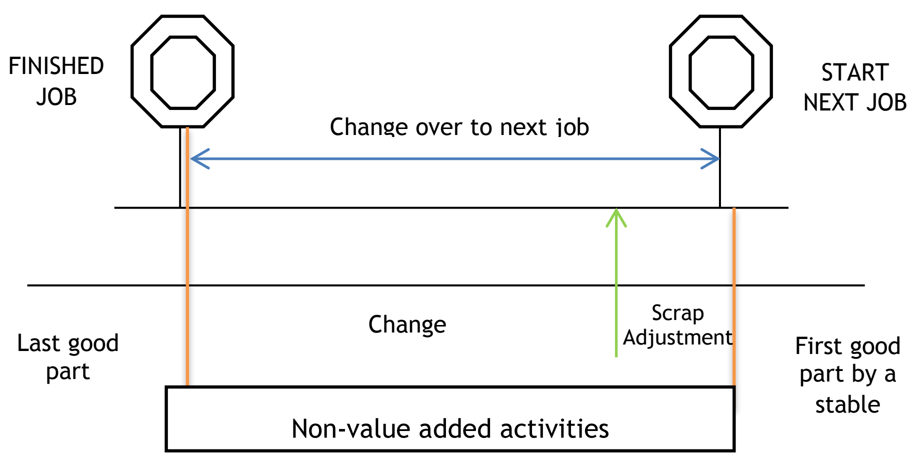


Figure 1: Process of SMED [7]

The setup period is constituted by internal setup and external setup. During the internal setup, there is no production takes place. In the run-up period, re-adjustments and trial productions are taking place. This period terminates when full output capacity is reached. SMED system includes three main steps. These steps are shown as in Table 1.

Table 1: SMED approach [8]

Steps	Items	Description
1	Separating Internal and External Setup	All change over element is performed while the equipment is topped. These are referred to as internal elements.
2	Converting Internal Setup to External Setup	To identify the element that can be performance while the equipment is running and make them external to the changeover.
3	Streamlining all Aspects of the Setup Operation	Streamlining all aspects of the Setup Operation To judge and review all elements for streamlining and simplifications. This shortens both changes over time and external time.

2 METHODOLOGY

2.1 EXTENDED SMED'S NEW APPROACH

The study was conducted by observing the complete dies set-ups at a benchmark 1200 tone Tandem Press Line in an automotive company in Malaysia. The current changeover procedure has been carefully evaluated to examine the type of improvements which can be made using the Extended SMED approach. The observations were undertaken using manual means by employing a standardized recording and analysis sheet [9]. This is to comply with the company policy which not allowed to use video recording during the set-ups as well as to prevent the operators from not to cooperate during the study.

The first step in the implementation of SMED was to separate internal (activities which can only be carried out when the machine is stopped) and external (activities which can be carried out when the machine is operating) changeover activities [10]. Once the internal and external activities were identified and separated, a checklist can be made which comprised of all the parts and steps during the current and preceding operations. The checklist of the changeover procedure also considered the sequence of activities involved during the actual operation. During the study, there were numerous waste activities that need to be eliminated, which were contributing to longer set-up times [11].

