A Quality Inprovement in Rubber Moulding Process to Achieve Zero Defect using Six Sixma

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***Abstract*: Quality products bring satisfaction to customers and success to the originating company. To a customer, quality means defect-free products and satisfactory services. To a manufacturer, the enforcement of tight control of product development process is as important as innovative designs. In the past decade Six Sigma has been broadly applied to manufacturing processes worldwide as a process design initiative to increase design margins and reduce process wastes. Pioneered by large corporations such as Motorola and General Electric, encouraging results were repeatedly reported in the literature. Survival and existence of companies are contingent on meeting and exceeding customer requirements. Such needs can be satisfied through emphasis on continual improvement of quality, with factors such as price and delivery time being kept limited to competitive levels, and exciting the customer at the same time. In Six sigma, the focus is on the reduction of defects in a product or process. In this paper it is proposed to analyze a case study in rubber moulding process. The application of Six sigma using DMAIC (Define, Measure, Analyze, Improve and Control) for the defect reduction is analyzed.**

Key words: Zero defect, Six Sigma, Rejection percentage, Critical To Quality.

1.INTRODUCTION

Industrial prosperity and survival of any industrial organization in the present-day competitive market depends upon many things, one solution is to prevent quality problems faced by the industry. The best strategy is to prevent quality problems from occurring. Prevention, as is well known, is a major result of quality improvement process. Lower costs, improved quality and enhanced competitive position are achieved through prevention rather than control and inspection. At the heart of quality improvement, processes are technology oriented towards prevention and Six sigma approach is one of them. The role of Six sigma is to build quality into products through processes improvement so that the need for expensive control and inspection is reduced. The word "Quality" has variety of meanings: fitness for the purpose, degree of excellence, degree of preference, grade, and degree of conformance to the design and specifications, measure of fulfillment of the promise made to customers. Under Six Sigma, 'Quality' is defined, as "Quality is a state in which value entitlement is realized for the customer and provider in every aspect of the business relationship".

2. SIX SIGMA

Sigma is a measure of variations. The performance of processes has been measured in terms of sigma such as 3 Sigma, 4 Sigma, and 6 Sigma etc. A process performance level of Six sigma means defects level in that process is equal or less than 3.4 parts per million. Currently the concept of Six sigma is proposed as a management tool for achieving process improvement, reduced costs, reduced wastage, increased customer satisfaction and above all increased profitability. Customer satisfaction by reducing defects and increasing bottom line is the hallmark of this concept. Though it is very deeply rooted in statistics, it addresses itself to business requirements of management. It is not restricted to only manufactured products and processes. It is equally applicable to service industries.

3.0 DMAIC METHODOLOGY

3.1 Define Phase

The "Define" phase is very important in Six sigma introduction. The "Define" stage should spell out why the company is adopting Six Sigma. Introduction of Six sigma should have clear link with the strategic goals and plans of the company. The four deliverables of the define phase are: (1) The project charter, (2) The Voice of customer (VOC), (3) The preliminary process map and (4) a fully formed and trained project team that is committed to accomplishing the project goals.

- **Measure phase**

Objectives of the measure phase include identifying process performance measures and settling their targets according to the VOC data. The current process is then evaluated against the targets. The gap between the current and target performance provides the Six sigma team with priorities and direction for further analysis. Identification of the process inputs and how they affect the process outputs are initiated during this phase. This involves identifying appropriate measurement data, followed by collecting the data and using it to measure base line performance

- **Analyze phase**

In this phase an action plan is created to close the gap between how things currently work and how the organization would like them to work in order to meet the goals for a particular product or service. Having collected data objectively, the next most crucial step is to analyze the data objectively. A good diagnosis is half cure. It is in this phase Six Sigma heavily relies on statistics. It is in this phase that

six sigma scores over other management improvement systems. Even though other quality systems too give lot of emphasis for statistical system, it generally never gets forcefully implemented. In case of Six Sigma its Black Belts, Green Belts and senior managers are well trained in statistical analysis.

