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Application of Lean and Quality Improvement Tools in Printing Machine Industries: An Indian Case Study

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Abstract: ***Lean Manufacturing as production methodology aims to improving the speed and efficiency of an organization by eliminating waste, which aims at drastic reduction in the number of defects occurring in manufacturing or service operations. Indian small and medium component manufacturing enterprises sector needs cost effective methods and techniques to handle critical to quality productivity problems. This paper presents the concept of integrating Lean manufacturing and 5S, which aims to increase the product throughput and to improve the quality of the product by reducing the process variability.***

Keywords: Lean manufacturing, 5S, Root cause analysis, Quality improvement, Printing machine.

1. Introduction

Lean manufacturing is a business strategy that enables organizations to increase their profits by optimizing their operations, improving quality and eliminating defects [1]. From the viewpoint of the customer of a product or service, 'value' can be defined as any action or process that the customer would be willing to pay for. The developer of the Toyota "just-in-time" Production System in the 1950s defined waste as any human activity, which absorbs resources but creates no value [2]. Lean is a production practice that eliminates waste.

At the beginning of the twentieth century the automobile industry started mass production as an alternative to craft production. The mass production had many advantages like high volume, low cost, less skilled operators, etc. But, it also had some disadvantages like very high cost of machinery, less variety, excess supplies, need of more workers, need of extra space to ensure smooth production, etc. Lean production came as an alternative to mass production combing the advantages of both craft and mass production [3]. Lean production should be viewed as a strategy for achieving value leadership [4] as it goes well beyond cost cutting. First, lean production dramatically raises the threshold of acceptable quality to a level that mass production, cannot easily match. Second, lean production offers over-expanding product variety and rapid responses to changing consumer tastes, something low-wage mass production finds hard to counter except through lower prices [5]. Lean production dramatically lowers the amount of high-wage work needed to produce a product and keeps on reducing it through continuous incremental improvement.

Lean production can fully utilize automation in many ways which mass production cannot [6].Lean and 5S is the combination of Lean production and 5S approach. It draws the philosophies, principles and tools of both in its approach. Lean focuses on elimination of waste and non-value added activities by process optimization while 5S focuses on reduction of process variation and hence drastic reduction of defects and meeting the requirements of all the stakeholders. Currently, Lean and 5S is an internationally established methodology for improving the organizational effectiveness [7].

2. Literature Review

Small-scale industries are facing critical problems while selling their product [8]. SSE (Small Scale Enterprise) is not having huge financial backup and therefore they are depending upon the revenue eared after selling their product. The product sales can only be increased by reducing the cost of the product [9]. The importance of small and medium scale industries in Indian context are plays an important role in Indian economy. Their contribution to the economic development of the nation is indeed significant. But the productivity level of these industries is quite low as compared to other country [10]. The performance and benefits of small scale manufacturing industry in India is that small scale industries form an important sector constituting 40% of the total output to the privet sector and much more significant is the employment generation capacity of small scale sector. The problem to sustain in global market, Lean manufacturing is hymn of survival and success of any organization [11]. The goal of lean manufacturing is to Minimize all types of waste so cost of the product can be reduced. The development of key areas which could be used to assess the adoption and implementation of lean manufacturing practice also presented some of the key areas developed to evaluate and reduce the most optimal project so as to enhance their production efficiency [12]. Implementation of lean on small manufacturer of all 4-wheel drive vehicles, through implementation of basic lean tool, the small manufacture rapidly increase output and reduce quality defects by 80%[13]. The methodology for determining the real problem associated with industries in implementation of lean also presented selection of required lean tools in the light of company's long-term vision [14]. The steps undertaken for implementation of 5S emphasizing on the benefit of an organization to initiate and benefits of 5S [15]. A continuous improvement strategy aiming to improve manufacturing at Auto car Exhaust to implementation of 5S, the immediate and significant effect on the sequence of activities in the work post, thus influences the performance of process in the analyzed company [16]. They worked on implementation of 5S on plastic molding industry [17]. 5S is used in small industry and also showed the advantages and benefits of 5S implementation and the methodology for calculation of each S in 5S system [18].

3. Case study

The company is manufacturing printing machines. It uses several blades for cutting, which are subsequently used in printing machine. In this paper the study is focused on implementing lean and 5S for reducing the rejection rate of blades.

3.1 Specifications of blade

The printing cutting blade is consisting of alloy steel material with the life span of 50-60-lakh cut at the rotational speed of 200 rpm.

