

IMPLEMENTING THE LEAN FRAMEWORK IN A SMALL & MEDIUM & ENTERPRISE (SME) – ACASE STUDY IN PRINTING PRESS

Rishi J P¹, Dr. Srinivas T R², Dr.Ramachandra C G³Dr.BC Ashok⁴

^{1,4} Assistant Professor, Associate Professor, Department of Mechanical Engineering, VidyaVardhaka College of Engineering Mysuru, India.

² Professor, Department of Industrial & Production Engineering, SJCE, Mysuru, India.

³ Professor, Department of Mechanical Engineering, Srinivas Institute of Technology Mangaluru, India

* Corresponding Author: rishiip@vvce.ac.in

Abstract: The last decades witnessed tremendous research into the field of manufacturing perfection which is popularly called as world-class manufacturing (WCM) such as LEAN manufacturing (LM), Total quality management (TQM), Total productive maintenance (TPM) and their manifestations in automobiles, Mechatronics and polymers industries. LEAN manufacturing is emerging as one of the top manufacturing approach in this millennium. This paper is all about a theoretical framework for adopting and implementing LEAN in a sticker Printing SME. LEAN tools, for example, 5S, quality circle, quality control, visual show and standardization are a low-cost investment techniques are attainable to execute in SMEs given the immense help from the top management. Small Medium Enterprise (SME) is facing cut-throat competition from big Enterprise as they can provide products with high value at low price. Further, this study is related to the newly incorporated simplified quality model similar to Six Sigma technique applied in an SME company and its implementation in a case study i.e. a printing press resulting in high profitability through an increase in productivity.

1. Introduction

Customers have great expectations that the product they buy is of superior Quality. This puts tremendous pressure on various industries to adopt a variety of quality management program so that best quality product can be offered with low lead time and low cost. This leads to the implementation of a variety of quality management program into the Manufacturing units. One of the latest and proven quality management program in SME's is the LEAN Manufacturing. (Buesa 2009; Kaushik et al. 2012). This aims at Elimination of non-value added activities yielding profits. Studies show implementing the LEAN framework to guide large industry was very successful (Thomas et al. 2009; Laureani and Antony 2010; Ray and John 2011). Now SME's must be more competitive in order to survive compared to Large Industry which could offer the Quality product at low cost. Whereas this study is concerned it provides a LEAN framework easily adaptable in the SME label printing press so that there is no waste of resources, high productivity and low printing cost [1].



2. Lean Practice

Different companies have different viewpoint regarding LEAN. Some would think LEAN as a production control system. Wherein LEAN tools used in the analysis in the initial stage whereas others suggest that LEAN becomes the mainstay framework. LEAN Manufacturing targets waste creations and eliminate non-value-added operations in production (Womack et al. 1990). This takes into considerations the strength, weaknesses and other aspects of each system to form the best system (Kumar et al. 2006; Snee 2010). Quality management offers a solution in the form of LEAN Manufacturing practice which would be useless if the implementation is difficult to achieve. Implementation of LEAN on a holistic basis so that every part of the LEAN framework is adopted such that it leads to unified operations through the SME's. LEAN is synonymous with quality management program (Shah et al. 2008), LEAN results in drastic changes resulting in the overall progress of SME's which results in low-cost operations. (Achanga et al. 2006), the main objective is to insist on quality all-round the SME's and stresses the needs towards continuous improvement at all level in the organization (Pepper and Spedding 2010).

Throughout LEAN implementation, a company would be able to identify key areas of improvement. The LEAN framework proposed in this paper is focused on an SME, which is a sticker printing press. The design the framework is based on company's profile viz., management style, workforce size and technology employed...etc. The conditions for LEAN adoption in this Printing Press are non-conducive for any quality management initiatives. The only objective of the company is printing and meeting customer deadlines. However, its Prime focus is printing only not improving quality of products, hence it becomes very difficult to adopt quality management like LEAN Manufacturing.

Implementation of LEAN is not an easy job in an SME as it lacks LEAN experts having years of experience in the area of LEAN to implement the project otherwise framework becomes complicated and the cost of implementation goes up. Due to this situation in SME's, it becomes impossible to design a generalized LEAN framework exhibiting flexibility of utilizing a variety of LEAN tools within the methodology [2]. Hence, this developed LEAN framework gives a detailed step by step procedure in every stage and even with people having low expertise and experience in the LEAN field can use it effectively.

