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Single Minute Exchange of Dies (SMED) in 200-Tonne Stamping Machine – A Case Study

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ABSTRACT

This paper presents the implementation of a lean manufacturing tool known as Single Minute Exchange of Dies (SMED) in a continuous production line of a manufacturing automotive part industry in Malaysia. This study focused on the reduction of set-up time at a 200-tonne stamping machine. The SMED started with understanding the current practices. Then, time study was conducted to identify current change over time for each internal and external activity. At the same time, current problems and wastes were also identified along with the set-up activity. For systematic project implementation, Deming's cycle or also known as the PDCA cycle, was referred to. By rearranging the set-up activities, maximizing the external activities and implementing kaizen in order to eliminate wastes, the existing set-up time managed to be reduced by 60.7%. This reduction helps to increase the machine capacity, which also leads to other production improvements in terms of productivity, inventory level as well as the overall production cost.

Keywords: *Single Minute Exchange of Dies (SMED), TPS, Kaizen, time study*

Introduction

SMED which stands for Single Minute Exchange of Die is one of Toyota Production System (TPS) tools focuses to systematically reduce machine change over time and aims for quick set-up. A single minute is bringing the meaning that the exchange of dies or the set-up process must achieve a single digit, which is less than 10 minute [1]. According to Mckonly [2], if the SMED principles are followed accordingly, drastic reductions in set-up time can be obtained.

The one who was first introducing the TPS was Sakichi Toyoda, with the philosophy to eliminate all wastes in whole production activities by using a set of TPS tools such as kaizen, kanban, standardized work, line balancing SMED and others [3], [4]. Shigeo Shingo introduced SMED at Toyota Motor in 1960 [5]. He emphasized that the best way to reduce set-up time is by externalizing the set-up activities as much as possible. The external activity can be referred to activities that can be done without having to stop the production process or machine [6], [7].

The set-up time can be considered as a non-valued added activity that should be reduced or eliminated [8]. This is because the long set-up times resulted with larger production batch size and buffering work-in-process inventories as well as poor process flow and performance. Wastes in a manufacturing process or also known as "Muda" in Japanese word can be identified in 7 different forms which are transportation, inventories, motion, waiting, over process, overproduction and defect [9]. Toyota chief engineer Taiichi Ohno acknowledged these seven types of waste. In order to reduce or eliminate wastes, there are a lot of lean tools that can be applied, such as SMED, kaizen, 5s Total Preventive Maintenance (TPM), and standardized work. Each tool comes with a specific function and objective, which at the end, the main aim is to improve the overall manufacturing performance [10].

Thus, this case study is about the implementation of single minute exchange of dies (SMED) in automotive manufacturing in Malaysia. The study area is one of the production lines in the company, producing sheet metal-based products named refined door left and right for model D54T by using a 200-tonne single stroke of stamping machines. The main objective is to reduce the existing set-up time and eliminate wastes with the aid of other TPS tools such as kaizen, 5s, and line balancing.

Methodology

Observation of current practices

This study is case-based research; therefore, data were gathered through direct observation during the set-up activities taken place by the maintenance people. The first step in SMED is to identify the external and internal activities during the set-up. Then, cycle times of each activity were recorded by using a stopwatch and a video recorder. The recording is started at the moment the last piece of product finishes and the first step of the die setter is prepared for changing dies. For cycle time analysis, time study method was used according to the method introduced by Frederick W. Taylor. Based on the observation, the set-up was conducted by two die setters, and after that, the machine operator started the production once getting approval from a quality control (QC) inspector.

As shown in Table 1, all the activities are internal, performed when the production is stopped. Meanwhile, the external activity is the one that can be done while the process is still running. The activity contributed the longest time to complete is material preparation with almost 350 seconds, followed by installing the new die. Most of the activities that contributed longer time were involved in waiting and walking from the machine to the die storage. To reduce the set-up time, it starts with transferring as many internal activities to external as possible.

Table 1: Exist set-up activities

No	Set-up activity	Internal	External	Time (sec)
1	Clean and tidy machine	/		68
2	Tools equipment preparation	/		25
3	Die setter standby	/		36
4	Dismantle old die	/		156
5	Transfer new die	/		246
6	Install new die	/		306
7	Transfer old die	/		188
8	Material preparation	/		350
9	CF Standby	/		60
10	QC Checking	/		152
11	Operator standby	/		121
12	Production start	/		
	Total			1708

As shown in Figure 1, there are three main activities that can be separated in the production area, which are preparation, set-up the die, and inspection before start production. For the preparation activity, it includes raw materials and dies to be installed. Some of the raw materials are stored in inventory and other places at the WIP section. The die settler had to transfer them to the first machine, and this caused unnecessary transportation, waiting, and movement.