Improve phase

The improve phase focuses on improving the processes that transform the inputs and outputs. The primary result of the improve phase is a redesigned process incorporating all the lessons learned through the project. There should be clear evidence that solutions generated and integrated into redesigned processes are capable of closing the gaps between the current process and the customer Critical to Quality (CTQ) requirements. The new process should also demonstrate direct cost savings or increased revenue to the company, given that Six sigma is a business strategy to increase bottom line profits.

Control phase

The control phase requires the process conditions to be properly documented and monitored through SPC methods. After a "settling in" period, the process capability should be reassessed. Depending upon the results of such a follow- up analysis, it may be sometimes necessary to revise one or more of proceeding phases. These parameters should be used for drawing up a new "control chart". The upper control limits and lower control limits calculated based on such data should form the basis of control. The objective of the control phase is to determine whether the expected improvements actually occur. Control chart have two basic purposes. The first is to analyze the past data and current performance of a process. The second is to measure control of the process against standards.

4.0 CASE STUDY

In this paper it is proposed to analyze a case study at a rubber moulding process for achieving Six sigma in a process. It is proposed to implement Six sigma in the Bellow and Dust Cover manufacturing cell. DMAIC is one of the Six sigma methodology used to control the defect reduction. To reduce the defect in the Bellow and Dust Cover Cell define, measure, analyze, improve and control (DMAIC) six sigma methodology is applied.

4.1 Define Phase

The specific tasks that are completed during define phase of work are customer focus, team charting.

3.2.1 Identify project CTQs

The customer for this project is Bellow and Dust cover cell in the rubber moulding process. The rubber product taken is Dust cover produced in the Bellow and Dust cover cell.

3.2.2 Develop Team Charter

A charter clarifies what is expected of the team, keeps the team focused, and keeps the team aligned with organizational priorities. The five major elements of a charter are:

a) Business case

The project is worth doing to improve customer satisfaction, decrease defects, increase market share. The rejection value in this product is on an average of Rs.15, 000/monthly and operating at a 2.6-sigma level. Increase in sigma level of this product will lead to increase in productivity, customer satisfaction, and business improvement.

b) Problem Statement

The customer complaints has increased in the past two months and if not focused may lead to high internal rejections. The problem occurs in the Bellow and Dust cover cell. The rejection percentage of product taken is 15%. The impact of the problem is internal rejections are high, long consumption of platen hrs/man hrs and customer dissatisfaction both internal and externally**.**

c) Goal statement

The goal statement of this project is to reduce the rejection of Dust cover from 15% to 1%.

d) Project Scope

The scope is one of the more important elements in the charter because it sets the boundary of what is included and what is excluded. The scope of this project includes the entire process that is involved from milling to inspection.

3.3 Measure Phase

In the measure phase, select one or more product or process characteristics to address and map the respective process to show what it actually looks like and validate measurement system. The three specific tasks that are completed during this phase of work are selecting the CTQ to improve, determining performance standards, ensuring adequate measurement system.

3.3.1 Select CTQ Characteristics

The Big Y is the CTQ of this project. The Big Y refers to the defect prevention in the Dust cover. Any product non-conforming to visual / dimensional standards is termed as defects.

