REDUCTION IN CHANGE OVER TIME OF PUNCHING MACHINE USING SMED METHODOLOGY IN INDIAN SME

[1]Jignesh H. Acharya, [2]Hemant R. Thakkar
[1]Mechanical Engineering Department
[1]G.H. Patel College of Engineering & Technology, Vallabh Vidyanagar, Anand, Gujarat.

Abstract: -In today's era of mass customization manufacturing firms feels short hand to timely deliver customer's order because of presence of several production wastes. Various Lean tools are helpful to overcome such production wastes. This paper presents reduction in changeover time of power press using Single Minute Exchange of Die in an Indian SME. Before implementing SMED causes for high setup time are identified by observation and brainstorming activity with production people. Implementing of SMED result into reduction of setup time from 25min53sec to 15min53sec approximately by 53.84%. Approximately 54.6 man-days per year saved and total monetary benefit per year is RS.41500.

Keywords— Lean manufacturing, SMED, Internal & External setup, Setup time, Lead time.

I. INTRODUCTION

In the global competitive environment majority companies are making attempts to reduce product lead time of their product to timely deliver their product to customer and to grab as maximum number of customers. Traditional approach is to focus on quantitative man hours, while modern approach is to focus qualitative man hours. The modern focus will be helpful to deliver the products on scheduled time and to cover as many orders as they can. The modern approach will reduce the cost of production. Especially SMEs having Make to Order environment with longer Lead time have more number of setups. The numbers of setups are also increased due to change in priority frequently. As there are many reasons for longer Lead time but in present case setup time reduction is vital to reduce Lead time. SMED methodology is helpful to reduce setup time. Dr.Shigeo Shingo defined Single minute exchange of die and classifies setup time process in to two activities, namely internal activity and external activity. An internal activity is the activity performed when machine is idle and external activity is the activity performed when machine is running. Hence, by converting internal activity to external activity, setup time will reduce. Reduction in setup time will result in reduction in idle time of machine means high productivity or lower lead time.

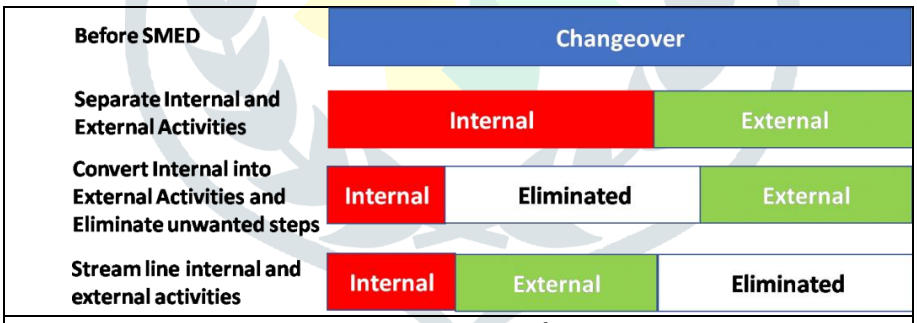

Figure 1: Concept of SMED

In this paper a case study is considered from a medium scale fabrication industry, having Make to Order environment. The lead time reduction is the only way to remain competitive. Here, SMED is implemented to reduce production lead time. After implementation of SMED setup time is reduced by 53.84% and 54.6 man days per year is saved.

II. LITERATURE REVIEW

Total 21 papers are reviewed which shows 52% of reduction in setup time by using SMED and other Lean tools. (Figure 2)Mostly setup time reduction achieved by SMED in various case studies. E. Costa et al. (2013) implemented SMED in turret punching machine and reduce setup time by 64%, WIP by 50%, operator movement by 99% and gain monetary benefit of €7,315.38 per year. Daina P. etal. (2015) implemented SMED with JIT and successively reduce setup time from 39min to 9.59min approximately by75% and gain monetary benefit of $7500 through SMED and overall benefit of $126302.27. J. Singh et al. (2018) reduced setup time by 80%, increased profit by Rs.1809378. &also improved overall equipment efficiency by 4%, after implementing SMED. H.K. Gupta et al.(2017) get 60% reduction in setup time by converting 40% of activity to external and 20% of activities to parallel & stream line activity. M. Shivkumar et al.(2015) used VSM to identify non-value added activities in setup processes and then used SMED to improve it and setup time reduced by 44%. D. Shetty et al.(2012) implement SMED on CNC turning with use of "idea assessment prioritization matrix" and reduced setup time by 48%. Brian T. Michels able to reduce setup time by 68% and man power from 3 to 1 by successfully implementing SMED. M. Cakmakci(2007) correlated SMED with equipment design by doing process capability analysis in Minitab software. R. Ahmad and M.S.F. Soberi (2017) use 5-why