3. Case study – A printing Press company

The Newly developed LEAN framework is introduced for SME sticker printing press. The sticker printing department prints variety of stickers such as labels and universal barcode for the identification process. The present management wanted to implement LEAN to a Sticker printing press having poor production volume with a high degree of waste; thereby increasing lead time and product price [3].

4. LEAN Framework

The Proposed LEAN framework consists of five stages, with each stage offering smooth transit events like root-cause identification and possible solution to get rid of the root cause through nonstop improvement. Also, it doesn't mean that this using this framework only we can have LEAN acceptance. Thomas et al (2009) highlighted this in their LEAN related studies. The formed LEAN structure mulls over the reasonableness of the environment where LEAN is implemented. The LEAN framework adopted is a simplified version of Six Sigma's DMAIC methodology using data-driven and guided standard approach of using a LEAN framework at all stage to improve the system.

4.1 Stage I: Define the Problem - Data Collection

The Printing industry is facing a lot of competition to offer their low-cost quality products at a faster rate. As a result, a company should generate zero waste. The printing press operates on optimized resources and becomes LEAN. This case study company cannot meet the customer orders resulting in customers being unhappy due to late delivery. Also, orders which are urgent in nature are not taken up thereby reducing the customers. The root cause of the problem needs to be identified and solved which will reduce the chances of the same problem recurring. So the root cause of the problem, label history data is collected and analyzed. Data pertaining to product mix, machine capacities and process capabilities is extracted. The data is collected is based on shop floor observation, also all levels of management of printing section were consulted for their opinion and suggestion were recorded. Also, time study of various processes was made. Poor Documentation of printing data in SME because they were paying attention only to meet customer demand, while there are no experts to implement LEAN initiative printing[4]. This is the current scenario of sticker printing press. Sticker printing requires one printer Machine for each assignment and every assignment different and is based on the types of ink, colour combination and text matter and consumables. Based on individual capabilities and workload orders are scheduled based on individual capabilities.

Table 1. Production volume of the sticker in printing section

Items	Type -A			Type- B	Type- C
	Machine-1	Machine -2	Machine -3	Machine-4	Machine-5
Printing volume (Printings/week)	250,000	250,000	250,000	130,000	250,000
Existing printing volume(Printings/week)	125,945	119,071	120,670	55,356	110,800

Referring TABLE 1, the existing printing volume of all 5 machines is nearly 45% less than capabilities for Machine type A; 35% and 40% less for Machine type B and C respectively. This data is based on current printing volume on monthly average basis of a current fiscal.

4.2 Stage II: Analyzing the primary data collected

After extensively collecting primary data which shows that low productivity was the main reason the printing SME was unable to satisfy the customer orders also demand for printing stickers with liquid ink jet printing is high than laser ink printing. Logically proceeding LEAN implementation commences from Machine-1. The Value Stream Mapping (VSM) for all the process involving Machine-1 with scope for further improvement is developed and illustrated in Figure 1[5].

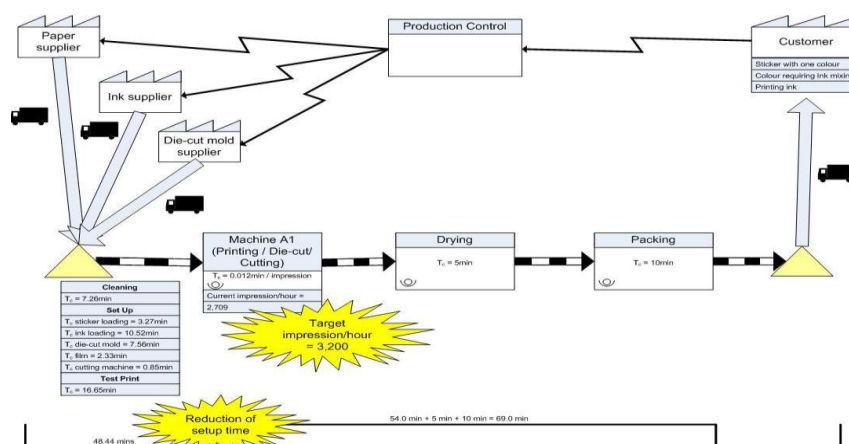


Figure 1. Value Stream mapping of present Machine-1

Figure 1, shows that time taken to print one assignment is 115 minutes (approx. 2 hours). Nearly 35 minutes (30% of the time) is used for setup. The printing processes such as trial printing, die-cut, cutting, drying and packing process have the negligible amount of shortcomings [6]. Organizing group discussion with all levels of management and finally, it was concluded that setup time has to be reduced hence further analysis being made. Time study is conducted to decide the time required for every setup and a Pareto chart in Figure 2 is created in view of the time utilized for every setup procedure.

