Cost Saving in an Automotive Battery Assembly Line Using Setup Time Reduction

DEROS B.M., MOHAMAD D., IDRIS M.H.M., RAHMAN M.N.A., GHANI J.A., ISMAIL A.R.
Department of Mechanical & Materials Engineering, Faculty of Engineering & Built Environment
Universiti Kebangsaan Malaysia
hjbaba@eng.ukm.my

Abstract: - Many past researches had found fast setups and a changeover is required to reduce setup time and manufacturing costs. The two main objectives of this study are: first, to identify the root causes of bottlenecks operations and implement possible solutions to the problems; second, to study the cost saving effect after reducing the setup time. Single Minute Exchange of Die (SMED) methods were applied at two major bottlenecks setup operations; cast on strap and heat seal. The result shows significant reduction of cast on strap setup time to 54% and heat seal setup time to 47%. This study has achieved more than the target 35% of setup time reduction. From setup time reduction, a total cost savings of RM168, 000 was achieved in assembly line A. Meanwhile the company level a total saving of RM1.11million was achieved for all assembly lines in Company X.

Key-Words: - cost saving, setup time, SMED

1 Introduction

The survival of any industry in today's competitive market place depends on response time, production costs and flexibility in manufacturing [1]. In recent years, companies have become increasingly focused on market demand and customers responsiveness. This has led to the implementation and adoption of lean manufacturing techniques in the automotive industry. Due to the complexity and demand behaviour from customers, the role of better change over or setup time reduction that enable better response and small batch manufacture [2].

Reducing setup time has many benefits such as increased manufacturing flexibility and capability, shorter lead time, reduced inventory levels and production costs. Basically, short setup time can be achieved if overall lead times are reduced. Short setup time reduces wastes and defects, and thereby improved product quality.

The main goal of setup time is to reduce machine down time. Reducing machine down time will boost your company's capacity, increase your manufacturing flexibility, and help increase overall output [3].

Roy [4] believed that setup time can be reduced by using Single Minute Exchange of Die (SMED) concepts, which can be achieved through better planning, process redesign and product redesign.

SMED is a scientific approach to reduce setup time that can be applied in any factory to any machine [5]. The ultimate goal of SMED is to perform machine setup and changeover operations in less than ten minutes. Several practitioners have proved that the SMED method really works in practice and in some situations reductions of 90 percent or more are feasible [6].

Past research conducted by Trovinger and Bohn [7] had combined SMED and IT-Based Methods to study about the lost of effective capacity to setup time in printed circuit board assembly. Their research results shows that reduction in key setup times had contributed to more than 80 percent in term of total cost savings and direct benefits of USD1.8 million per year.

An investigational research had been performed by Cakmakci [8] to observe the relation between SMED methodology and equipment design in the automotive industry. The results of this research had indicated that SMED is an appropriate method not only for manufacturing improvement but also for equipment and die design development. Other past researchers who had conducted studies in setup time reduction are such as: Gilmore and Smith [9], Enns et al. [10], and Van Goubergen and Lockhart [11].

This case study is concerned with reducing setup time and manufacturing costs for a battery manufacturing company. Faced with increasing production volume and a desire to increase capacity,

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operational availability, reduce battery cost and increase flexibility to meet demands from customers, the company began evaluating options and actions in order to cope with these issues. The adoption of this approach and proposed countermeasures will be based on the company requirement to increase production output and at the same time try to reduce the operating cost.

The main objective of this study is to reduce machine setup time and achieved higher cost savings. SMED method was applied in reducing the setup time at the battery assembly line in Company X. The two main objectives of the study are; first, to identify the root causes of the bottlenecks operations and implement possible solutions to the problems; second, to study the effect on cost saving after reducing the setup time.

2 Methodology

This study was conducted in Company X. Only one battery assembly line involved, which is known as the main assembly line A.

2.1 Data Collection

Statistical data were collected and analysed to measure the machine setup time in assembly line A. First, data check sheet was developed prior to data collection and measured by using a stopwatch. Prior to that, the production process flow and standard operation procedure were briefly reviewed before developing the data collection check sheet. Based on the actual production, data was collected and recorded on daily basis by different types of time loss from the assembly line A. Later, a statistical bar chart is plotted to monitor and analyse the problems. These methods had helped the authors to identify the main contributor to high time loss in the battery assembly line A and help to visualise and better understand the root cause of problems and finding possible solutions to the problems.

2.2 SMED Techniques

The SMED method investigated in this study consists of eight techniques; (1) separate internal from external setup operations; (2) convert internal to external setup; (3) standardise function, not shape; (4) use functional clamps or eliminate fasteners altogether; (5) use intermediate jigs; (6) adopt parallel operations; (7) eliminate adjustments and (8) mechanisation.

2.2 Data Analysis

The analysis of data and information gathered that led to significant improvement will be carried out in three different categories such as; mechanical improvement, electrical improvement and organisational improvement. Comparison results of before and after SMED implementations are extensively discussed. Total savings are also discussed and explained.