analysis, cause and effect diagram with SMED and able to reduce setup time by 44% and internal activity time by 48% of 5 axis CNC machine. R. Sousab et al.(2011) described usefulness of SMED to improve manufacturing efficiency in power controls industrial company they implement SMED in Bending machine, punching machine and injection molding machine and reduce their setup time by 59 to 90%,reduce WIP from 17.05 to 7.74days and average reduction in distance travel by operator is approx. 302m. Franco Lucherini & Mario Rapaccini(2017) implemented Lean tools like VSM, JITs with SMED and demonstrated its effect on manufacturing flexibility. S. Benjamin et al.(2012) convert 5min of internal setup activity to external setup activity using SMED to get rid of from small setup time and improve OEE by 2.08%.B. J.Singh and D. Khanduja(2009) describedhow SMED,5S,Poka-Yoke and Ishikawa diagram are helpful to reduce 40% setup time in foundry shop. Elif Ayva et al.(2013) implemented SMED with Taguchi approach and improve OEE by 6% and reduce setup time by 15min. A. Allahverdi and H.M. Soroush(2008) shows effect of SMED on scheduling and shows 20% reduction in setup cost. Dr. RM Belokar and R.shrma(2017) implementing SMED in water jet cutting machine and thereby reduce setup time and operator's movement by 23% and 72% respectively. A. Sayem et al.(2014) describe how SMED improve performance of furniture industry authors were able to reduce setup time by 65.28%. H. Radu et al.(2017) reduce setup time by 30% after implementing SMED in pharmaceutical company.

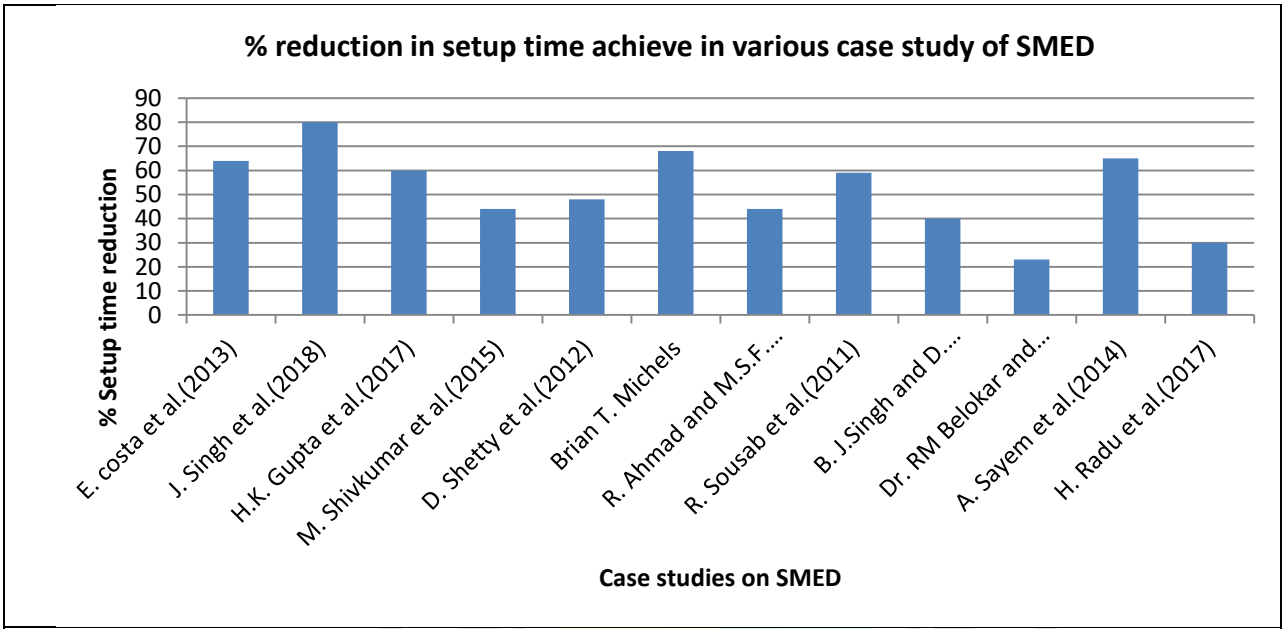

Figure 2. % reduction in setup time achieve in various case study of SMED.