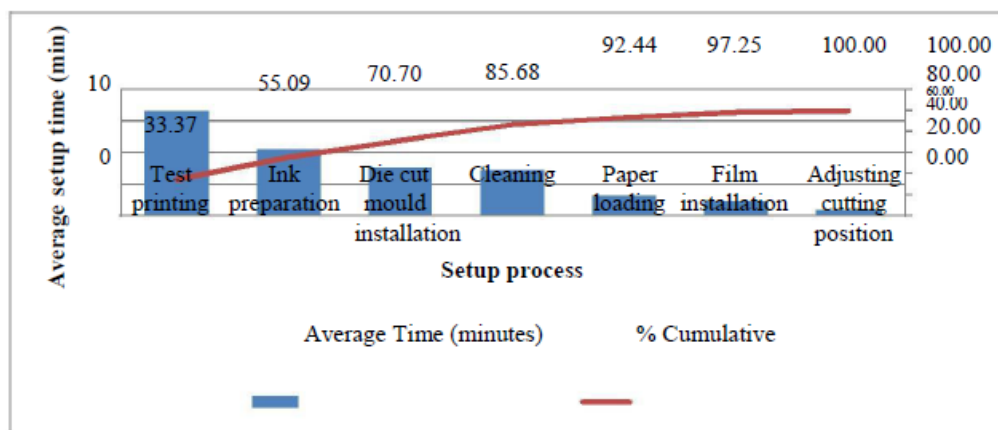


Figure 2. Pareto chart for Machine -1 reflecting setup time for all printing process

According to Pareto principles, 80% of the problem is due to 20% of the causes. Here the main problem is depicted in Figure 2; the chief reason for long setup time is because trial printing, ink blending and die-cut mould fixing. Using Time study and Pareto chart, the problem areas resulting in low outputs are determined. All setup process are further analyzed to find the root causes for long setup time in the next stage.

4.3 Stage III: Root Cause Identification

After observation in the printing section of every printing Machine with consultation from line supervisors, the time taken to test print varies directly with the setup. Where test printing time is repeated due to trial and error method of executing setup. If all setup operations are done accurately then test printing time will be low [7]. Thus, the concentration of underlying root-cause analysis will move to the setup of ink readiness and die cut mould installation. A fishbone chart is generated by

brainstorming and Group discussion with all levels of Management of sticker printing section for all set up to help discover the reason for this issue.