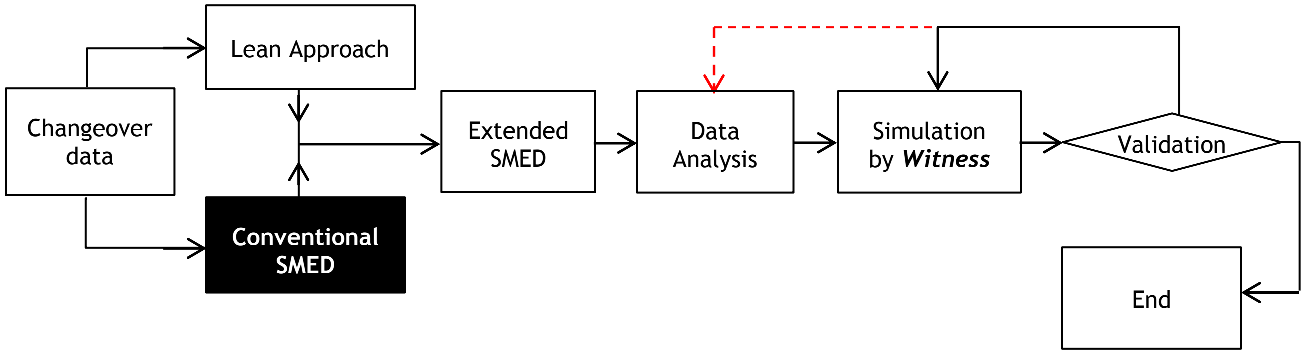


Figure 2: Schematic Process Flow in Extended SMED

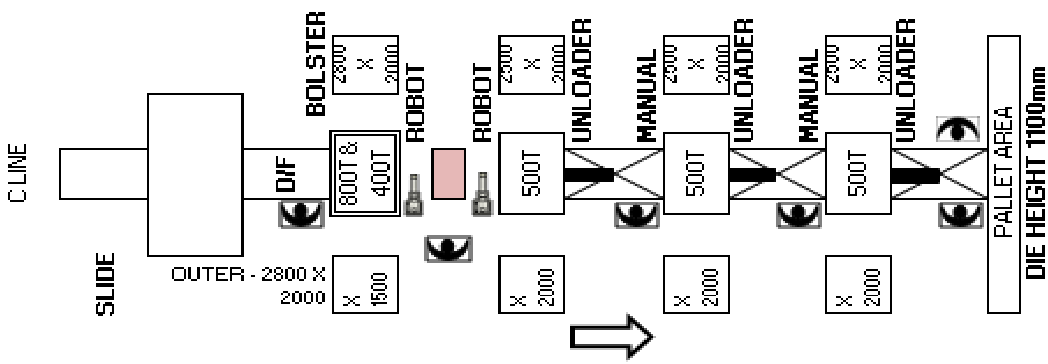
The basis for extended SMED approach was based on the conventional SMED method as illustrated in Figure 2. The framework of Extended SMED is focusing more on Lean Tools as the key factor of successful continuously improvement criteria which includes Value Stream Mapping (VSM), Plan Do Check Act (PDCA), 5'S, and Work Station Design. The collected data from the combination of all related tools designed in this framework will be analyzed by Witness simulation software [12, 13] and validated at different press line.

Results comparison before and after Extended SMED implementation was extensively reviewed during the study. The Witness simulation makes it possible in creating variety of discrete and continuous elements. Subject on the type of component, each can be in any quantity of 'states' which means either idle, busy, blocked, in-setup, broken down, and waiting for labor [14]. The data analysis had led to significant improvement which reflected to three major improvements such as mechanical, electrical, and organizational of the company.

3 RESULTS AND DISCUSSION

3.1 EXTENDED SMED APPROACH

The layout of the 1200 tonne Press Line is illustrated in Figure 3. It comprises of four press machines, two robots, and eight workers. During the study, the entire stamping production cycles data has been taken for 30 working days. The cycle time for each process performed was taken to ensure the accuracy of the data and to observe variations in each cycle time.



Machine Tonnage	M1	M2	M3	M4
	1200T	500T	500T	500T
Robot	Robot1	Robot2	Manual loading	Manual Loading
Man-power	6 person			
Tamakake (Die Setting)	2 person			

Figure 3: Machine Layout Press Line

According to the actual production requirement, the 1200 press line needs to produce a minimum of five strokes/part/shift production planning with an additional of two hours allocated for over time. The production planning deployed for this press line is to ensure ample time for changeover period. Hence, it is among the importance production criteria to achieve demanding supply with small batch of lot size. During the initial changeover activity, 21 sequences processes were recorded separately for each machine in this 1200 tonne press line. The overall data was recorded in the average reading, representing the findings of the four machines used in this study.

In the new approach known as Extended SMED, VSM was implemented to map every processes in the press line which enabled to identify areas in need for refinement [15]. The findings have been classified as critical areas and need to be focused for the next activity.

Table 2: Summary of Changeover performance in case study

Items	Machine 1	Machine 2	Machine 3	Machine 4	Average time	
					Sec.	Minute
Initial Data	1717	1402	1428	1428	1493.75	24.89
SMED Approach	1224	1192	1207	1207	1207.5	20.13
Extended SMED	561	564	560	560	561.25	9.35

Initial changeover data after implementing Conventional SMED approach reduced the average time from 24.89 minutes to 20.13 minutes (19% improvement). By implementing the novel Extended SMED approach, a new changeover time recorded showed a decreasing time from an average of 20.13 minutes to 9.35 minutes, which was 53 % achievement (refer to Table 2 and Figure 4). This method manifests a very promising results as the main target for the changeover in SMED approach needs to be in a single minute and it is achieved by using Extended SMED.