III. METHODOLOGY

This research is focused on reduction in lead time using SMED in an Indian fabrication SME having Make to Order environment. Before implementing SMED Bottleneck machine is identified using Time study as shown in figure 3.From time study it is observed that, bottleneck occurs at the punching machine, So SMED should be applied on this machine.

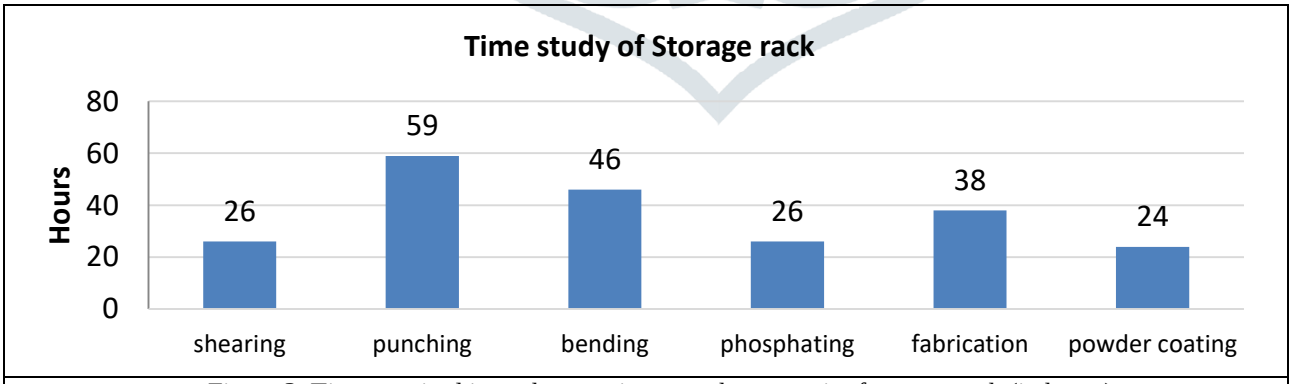

Figure 3. Time required in each operation to make one unit of storage rack (in hours).

Cause and effect diagram methodology (figure 4) is used to identify root cause for high setup time after doing brain storming activity with machine shop supervisor and punching machine operators. The process steps of making whole setups processes are identified by visual observation. Then actual time study is carried out using stopwatch. After analyzing whole setup process some actions are proposed to reduce current setup time.

Table 1.Time study for changeover time on Punching Machine

Step	Operation	Time	Internal	External
1	Find supervisor for what to take next	7m		
2	Material movement from shearing m/c to punching machine	5m		
3	Remove the clamp	2m		
4	Remove the shank holder	1m16s		
5	Remove the die and place it on table	10s		
6	Remove shank from die	30s		
7	Replace that die with new die	1m12s		
8	Fit shank on new die	30s		
9	Fix die on punching machine	1m25s		
10	Fixing clamp and make necessary adjustment	5m		
11	Take a scrap piece and test it	1m		
12	Take fist piece of batch and punch it	1m		
	Total time	25m53s	25m53s	0

From table 1 it is found that first 2 activities i.e. lack of clarity about what to do next and material handling are consuming more than 50% of time so improving it will result in reduction of setup time by 50% other activities like Fixing clamp and make necessary adjustment have comparatively more time related to remaining activities but as jobs are non-standard so standardization in clamping is not feasible so here we focus on first two activities.

Table 2. Time study of Storage rack

Operations	Shearing	Punching	Bending	Phosphating	Fabrication	Powder coating	Total (Hrs)
Time(Hrs)	26	59	46	26	38	24	219

From time study it is identified that the average time required to make one storage rack is 219 hrs.(Table 2) Here, it is observed that setup time is predominantly high, and there is large scope of reducing set-up time. Several causes for high set up time is idenfied and plotted in cause and effect diagram.