3.2 Dimensions of the cutting blade, which are used for printing machine

- Bottom stationery blade 75*22 mm.
- Upper rotary blade 75*840 mm.

The printing machine-cutting blade are gone through the following tests:

3.3 Material Testing

Material testing is the process of pulling, bending, twisting, turning, hitting, and squeezing materials or components to make sure they withstand the intense stresses, strains and impact forces they are likely to experience in use and application. In other words, materials' testing examines the overall strength, toughness, flexibility, suitability and fitness for purpose.

3.4 Hardness testing

The principal purpose of the hardness test is to determine the suitability of a material, or the particular treatment to which the material has been subjected. The hardness test is typically performed by measuring the Depth of indenter penetration or by measuring the size of an impression left by an indenter the hardness of a material can be defined as "the resistance the material exhibits to permanent deformation by penetration of another harder.

3.5 Crack Testing

Cracks in cast iron or steel components, which can be magnetized using a permanent or electro magnet and then small iron oxide particles in dry form or in a solution in water. Based on above three tests, the blades are either accepted or rejected. Our study was included by taking 10 samples of sample size 50 are tabulated in table 3.6.

Table.3.6: Shows number of sample with respective defective units.

Sample (g)	No. Of defective units (x)
1	12
2	10
3	17
4	9
5	10
6	11
7	12
8	8
9	7
10	9
Total	105

Equations: Centre line for the np-chart is

$CL_{np} = \frac{\Sigma xi}{g}$=105/10=10.5

The control limits are found out by using equation

$$UCL_{np} = np + 3\sqrt{np(1-p)} = 10.5 + 3\sqrt{10.5(1-\frac{10.5}{50})} = 19.14$$

UCL= Upper control limit. The value of any sample if more then this value then it will be rejected.

$$LCL_{np} = np - 3\sqrt{np(1-p)} = 10.5 - 3\sqrt{10.5(1-\frac{10.5}{50})} = 1.86$$

LCL= Lower control limit. If lower control limit for p turns to be negative, the lower control limit is simply counted as zero because the smallest possible value of the proportion nonconforming is zero.

Based on the above mean value and control limits, we had drawn an np-chart shown the relationship between samples and their respective number of defective units and shown in Figure (fig) 3.7.

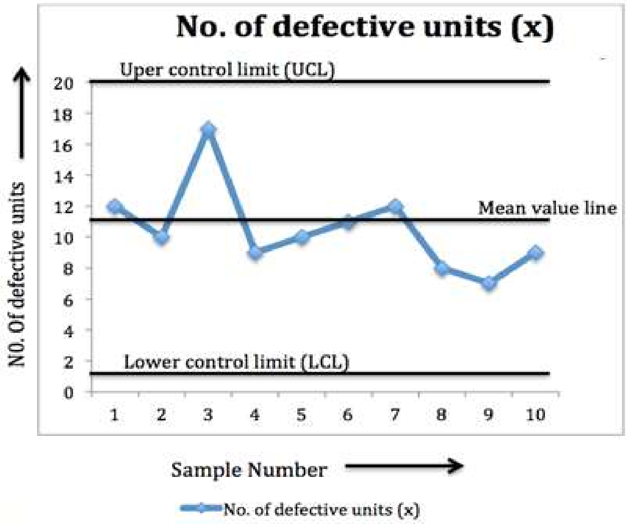

Figure 3.7: shows the variation in mean value for the defctive units

4. Analysis

From thenp-chart it is clear that there is a pattern of defective units in the samples under consideration. Some points are very close to the upper specification limit. There is much variation in number of defective units about the mean value. During the study it has been observed that the units are found to be defective due to the following defects.

4.1 Material composition problem

Due to the variation in the composition of the raw material blades properties get changed which can lead them to rejection.

4.2 Over hardness

The blades material supposed to be of optimum hardness as it is being used for cutting purpose but if the blade is of more then required amount of hardness it will become useless.

4.3 Hairline crack

During the crack testing of the blade if blade is found to have hairline crack then there is a possibility of breakage during the operation which tends to failure of blades. It also reduces its tool life.