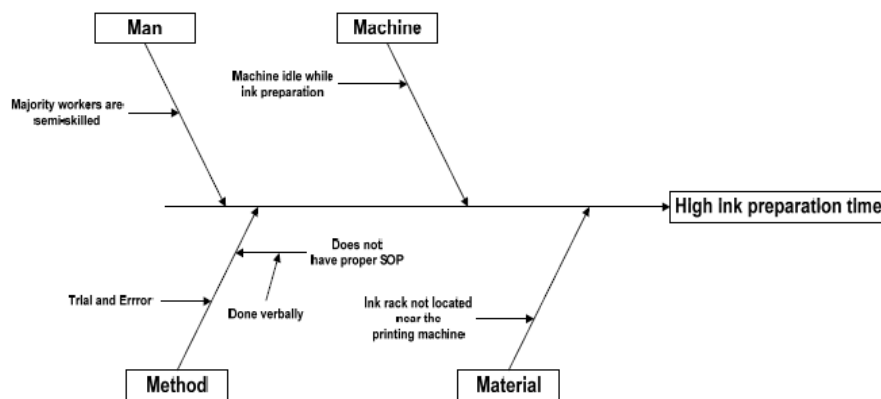


Figure 3. Fish bone chart for high in mixing time

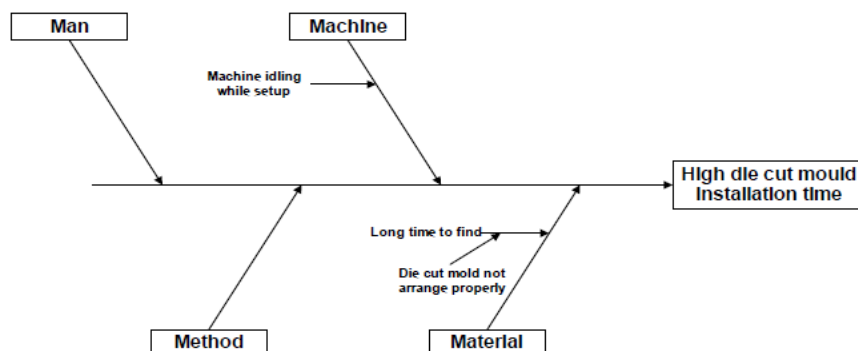


Figure 4. Fish Bone chart for long die cut mould fitting time.

Figure 3 and 4 are fish bone diagrams for both cases reflecting the chief causes resulting in long setup time is illustrated in TABLE 2.

Table 2. Main reasons for long setup time

Setup	Major Causes
In Preparation	<ul style="list-style-type: none"> ➤ Hit & Miss ink blending. ➤ Stop Machine then only setup can be done
Die Cut Mold Installation	Difficult to locate die cut in mould

The major causes for every setup are determined from interview-based analysis with all levels of management of the sticker printing section using fishbone chart. Die cut mould fitting has long setup time because of difficulty to find the materials required during both setups. Ink blending done when the machine was idle is high due to trial and error method utilized for mixing and it requires a qualified worker to obtain the desired colour at a fast rate [8]. Even if there is a colour pallet guiding the worker to mix base with the colour stainer to get the preferred colour, this process is not accurate. Factors such as kind of sticker to be printed and the quality and quantity of ink consumed yield different outcomes. The major causes recognized are subjected to further analysis to establish the root cause for long setup time per machine using 5Why analysis as demonstrated in TABLE 3 and 4.

Table 3. “FIVE-WHY” analysis for a difficulty in locating the ink materials

Main cause	Difficult to locate die-cut from mould
WHY 1	Improperly arranged Die-cut mould in a drawer.
WHY 2	Not suitable and difficult to arrange.
WHY 3	Non- sustainable arrangement.
WHY 4	This existing method is inconvenient to locate and place the die-cut mould.
WHY 5 / Root cause	No correct slot to maintain the die-cut in mould.

Table 4. “FIVE-WHY” analysis for under-utilization of Printing Machine.

<i>Main cause</i>	<i>Machine is under utilized</i>
<i>WHY 1</i>	<i>Short Availability of the Machine.</i>
<i>WHY 2</i>	<i>Machine idle during initial setup phase.</i>
<i>WHY 3</i>	<i>Stop Machine then only setup can be done</i>
<i>WHY 4</i>	<i>Machine is part of printing setup</i>
WHY 5 / Root cause	Setup is integral part of production

4.4 Stage IV: Implement Feasible Solutions

After the root causes being traced during stage 3 using Fishbone diagram and 5Why tool, a possible solution is generated by group discussion and brainstorming session involving all stakeholders in order to lessen the root causes effect. To cut down the time to trace the die cut mould and ink, an innovative storage bin is designed. Wherein it is trouble-free to pick and place the material. Which lessen the time to locate these items, as a result, setup time will shrink drastically this is accomplished by using pigeon hole storage design concept, wherein the die-cut mould is kept in the slot with customer code. So as to permit the die-cut mould to be arrayed into space effortlessly, a cardboard is appended to the die-cut mould to enable the form to remain without inclining onto each other. All die-cut mould will be colour shaded, as indicated by the customer code thereby diminishing the likelihood of losing the die-cut mould. Another feasible solution is by isolating the setup process away from live printing process called exterior setup hence; production can run continuously. Setup and printing are done simultaneously. The ink blending setup remotely located whereby a committed cell with one experienced labourer is loading the ink on Machine-1. Subsequently, the time required for ink mixing decreases radically since only one stage is required to set up the ink.