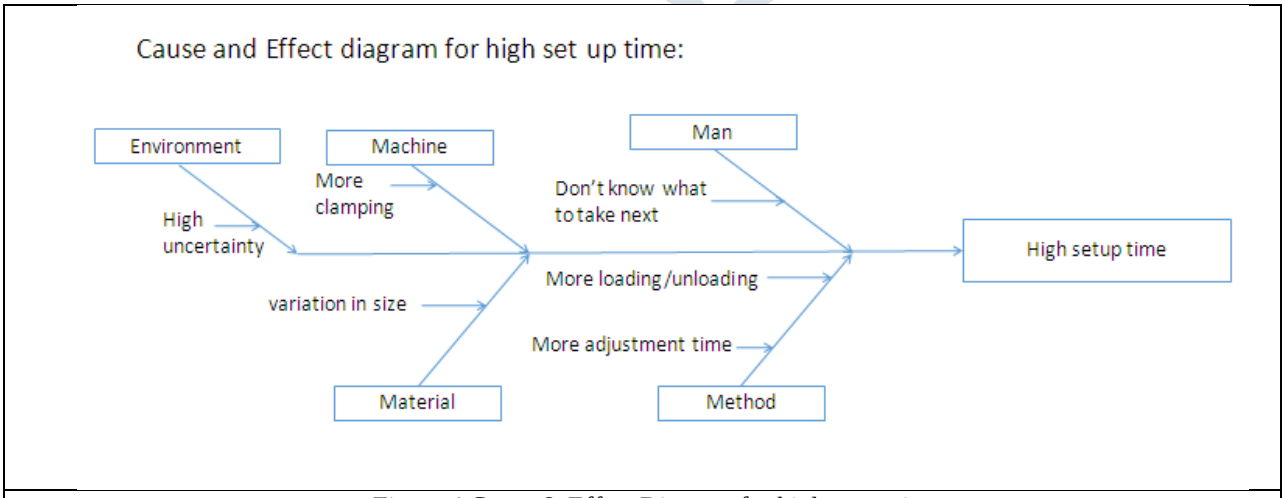

Figure 4.Cause & Effect Diagram for high setup time.

From observation we found that:

1) Two workers behind shearing machine are involved in non-value added activities like arrange cutting pieces which indicates over processing waste.

2) Punching machine operator comes to shearing machine to take required material, which indicates motion waste.
3) Punching machine operators have lack of clarity about their whole day work.

From above observation we propose some action to convert internal activity to external activity as given below:

1) Shearing machine workers can send required material to punching machine.
2) Production planning board is placed in machine shop area which shows production schedule for a day and should be updated as an when production planning change and machine shop supervisor assign 3 to 4 job and write sequence of it on drawing.

By implementing above thing first two activities are converted to external activities as shown in table number 3. Before after comparison is as shown in Table 4.

From Table number 3 time saved per setup =12min, number of setup require for selected product = 26.

So, time saved in fabrication of one unit = time saved per setup* number of setup require for selected product/unit.

=12min*26

=312 min/unit.

Table 3.conversion of internal activity to external activity

Step	Operation	Time	Internal	External
1	Supervisor give new drawing prior to completion of current task	7m		
2	Material movement from shearing m/c to punching machine	5m		
3	Remove the clamp	2m		
4	Remove the shank holder	1m16s		
5	Remove the die and place it on table	10s		
6	Remove shank from die	30s		
7	Replace that die with new die	1m12s		
8	Fit shank on new die	30s		
9	Fix die on punching machine	1m25s		
10	Fixing clamp and make necessary adjustment	5m		
11	Take a scrap piece and test it	1m		
12	Take fist piece of batch and punch it	1m		
	Total time	25m53s	13m53s	12m

IV. RESULT& CONCLUSION

During implementation of SMED in fabrication industry punching is identified as bottleneck operation using time study. To convert internal activity to external activity 7 wastes were identified out of that over processing and waiting were identify as 2 major wastes and actions were taken to overcome it. Setup time is successfully reduced by 53.84% by converting 2 internal activities into external activity. Around 109.2 man-days and approximately RS.41500 is saved for one year. These results are achieved without incurring any extra cost.

Table 4.Before after comparison of SMED

Sr. no.	Description	Before	After	% improvement
1	Total change over time	25m53s	13m53s	53.84%
2	No. of internal activities	12	10	reduce by 16.67%
3	No. of external activities	0	2	improved from 0 to 2

For implementing SMED only 2 activities were converted from internal to external activity. It was aimed to reduce set up time. Further improvement scope is possible by implementing other Lean tools other performance measures can be improved.

V. REFERENCE

[1] R. Natholia, "Study of SMED Methodology and Its Systematic Procedure of Implementation," vol. 3, no. 1, pp. 1–5, 2017.

[2] G. Tamizharasi and S. Kathiresan, "Lean manufacturing in carriage building press shop," *World Appl. Sci. J.*, vol. 29, no. 10, pp. 1333–1340, 2014.

[3] S. Pellegrini, D. Shetty, and L. Manzione, "Study and implementation of single minute exchange of die (SMED) methodology in a setup reduction kaizen," *3rd 2012 Int. Conf. Ind. Eng. Oper. Manag. 3-6 July 2012*, pp. 2353–2363, 2012.

