International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 5 Issue 1, January-2016

Productivity Enhancement Using DMAIC Approach: A Case Study

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ABSTRACT

In modern era, the Six Sigma approach have been executed in various industrial sectors, which strive to ameliorate continuous improvement, productivity enhancement and high quality of end products. This paper present a case study conducted at a small gas stove manufacturing unit situated in Baddi, Himachal Pradesh. The present work narrowly focuses on analyzing and elimination of in process variations causing rejection and rework at different stages of production by using Define-Measure-Analyze-Improve-Control (DMAIC) approach. By implementing DMAIC approach as a problem solving technique the rejection rate was reduced from 8.79 % to 5.30 % and rework rate from 12.8 % to 8.2 %. Also, a significant enhancement in sigma level was obtained from 2.85 to 3.13.

Keywords: Productivity, DMAIC, Sigma level.

I. INTRODUCTION

Small scale industries constitute about 7% of the GDP growth in India. As per survey conducted by all India censuses of small scale industries in (2004) the number of Small and medium enterprises (SME's) has increased from 80,000 units in the 1940's to about 10.52 million units. The competitive dynamic environment has exposed small scale industries to reexamine their business method. In order to remain competitive in global market, industries must not only design and offer better product and services but need to improve their manufacturing processes and operations also. DMAIC approach is one that meets high service requirement and used for eliminating process variation to ensure high quality product and customer satisfaction. It is a measure of variation about the average in manufacturing industry. Using DMAIC approach the waste, variances and errors occurs in any process and be minimized (Kumar et al., 2011). In order to identify areas for improvement, DMAIC technique can be integrated with statistical quality control (Pfeifer et al., 2004).

DMAIC approach consist of five phase starting with defining the problem. After defining phase, Measure phase reveals the assessment of different parameters through brain storming process. In analyze phase, the root causes behind the variations/errors were identified at different stages. Then, proper implementation program has been prepared for whole process and a complete control over the process has been obtained. DMAIC approach is homogenous in function such as plan-do-check-act method and seven step method of Juran and Gryna for any problem solving technique. With the concept of organizational routines, it is a meta-routine process: a process for changing existing routines. This approach is applied in practice as a generic problem solving and improvement approach (Mast and Lokkerbol, 2012). This should be used when any process is in existence at a company but is not as per customer specifications or is not performing adequately. The present work demonstrate the case study conducted at small scale industry manufacturing gas stoves, facing the problems of in process variations at different stage of assembly process. DMAIC approach has been implemented and significant reduction in rejection and rework has been achieved.

II. LITERATURE REVIEW

A numerous research had been done in implementing DMAIC technique in different process and manufacturing industry. Wang and He (2004) demonstrate a review regarding developments made in the areas of forging of connecting rods to meet the demand of geometrical accuracy and internal quality. Different technology have been discussed and explained and some new equipment has been introduced to improve the production capabilities of manufacturers of connecting rods. Kaushik et al, (2008) made an effort to justify the role of quality management techniques like DMAIC for SMEs which are normally executed in the domain of large and medium scale industries. Six Sigma techniques have been applied to a small scale

manufacturing bicycles chains unit and significant enhancement in sigma level has been achieved from 1.40 to 5.46. The results obtained in context of sigma level are equivalent to monetary saving of Rs 0.288 Million per annum. Kumar et al. (2011) presented some facts and benefits of using DMAIC Approach in improving the efficiency and performance level of the casting process unit with lowest possible cost. Optimum process parameters have been evaluated resulted in minimum casting defects. Gebremeskel and Uppsala (2012) evaluated the rejection rate of grinding steel ball for a cement industry. Due to absence of temperature controls and atmosphere controls in the furnace, some deviations were observed during the heat treatment process.

The results revealed that the carbon content and chromium were the main reasons behind rejection of the product. Kumar and Sambhe (2012) presented a case study conducted at medium sized auto ancillary unit having 375-400 employees which had recently implemented six sigma methodologies. Various defects have been observed which are critical to customers. Mathew et al. (2013) implemented statistical quality control technique for assessing the internal defects occurring in an integral axle arm. The various defects have been identified in the arm like un-filling, crack, lap, scale pit, mismatch and oversize. Pareto analysis was used to analyze the intensity of defects and it shows that 83.33% of the total rejection were due to un-filling and lap. Thottungal and Sijo (2013), identified the intensity of defects in a forging unit by using fish bone diagram and Pareto analysis techniques. Different remedial actions like the proper use of anti-scale coating, venting process to prevent the under filling, the simulation software for determining the material flow and proper lubricant (Espon-lss) instead of furnace oil have been proposed to reduce the rejection rate. Joshi and Kadam (2014) evaluate various defects and their causes for manual metal casting operation in automotive industry using Pareto analysis and cause & effect diagrams.