Process of changing the die required many movements which are one of waste and non-value added activities. The current flow of changing die takes longer time for waiting for the forklift to transfer the die to die rack where the distance between the die's rack and the stamping machine is quite long according to the address system on the rack. Therefore, time taken for transfer of the die varies according to its position on the rack to the machine. Before mass production, a QC inspector has to do dimension checking on the first production output. The QC inspector has to walk from the machine to the inspection area that also caused unnecessary movement and waiting.

1. Preparation 2. Dies set-up 3. Inspection area

Figure 1: The main set-up activities

Converting the internal activities to external and eliminating wastes

Through observation, it was found that most of the activities under preparation can be directly transferred to external sources. At the same time, TPS tools such as kaizen, 5s and total preventive maintenance have also been conducted to eliminate those identified wastes as listed in Table 2.

The main identified waste was the transfer process activity for the metal sheet, the dies, and CF checking. To eliminate it, a new, improved layout for the set-up process has been proposed as in Figure 2. Before starting the set-up, the die for the next production will be prepared earlier. The storage location for the dies also changed; make it closer to the machine by using a new chute rack so that the walking distance can be reduced. At the same time, the location of the checking fixture (FC) also improved; making it closer to the machine. Thus, it helps to reduce the distance of walking for the QC inspector to do a final inspection on parts before production can start mass production.

The introduction of 5S concepts also gave a significant impact on the set-up time reduction. Before SMED, the machine operator leaves the machine for set-up without 5S, with scraps around the machine. Thus, the die setter has to remove and clean all the scrap for a smooth dies changing process. By implementing the 5S concepts, the non-value added activities were removed. At the same time, the operator was trained to do 5S before and after the production process. At the same time, the 5s culture also managed to be implemented in the whole production system for an efficient manufacturing system.

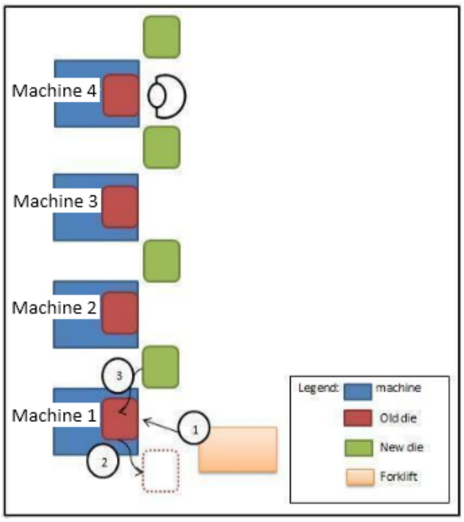

Figure 2: Flow set-up die

Table 2: Waste identification in the study area

No	Activity	Identified waste	Proposal and Action
1	The transition between the current and new process	Waiting	Planning, training
2	Tools case	Transport	5S with proper trolley system
3	Die transfer process	Motion	Design new route, optimize chute and provide training
4	Equipment movement	Motion	Transfer this task to the machine operator
5	Checking Fixture (CF)	Motion, waiting	Prepare CF as external activity
6	Tool wear	Waiting	Improve the pneumatic tools
7	Die tool change	Defect	Label all nuts and bolts according to dies
8	QC inspection	Waiting	Prepare checking jig for faster dimension checking

Results and Discussion

Table 3 lists down the new set-up time and activities after the improvement took place. After the SMED implementation, the set-up time managed to be reduced by 60.7%, which is from 1708 to 666 seconds. The time collection is based on the average set-up time being held during the implementation session. As shown in Table 1, 4 internal activities which are activity 1, 2, 8 and 9 have been transferred to external. This new set-up procedure has been materialized by having proper planning and early preparation before production stops the process for die set-up. Thus, the set up die ratio can be increased up to 5 times per working day as compared to 2 to 3 times as before. This is important as the products can produce in small volumes and reduce their inventories and WIP storage.

Table 3: New set-up time after implementation

No.	Activity	Set-up time at the Stamping machine	
		Before	After
1	Inform the supervisor	266	-
2	Tool and Die preparation	182	-
3	Material preparation	350	-
4	Changeover	722	530
5	QC approval	152	100
6	5s and scrap removal	36	36
	Total (sec)	1,708	666

Conclusion

This case study proved that SMED is a practical and efficient tool for improving and reducing set-up activities. Thus, the flexibility of the machine can be increased in order to reduce inventory and meet demand. At the same time, the 5S and kaizen culture can also be implemented in the whole production process. To maintain the performances, it is suggested for the company to implement Total Productive Maintenance (TPM) technique for a smooth manufacturing process.

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