[4] D. Ribeiro, F. Braga, R. Sousa, and S. Carmo-Silva, "An application of the smed methodology in an electric power controls company," *Rom. Rev. Precis. Mech. Opt. Mechatronics*, no. 40, pp. 115–122, 2011.

[5] B. Michels, "Application of Shingo's Single Minute Exchange of Dies (SMED) methodology to reduce punch press changeover times at Krueger International," 2007.

[6] S. Patel, B. G. Dale, and P. Shaw, "Set-up time reduction and mistake proofing methods: An examination in precision component manufacturing," *TQM Mag.*, vol. 13, no. 3, pp. 175–179, 2001.

[7] M. Cakmakci, "Process improvement: Performance analysis of the setup time reduction-SMED in the automobile industry," *Int. J. Adv. Manuf. Technol.*, vol. 41, no. 1–2, pp. 168–179, 2009.

[8] M. Braglia, M. Frosolini, and M. Gallo, "SMED enhanced with 5-Whys Analysis to improve set-upreduction programs: the SWAN approach," *Int. J. Adv. Manuf. Technol.*, vol. 90, no. 5–8, pp. 1845–1855, 2017.

[9] R. Ahmad and M. S. F. Soberi, "Changeover process improvement based on modified SMED method and other process improvement tools application: an improvement project of 5-axis CNC machine operation in advanced composite manufacturing industry," *Int. J. Adv. Manuf. Technol.*, vol. 94, no. 1–4, pp. 433–450, 2018.

[10] F. Lucherini and M. Rapaccini, "Journal of Industrial Engineering and Management Exploring the Impact of Lean Manufacturing on Flexibility in SMEs," vol. 10, no. 5, pp. 919–945, 2017.

[11] S. Jebaraj Benjamin, U. Murugaiah, and M. Srikamaladevi Marathamuthu, "The use of SMED to eliminate small stops in a manufacturing firm," *J. Manuf. Technol. Manag.*, vol. 24, no. 5, pp. 792–807, 2013.

[12] B. J. Singh and D. Khanduja, "SMED: For quick changeovers in foundry SMEs," *Int. J. Product. Perform. Manag.*, vol. 59, no. 1, pp. 98–116, 2010.

[13] A. Allahverdi and H. M. Soroush, "The significance of reducing setup times/setup costs," *Eur. J. Oper. Res.*, vol. 187, no. 3, pp. 978–984, 2008.

[14] M. Kemal Karasu, M. Cakmakci, M. B. Cakiroglu, E. Ayva, and N. Demirel-Ortabas, "Improvement of changeover times via Taguchi empowered SMED/case study on injection molding production," *Meas. J. Int. Meas. Confed.*, vol. 47, no. 1, pp. 741–748, 2014.

[15] J. Kansal and S. Singhal, "Application and Validation of Dmaic Six Sigma Tool for Enhancing User Satisfaction in an Indian Government R & D Establishment," *Ind. Eng. J.*, vol. 10, no. 10, pp. 37–47, 2017.

[16] A. Sayem, M. A. Islam, and M. M. A. Khan, "Productivity enhancement through reduction of changeover time by implementing SMED technique - In furniture industry," *Int. J. Ind. Syst. Eng.*, vol. 17, no. 1, pp. 15–33, 2014.

[17] A. A. Karam, M. Liviu, V. Cristina, and H. Radu, "The contribution of lean manufacturing tools to change over time decrease in the pharmaceutical industry. A SMED project," *Procedia Manuf.*, vol. 22, pp. 886–892, 2018.

[18] E. Costa, S. Bragança, R. Sousa, and A. Alves, "Benefits from a SMED application in a punching machine," *World Acad. Sci. Eng. Technol.*, vol. 7, no. 5, pp. 379–385, 2013.

[19] B. Rajeev, *Information systems and ophthalmology.*, vol. 44, no. 4. 1996.

[20]R. Rodríguez-Méndez, D. Sánchez-Partida, J. L. Martínez-Flores, and E. Arvizu-Barrón, "A case study: SMED & JIT methodologies to develop continuous flow of stamped parts into AC disconnect assembly line in Schneider Electric Tlaxcala Plant.," *IFAC-PapersOnLine*, vol. 28, no. 3, pp. 1399–1404, 2015.

[21]J. singh, "SMED for quick change over in Manufacturing Industry – A case study," 2017.