3 RESULTS AND DISCUSSION

Basically, there are nine processes and machines involved in mould setup activities in assembly lines A. Processes and machines involved are enveloping, cast on strap, polarity tester, spot welding, short circuit, shear tester, heat seal, post burning and air leak tester.

3.1 Identifying Bottleneck

The current setup time in all nine processes in Assembly line A were collected and analysed thoroughly to investigate the bottleneck process. This data analysis is vital to observe the current setup time activities and performance and to identify which current setup processes need to be focused on this study before SMED can be implemented on mould setup in the assembly line A. The current setup time of nine processes involved in mould setup collected are shown in Table 1.

It is apparent from Table 1 that the cast on straps process and heat seal machines takes longer setup times compared to other processes. Over the past 2 months, with an average of 52 minutes were used to perform the cast on strap machine setups and an average of 32 minutes were used to perform the heat seal machine setups.

From this analysis, cast on strap and heat seal machines were identified as the two major bottlenecks. These two setup processes spent approximately about 59% of the total average minutes to complete the tasks.

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Table 1: Current setup time of nine processes involved in mould setup

No	Process/Task (minutes)	Time (minute)										
		1	2	3	4	5	6	7	8	9	10	Average
1	Enveloping machine	13.5	10.2	11.3	11.5	14.2	12.1	12.9	12.3	13.3	11.1	12.24
2	Cast on strap machine	52.2	50.1	55.2	51.3	53.6	59.2	51.2	53.6	50.2	49.5	52.61
3	Polarity tester machine	9.4	7.2	7.5	7.3	7.1	7.9	9.1	8.3	8.5	8.1	8.04
4	Spot weld machine	11.2	13.5	10.1	15.7	12.4	12.3	11.8	13.1	12.2	12.9	12.52
5	Short circuit machine	8.1	6.6	7.4	8.3	8.8	9.2	6.7	7.2	7.3	7.5	7.71
6	Shear tester machine	9.3	10.1	10.5	11.3	10.3	10.2	11.2	12.6	10.6	10.2	10.63
7	Heat seal machine	36.2	31.1	35.2	29.6	33.1	35.3	31.7	31.4	34.4	33	32.7
8	Post burning	406	5.1	5.8	4.3	5.9	4.6	4.1	4.7	4.5	5	4.86
9	Air leak tester	3.9	4.5	3.5	3.7	3.3	3.8	3.2	3.6	3.7	5	3.82

3.2 Reduce Setup Time

There are 13 tasks involved in the cast on strap setups on mould changing at the assembly line A. Data analysis on setup data was used to identify, which current cast on strap activities delayed the setups processes and contributes to longer setup times.

The eight SMED techniques have been applied to the cast on strap setup operations. A thorough time study analysis of the cast on strap and heat seal setup activities were conducted in order to evaluate the setup performance for each setup activity after the implementation of the eight SMED techniques.

After successful implementation of SMED and a few improvements that have been made in cast on strap setup activities, the overall setup time was reduced from 52 minutes to 24 minutes. A total of 28 minutes or 54% of setup time were reduced in the cast on strap setup operations. Figure 1 shows the time comparison before and after SMED implementation in cast on strap.

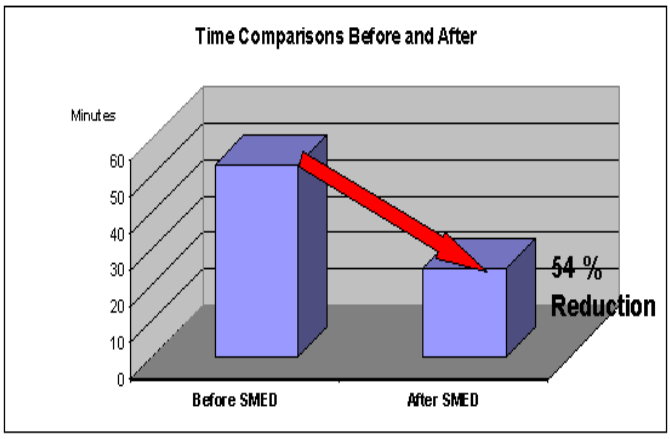

Figure 1: Time comparison before and after SMED implementation in cast on strap

There are 12 tasks involved in heat seal setups which are currently done by a single worker. In the current practice, all the internal activities involved during the setup for a battery heat sealing machine are performed while the machine is not running. Setup time data for each activity involved in battery heat sealing setups were collected and analysed. The same SMED techniques used in the cast on strap setup were then applied in the heat seal machine setup. The data collected shows significant improvement in all bottlenecks activities after SMED techniques were applied in assembly line A.

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After successful implementation of SMED and a few improvements have been made in heat sealing machine setup activities, the overall setup time was reduced from 36 minutes to 19 minutes. A total of 17 minutes or 47% was reduced in the heat seal setup operations. Figure 2 shows the time comparison before and after SMED implementation in heat seal.