III. RESEARCH METHODOLOGY

The present study was based on the assessment of various in process variation occurring at different stage of small gas stove manufacturing unit situated in Baddi, Himachal Pradesh. The unit consists of 250-275 employees having capacity of manufacturing 550- 590 gas stove per week. Proper invigilation has been performed at each stages of process and several variations with their causes have been identified by using brainstorming session, cause and effect diagram. The flow chart of research methodology is shown in figure 1.

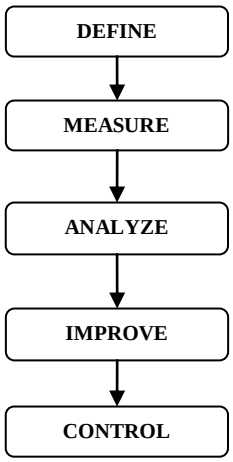

Figure 1: Flow Chart of Methodology

STEP 1: DEFINE PHASE

The main objective in this phase is simply writing down what we currently know about the problem, to set objectives and to define the problem statement. Problem Statement. Selected unit was facing the problem of rejection and rework of gas stove units due to in process variation occurring at different stages resulted in production loss.

STEP 2: MEASURE PHASE

The main objective in this phase is to collect data pertinent to the scope of the problem. Reliable baseline data for different weeks have been collected through observation. Observed data for five weeks is shown in table 1. From collected data, 8.79 % rejection rate and 12.8 % rework rate has been observed in the unit. From the measured data, performance level for the

current process has been computed as 2.85. It is evident from the value of sigma level that the current process was not satisfactory which need to be enhanced.

Table 1: Number of Rejection and Rework units per Week

Week No.	Total Production	Rejection	%	Rework	%
1	567	51	8.99	73	12.87
2	558	48	8.60	78	13.98
3	583	56	9.60	67	11.49
4	563	52	9.24	79	14.03
5	573	43	7.50	69	12.04
	Total: 2844		**Average: 8.79 %**		**Average: 12.8 %**

STEP 3: ANALYZE PHASE

The root causes that impacts production at different stages have been identified and analyzed through brainstorming session, so that process improvement can be done in respective areas. The cause and effect diagram shown in figure 2 was analyzed to identify different factors that contribute to rejection and rework. Pareto analysis for rejection and rework has been performed and shown in figure 3 and figure 4 respectively.