To analysis these problems we plot a root cause analysis diagram shown in Fig 4.4

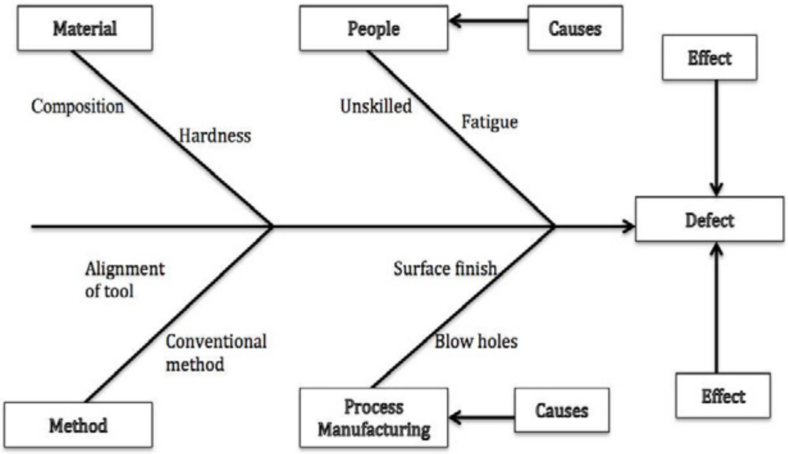

Figure 4.4: shows the cause, which tends to the rejection of the samples

5. Improvements

5.1 Material

Composition of the material is made so that it will result in the optimum hardness, So Suitable actions were taken at vendor level to optimize the composition and hardness of the material

5.2 People

- Proper training was provided to the operators.
- Suitable environment and adjacent shifts were provided to reduce their fatigue
- Special incentives were provided for moral booster.
- Ideal time of workers was reduced by time and motion study.

5.3 Methods

- Automated tool settings were used to increase the accuracy level.
- New manufacturing methods were adopted so that defects can be reduced.

5.4 Process manufacturing

- The 5S technique was used to eliminate the waste. As many unessential items, which were not desired at workplace, were present at the work place was removed. Also workplace was cleaned at the end of the shift and everything is restored to its proper place so that person who comes for the next shift does not feel irritated, as it will reduce efficiency of the person.
- Blow wholes were eliminated by proper venting and using proper molding sand.
- More accurate machines were used to increase the surface finish.
- Better tools were used in the manufacturing operations.
- After doing the above improvements, we again studied the number of defect in the blades and are Shown in table 5.5.

Table 5.5: Shows the defective units after improvments.

Sample (g)	No. Of defective units (x)
1	6
2	5
3	10
4	6
5	8
6	9
7	7
8	4
9	3
10	7
Total	65

Centre line for the np-chart is

$$CL_{np}=\frac{\Sigma xi}{g}=65/10=6.5$$

The control limits are found out by using equation

$$UCL_{np} = np + 3\sqrt{np(1-p)} = 6.5 + 3\sqrt{6.5(1-\frac{6.5}{50})} = 13.63$$

$$LCL_{np} = np - 3\sqrt{np(1-p)} = 6.5 - 3\sqrt{6.5(1-\frac{6.5}{50})} = -0.63$$

Take LCL as zero because defective units cannot be negative.

The graph is again plotted to find out the variation is shown in Fig 5.6.

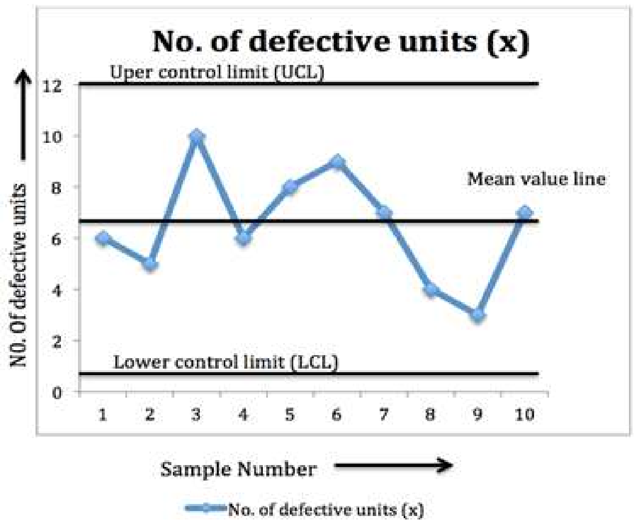

Figure 5.6: shows te control limts after improvments

6. Results

This research work has been intended to root cause analysis, which is becoming an essential tool for realizing lean manufacturing in actual production settings.The results come out by comparing number of rejected parts before and after the quality improvement phase.