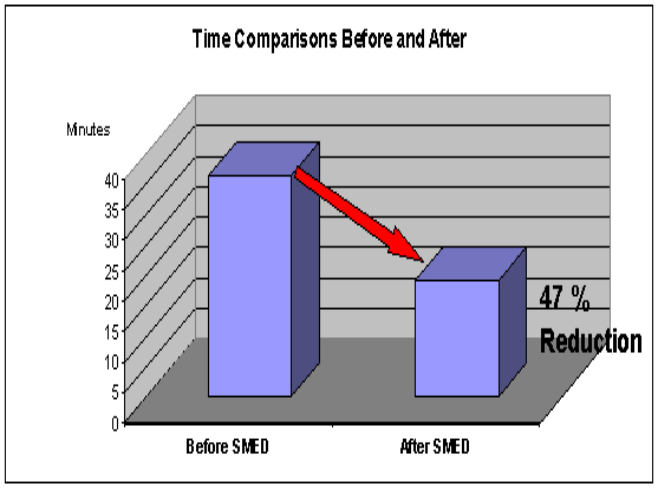

Figure 2: Time comparison before and after SMED implementation in heat seal

After the SMED techniques have been applied in the 2 bottleneck processes (cast on strap and heat seal), the total time taken to perform cast on strap setup activities at assembly line A was shortened by 54 percent from 52 minutes to 24 minutes, meanwhile heat seal machine setup time was reduced from 36 minutes to 19 minutes, resulting in a 47 percent reduction in setup process time.

3.3 Total Savings and Cost

The biggest financial impact of the new improvements on the set up methods is the total machine down time reduced during the setup activities.

Both scheduled and unscheduled loss times are valued at RM2, 600 per hour or RM43 per minute. A total of 29,913 minutes are lost per year due to the mould setup activities and 575 setups per year (based on 52 minutes per setup) with setup costs averaging RM1.1 million per setup per year. Table 2 shows the detailed calculation of total saving for all the assembly lines.

Meanwhile, if we zoom in to the details of total saving for assembly line A, it shows that a total of RM168, 000 could have been saved during the setup. Total saving for cast on strap and heat seal setup processes in the assembly line A are shown in Table 3. This calculation method is based on the past data information in which about 87 setups per year has been performed in the assembly line A. This total saving is estimated in term of cost and cost savings in assembly line, which is valued at RM2, 600 per hour or RM43 per minute respectively.

The highest total saving for total assembly lines shows that it is critical to apply the SMED or setup reduction techniques into manufacturing plant to reduce the setup times and costs. The study also revealed that the setup and manufacturing costs could have been reduced a long time ago if the SMED principles were applied in the setup operations.

4 Conclusion

This study examines the setup time reduction in battery assembly line by implementing SMED techniques. The study aims to reduce set up time by exploring the efforts on assembly line improvements, the required further improvements, and factors that can contribute to further reducing set up time in battery assembly. The SMED techniques were implemented in the two bottleneck processes, in cast on strap and heat seal. The main goal is to reduce machine downtime during the setup operations. Reduction in setup times makes it possible to increase manufacturing system flexibility to manufacture a variety of products. By implementing the eight SMED techniques, the total time taken to perform cast on strap setup activities at assembly line A was reduced by 54% or from 52 minutes to 24 minutes. Meanwhile, the heat seal machine setup was reduced from 36 minutes to 19 minutes, resulting in a 47% reduction in setup process time. In this study, the benefits achieved through the decreased in lead time on the bottleneck processes, set up reductions on processes are also valuable. Due to setup time reduction, a total savings of RM168, 000 was estimated in term of cost savings in assembly line A and a total saving of RM1.11 million was estimated for all assembly lines in Company X. However, the results from this study need to be treated with caution because the SMED techniques were not applied to the other three main assembly lines, B, C and D. Therefore, the authors had strongly recommend the company to implement the SMED techniques in main assembly lines B, C and D, so that the total assembly loss time due to setup or mould change over could be reduced and thus improves their production efficiencies and total cost savings.

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Table 2: Total saving for all assembly lines in Company X

No	Process	Time (s)		Minutes +/-	% Change	RM Saving/Year with 575 setups/Year
		Before	After			
1	Cast on Strap set up loss time	52 minutes	24 minutes	28	-54%	692300
2	Heat Seal set up loss time	36 minutes	19 minutes	17	-47%	420325
					Total	1112625

Note: Estimated RM2600/hr @ RM 43/minute

Table 3: Total savings for assembly line A

No	Process	Time (s)		Minutes +/-	% Change	RM Saving/Year with 87 setups/Year
		Before	After			
1	Cast on Strap set up loss time	52 minutes	24 minutes	28	-54%	104748
2	Heat Seal set up loss time	36 minutes	19 minutes	17	-47%	63597
					Total	168345

Note: Estimated RM2600/hr @ RM 43/minute

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