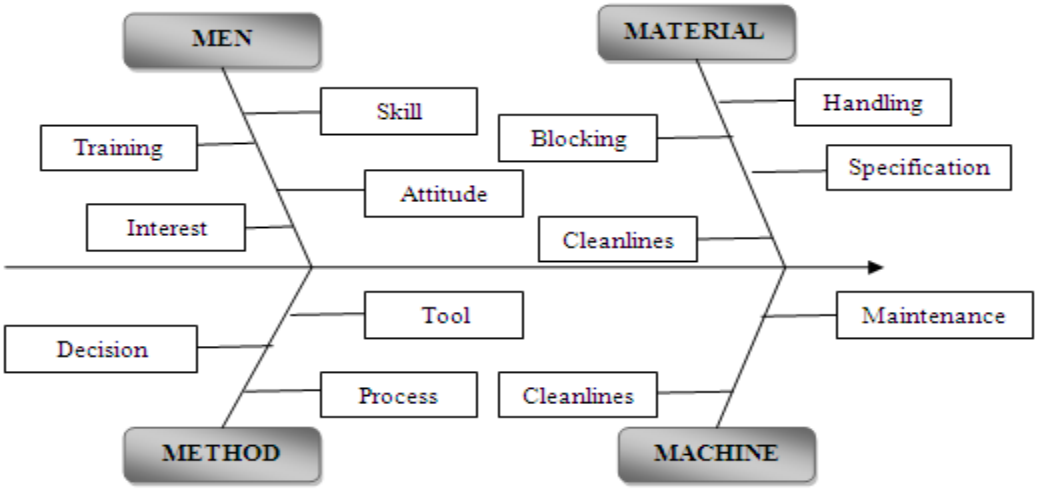

Figure 2: Cause and Effect Diagram

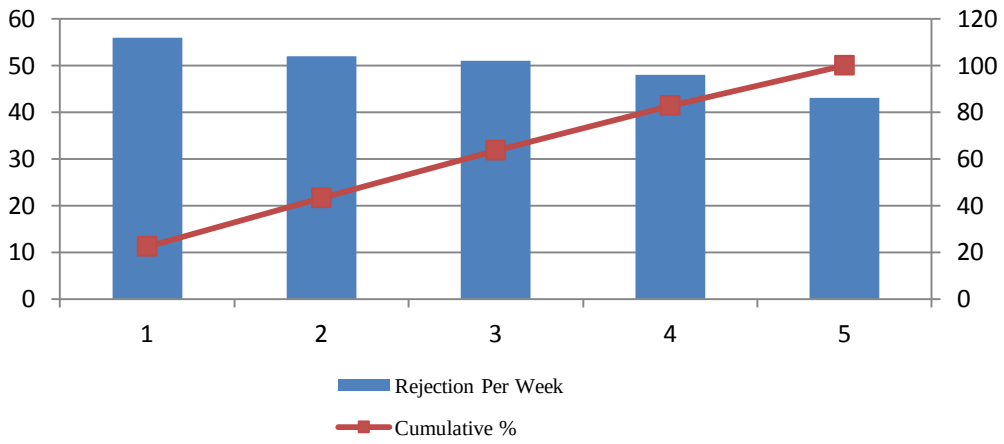

Figure 3: Pareto Chart for Rejection

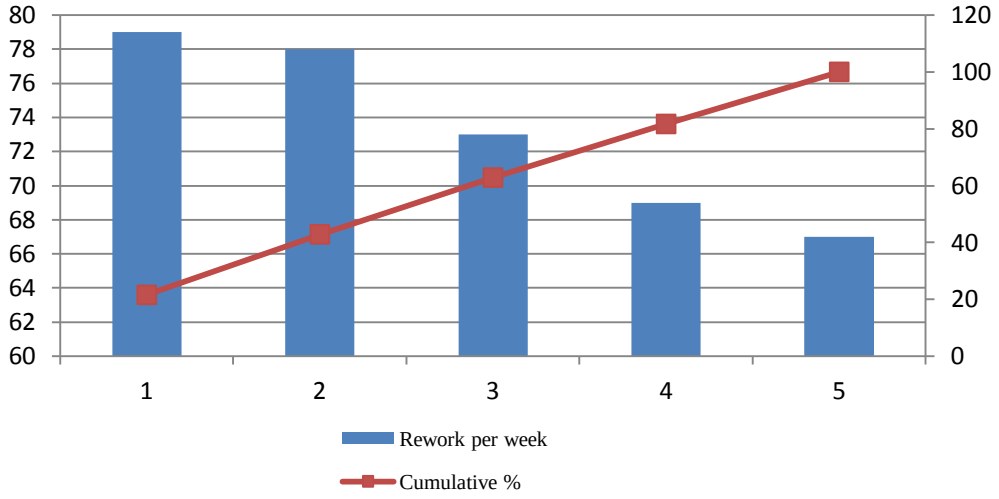

Figure 4: Pareto Chart for Rework

STEP 4: IMPROVE PHASE

Improve phase concentrate on improving and optimizing the different areas of improvement for productivity enhancement. The main objective at the end of this phase is to complete a test run of a change that is to be widely implemented. Various action plans have been executed for different variations. Table 2 shows the various action plans for different operations. After implementing these action plans, again data has been observed for next 5 weeks. After implementation, significant enhancement in sigma level from 2.85 to 3.13 has been observed which indicate that the process was satisfactory. Observed data for next five weeks is shown in table 3.

STEP 5: CONTROL PHASE

The objective of the last phase of the methodology is to develop metrics that will help workers and employees of industry to monitor and document continued success. DMAIC approach is adaptive and ongoing. New adjustments and changes can be made and implemented as a result of the completion of this first cycle of the process. So finally a control plan with standard procedure has been prepared to monitor the control over each process.

Table2: Improvement Plan

TYPE	IMPROVEMENT PLAN SUGESSTED
MEN	Must have skill/training-Knowledge. Must have good attitude/pay full attention. Follow work procedure properly.
MATERIAL	Every incoming material must be properly handled. Standardization and specification
METHOD	Proper process and Tooling Light should be proper.
MECHINE	A preventive maintenance ensure machine always in good condition.

Table 3: Number of Rejection and Rework units per Week after Improvement

Week No.	Total Production	Rejection	%	Rework	%
1	579	34	5.87	52	8.98
2	577	36	6.24	48	8.32
3	585	30	5.13	50	8.54
4	581	28	4.82	46	7.91

5	583	26	4.46	42	7.20
	Total: 2905		**Average: 5.30 %**		**Average: 8.2 %**

CONCLUSIONS

The present work focus on deploying DMAIC approach in order to enhance the productivity of a small scale industry by reducing rejection and rework at each stage of production process. The finding demonstrate significant enhancement in process sigma level from 2.85 to 3.13. The rejection rate was reduced from 8.79 percent to 5.30 percent and rework percentage reduces from 12.8 percent to 8.2 percent. Also, 2.15 percentage increases in productivity has been achieved. The present study can be further exposed to deploying another quality control tool in the industry and can be implemented in other small scale industries for productivity enhancement and quality improvement.

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