7. Conclusion

Our study was focused on decreasing rejection rate of blade used in printing machine by doing process capability study and root cause analysis. We are able to decrease the rejection rate 38%. This study can be applied in whole the industry that can improve the process capability of entire industry. Further one can use DMAIC (define, measure, analysis, improvement, control) theory to enhance the capability of industry. Another application can be with use of other quality improvement tools like TQM (total quality management), QFD (Quality function deployment), FMEAC (Failure Mode Effect Analysis and Control) can be done.

Because of many limitations, it was not possible to see the total effect of the improvement strategies presented in this study. Future works on lead time reduction consists of using lean tools like Kanban, Single Minute Exchange of Dies (SMED), Total Preventive Maintenance (TPM), Poka-yoke technique, JIT, Heijunka, Jidoka, and Standardized Work etc. for better improvement. Even though, the complete success of the application of lean thinking in the extensive run depends on close understanding between the management and shop floor personnel. Effective management information systems are required for instilling proper organizational values and continuous improvement programs. Future studies can be made on supply chain management, to achieve good control, reliability and consistent performance. Further Analytical Hierarchy Process (AHP) fuzzy can be used to select the best 5s tool that will give the highest rate of improvement for a particular case study.

References

[1] Andrew Thomas, Richard Barton, Chiamaka Chuke-Okafor. (2009), "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

[2] Annalisa L. Weigel. (2000), "A Book Review: Lean Thinking by Womack and Jones". A Aruleswaran. (2011), "Lean Six Sigma – A Practitioner's Tool Book", Productivity & Quality Publishing Pvt. Ltd.,

[3] Madras, India. Aza Badurdeen. (2007), "Lean Manufacturing Basics", Craig Gygi, Neil DeCarlo, Bruce Williams. (2005), "Six Sigma For Dummies", Wiley Publishing, Inc. Eckes, (2001), Making Six Sigma Last: Managing the Balance Between Cultural and Technical Change. Wiley, New York.

[4] Forrest .W. Breyfogle III. (2003), "Implementing Six Sigma – Smarter Solutions Using Statistical Methods", Austin,

[5] TX: John Wiley & Sons, Inc., 2 edition. George Byrne, (2007), "Using Lean Six Sigma approach to drive innovation", Strategy & Leadership, Emarald

[6] Group of Publishing Limited, ISSN 1087-8572, Vol. 35 No. 2, pp. 5-10 Harry, Crawford, D, (2005), "Six sigma - The next generation", Machine Design Cleveland, Estados Unidos, 77, (4), pp. 126 -130

[7] James P. Womack, Daniel T. Jones, and Daniel Roos. (1990), The Machine That Changed the World: The Story of Lean Production. Harper Perennial, New York.

[8] Chauhan, "Measuring the status of Lean manufacturing using AHP" International journal of Emerging technology vol.1 no.2, pp.115-120. 2010.

[9] Miller et al., "A case study of Lean, sustainable Manufacturing" journal of Industrial Engineering and Management, vol.3 no.1, pp.11-32. 2010.

[10] Girish Sethi and Prosanto Pal, "Energy Efficiency in Small Scale Industries – An Indian Perspective"Tata Energy research Institute.

[11] Chakraborty et al. "Internal obstacles to quality for small scale enterprises"', International Journal of Exclusive management research, vol. 1, no. 1, pp. 1-9, 2011.

[12] Upadhye "Lean manufacturing system for medium size manufacturing enterprise: An Indian case"International journal of management science and engineering management. Vol.5, no. 5 pp. 362-375, 2010.

[13] Hudli and Imandar, "Areas of Lean manufacturing for productivity improvement in a manufacturing unity", world academy of science, engineering and technology vol. 69, 2010

[14] Lukas et al. "Lean implementation in a low volume manufacturing environment: A case study" Proceedings Industrial Engineering Research Conference (2010)

[15] Kumar and Kumar. "Steps for Implementation of 5S", International Journal of management. IT and Engineering. Vol. 2, no.6, pp. 402-416, 2012.
[16] Gheorghe Dulhai. "The 5S strategy for continuous improvement of the manufacturing process in auto car exhausts", Management and marketing vol. 3, no. 4, pp. 115-120, 2008.
[17] Khedkar at el. "Study of implementing 5S techniques in Plastic Moulding" International Journal of modern engineering research. vol. 2, no 5, pp. 3653-3656, 2012.
[18] Prashant Koli." General Implementation and Calculation of 5S Activity in any Organization" International journal of Science and Research vol.1 no.3pp.229-232, 2012

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