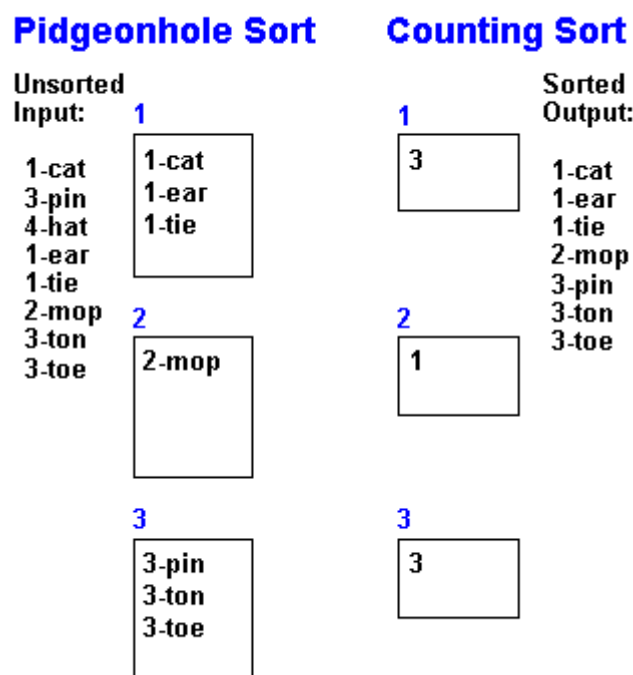


Figure 5. Fish Pigeon hole storage bin to easily locate Die cut Mould.

4.5 Stage V: Control

This stage is imperative in the LEAN Six Sigma execution as LEAN does plan to diminish squander as well as to have the capacity to manage the change effected. 5S along with Standard Operating Procedure (SOP) were effectively utilized to control the LEAN system. Since SOP gives the rule to manage the course of action of the die cut mould while 5S gives a well-ordered channel in actualizing setup procedure since a portion of setup procedure is moved remotely. 5S is an acronym of five steps viz. seiri, seiton, seiso, seiketsu and shitsuke which means sort, arrange, clean, standardize and sustain workstation [7]. This technique is basically vital to managing the way die cut mould are located as this manages the course of action of the array of die cut mould in the storage bin. SOP is a guided methodology for an administrator to complete a specific operation like ink blending setup is made outer; an SOP is intended to manage the difference in work exercises by an administrator, for example, the procedure stream for setup on a Machine - 1 and the procedure stream of remotely blending ink [10].

5. Difficulties In Lean Framework Implementing

Challenges faced during LEAN implementation in the SME label printing section is tremendous. The challenges may be due to the management policies of the SME sticker printing department and the LEAN framework itself. Since there is a less administration bolster towards the LEAN reception in the underlying stage as the management can't appreciate the advantage of such program. The primary objective of SME management is to print rather than investing its resources to improve the value of it.

The inflexibility of management for work and culture related issues in the sticker printing department. Because they feel that these are trivial issues related to production and would have the negative impact on production. So to overcome this implementation of solution issues, fragmented wise changes are made so that changes are not too fast to cope up with the development attained a logical way by the management. Secondly, the organization has poor skills and management practice of LEAN frameworks applied to printing. The SME sticker printing section does not have methodological experts in LEAN implementation, in any case, they need to endeavour to keep in mind the final goal to contend in the Industry [11]. Subsequently, the LEAN framework developed for the SME sticker printing segment must be a beacon in clarifying the capacity of each stage and instruments utilized. The LEAN system is an information technology(IT)-driven system; where issues and answers for the issues are started by information. Notwithstanding, the sticker printing segment does not have a proper documentation structure as their prime concentrate is only printing. Hence, all info regarding product mix, the machine capacities and Process capabilities of the printing section and the material flow has to be composed of the grassroots level. Since no documentation of their printing process which increases the data collection time. Also, lack of support from the top management during initial Stage of the LEAN framework requires long implementation period. This initiative of LEAN in the sticker printing section offers a plethora of documentation related to the label printing section which can be updated frequently to facilitate continuous improvement in the future.