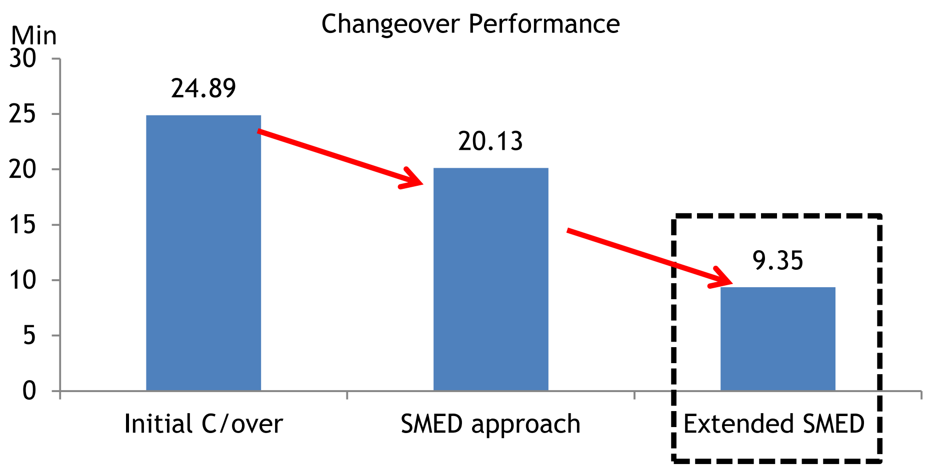


Figure 4: Changeover performance review

3.2 SIMULATION

The performance for current production data was run in Witness software, and the results were shown in Tables 3 and 4 for both Conventional SMED and Extended SMED approaches. According to the results of performance comparison for overall changeovers, output of production and machine performance has increased and able to produce six parts/shift instead of five parts/shift.

Table 3: Analysis by Witness software on SMED Conventional Approach.

Name	% Busy	% Idle	Quantity	No. of Jobs	No. of Job Started	No of Job Ended	Avg Job Time (s)
Sub-group 1	99.82	0.18	1	2164	1	0	0.22
Sub-group 2	99.82	0.18	1	2168	1	0	0.22
Sub-group 3	98.71	1.29	1	2151	1	0	0.22
Sub-group 4	99.78	0.22	1	2139	1	0	0.22

Table 4: Analysis by Witness software on Extended SMED Approach.

Name	% Busy	% Idle	Quantity	No. of Jobs	No. of Job Started	No of Job Ended	Avg Job Time (s)
Sub-group 1	98.80	1.20	1	2269	0	0	0.21
Sub-group 2	98.82	1.18	1	2273	0	0	0.21
Sub-group 3	98.23	1.77	1	2257	0	0	0.21
Sub-group 4	99.78	0.22	1	2244	1	0	0.21

Based on the simulation activities, by using Conventional SMED, it showed that the last part in the shift operation just could produce 119 out of 300 pieces as planned. Meaning that the remaining 181 pieces need to be produced in the next shift. However, by introducing Extended SMED approach as shown in Table 5, all 300 pieces were able to be produced in the same shift operation.

Table 5: Result comparison of Witness simulation finding.

SMED Approach		Extended SMED Approach	
Name	*Total In*	*Name*	*Total In*
Bf_Bin001	*200*	*Bf_Bin001*	*200*
Bf_Bin002	*200*	*Bf_Bin002*	*200*
Bf_Bin003	*200*	*Bf_Bin003*	*200*
Bf_Bin004	*200*	*Bf_Bin004*	*200*
Bf_Bin005	*300*	*Bf_Bin005*	*300*
Bf_Bin006	*400*	*Bf_Bin006*	*400*
Bf_Bin007	*400*	*Bf_Bin007*	*400*

Bf_Bin008	*199*		*Bf_Bin008*	*300*

4. CONCLUSION

A novel approach known as Extended SMED framework has been introduced to tackle the changeover issues faced by automotive stamping companies. Normally, the manufacturers run on small batch technique to cater for supply demands and press machines optimisation. Extended SMED framework methodology applied lean tools and simulation technique as an additional to the Conventional SMED. A comparison study was done on the actual press line in order to the measure the effectiveness of the Extended SMED approach. The results and achievements of before and after Extended SMED implementation were analysed and revealed that they were able to reduce a significant 53 % the changeover processes.

5. ACKNOWLEDGEMENT

The author would like to acknowledge the Universiti Malaysia Pahang for supporting this study.

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