Table 5. Main reasons for long setup time

Items	Before	After	change	% Improvement
Output (printings/hour)	2,800	3,400	600	21.14
Average setup time (minutes/job order)	51	35	16	45.71

6. Results and Discussions

The production output of an 8hrs shift label printing section with production capabilities of 5142 printings/hrs shows an increase by 600 Printings/hour, (or 4800 Printings/day or 28,800 Printings/week or 115,200 Printings/month or 1,382,400 Printings/year) with a improvement of 21.14% compared to before situation. Also the average setup time dropped from 51minutes to 35 minutes which is an improvement of 45.71% compared to earlier set up time. With the expansion of the profitability of Machine-1, printing segment can have an additional time limit about two months which would enable them to adapt to client requests and have greater adaptability when managing urgent requests from clients.

7. Conclusions

While LEAN framework is a system acts as a guide to trace a the root locus of the problem. It also provides a feasible solution and sustainable improvements in quality. A detailed stage wise overview of LEAN framework is demonstrated in this work. Because of this implementation Machine-1 has a surplus of 1,382,400 Printings/hour capacity which can be utilized by Printing press to meet additional orders. This surplus capacity is equivalent to two months of the present capacity of sticker printing press. A substantial improvement by Machine -1, yielding 3,400 Printings/hour from 2,800 Printings/hour with an increase of 21.14% which is a quiet a good improvement and average setup time reduced by 16 minutes with an improvement of 45.71%.

References

- [1] Achanga, P., Shehab, E., Roy, R. and Nelder, G., Critical success factors for LEAN implementation within SMEs, *Journal of Manufacturing Technology Management*, vol. 17, no. 4, pp. 460-471, 2006.
- [2] Assarlind, M., Gremyr, I. and Backman, K., Multi-faceted views on a LEAN Six Sigma application, *International Journal of Quality & Reliability Management*, vol. 29, no. 1, pp. 21-30, 2012.
- [3] Bendell, T., Structuring business process improvement methodologies, *Total Quality Management & Business Excellence*, vol. 16, no. 8-9, pp. 969-978, 2005.
- [4] Bendell, T., A review and comparison of six sigma and the LEAN organisations, *The TQM Magazine*, vol. 18, no. 3, pp. 255-262, 2006.
- [5] Buesa, R. J., Adapting LEAN to histology laboratories, *Annals of Diagnostic Pathology*, vol. 13, no. 5, pp. 322-333, 2009.
- [6] Hoerl, R. W. and Gardner, M. M., LEAN Six Sigma, creativity, and innovation, *International Journal of LEAN Six Sigma*, vol. 1, no. 1, pp. 30-38, 2010.
- [7] Kaushik, P., Khanduja, D., Mittal, K. and Jaglan, P., A case study: Application of Six Sigma methodology in a small and medium-sized manufacturing enterprise, *The TQM Journal*, vol. 24, no. 1, pp. 4-16, 2012.
- [8] Kumar, M., Antony, J., Singh, R. K., Tiwari, M. K. and Perry, D., Implementing the LEAN Sigma framework in an Indian SME: a case study, *Production Planning & Control*, vol. 17, no. 4, pp. 407-423, 2006.
- [9] Laureani, A. and Antony, J., LEAN six sigma in a call centre: a case study, *International Journal of Productivity and Performance Management*, vol. 59, no. 8, pp. 757 - 768, 2010.
- [10] Pepper, M. P. J. and Spedding, T. A., The evolution of LEAN Six Sigma, *International Journal of Quality & Reliability Management*, vol. 27, no. 2, pp. 138 - 155, 2010.
- [11] Ray, S. and John, B., LEAN Six-Sigma application in business process outsourced organization, *International Journal of LEAN Six Sigma*, vol. 2, no. 4, pp. 371-380, 2011.
- [12] Shah, R., Chandrasekaran, A. and Linderman, K., In pursuit of implementation patterns: the context of LEAN and Six Sigma, *International Journal of Production Research*, vol. 46, no. 23, pp. 6679-6699, 2008.
- [13] Snee, R. D., LEAN Six Sigma – getting better all the time, *International Journal of LEAN Six Sigma*, vol. 1, no. 1, pp.9-29, 2010.
- [14] Thomas, A., Barton, R. and Chuke-Okafor, C., Applying LEAN six sigma in a small engineering company – a model for change, *Journal of Manufacturing Technology Management*, vol. 20, no. 1, pp. 113-129, 2009.
- [15] Womack, J. P., Jones, D. T. and Roos, D., *The Machine That Changed The World: The Story of LEAN Production*, Free Press, 1990.