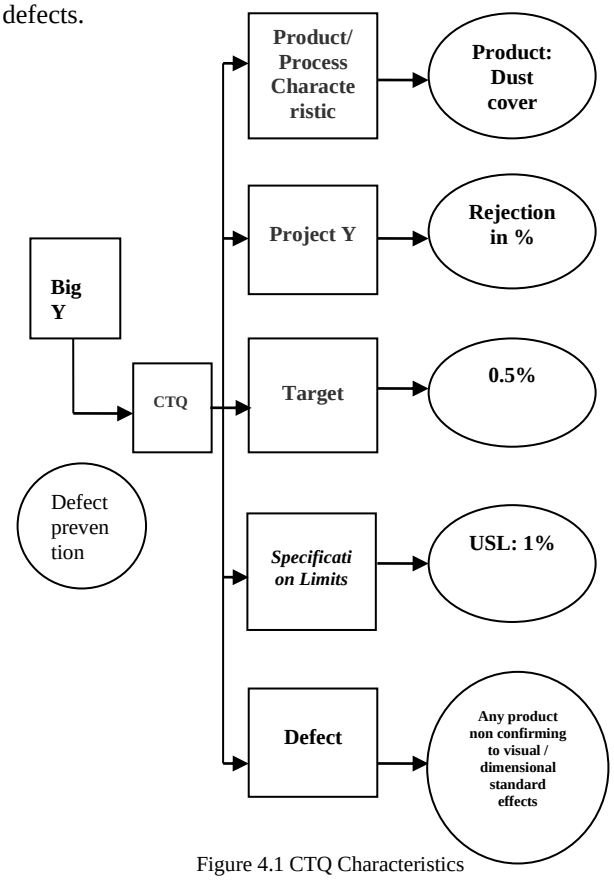

Figure 4.1 CTQ Characteristics

Results and plan for attribute R&R

The results and the improvement plan for the attribute R&R is shown in Table 1.

Table: 1

	Thumb Rule	Achieved	Comment
1	% Repeatability [>= 90%]	92.5 %	Ok
2	% Reproducibility [>= 90 %]	60 %	Need to improve
3	% Accuracy [>= 90 %]	90.5 %	Ok

Plan for improvement: Will work on reproducibility problem by conducting a team meeting with the two operators and discussing the difference in their measurements. Suspect that additional training is needed for less experienced operators because the data showed less experienced operators answering differently. Will also investigate if there is any unique with each of the sample where reproducibility is an issue.

4.1 Analyze Phase

The three specific tasks that are completed during this phase of work are baseline process capability, statistical goal of the project is established, and variation sources are identified through analysis of historical data.

Define performance standards

Customer VOC: Variation should come down and a shift in central tendency.

Current DPMO is 150,000.

Project goal	Base line	Target
DPMO	150,000	10,000

Project goal: Reduce variation (span) and shift central tendency (medium).

i. Identify variation sources

Variation sources are identified through analysis of historical data. With the help of historical and Pareto chart factors that influence the rejection most can be identified. The critical process output measures or Y's have already been identified through VOC and other data. Pareto chart help in identify the critical Y's that have the most impact on the process.

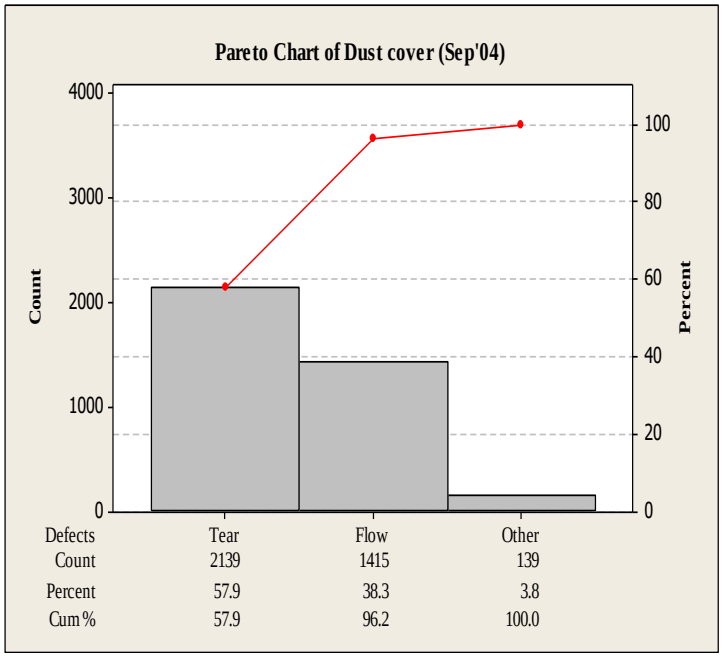

Fig: 4.1

From the Fig: 4.2, it is understood that 96 % of rejection is due to flow and tear type defects. In searching for the critical X's that cause the critical Y's, one very useful tool is the cause and effect diagram – the X's are the causes and the Y's are the effects. The cause and effect diagram for flow and tear type of defect are shown in Fig: 4.3 and Fig: 4.4 respectively.

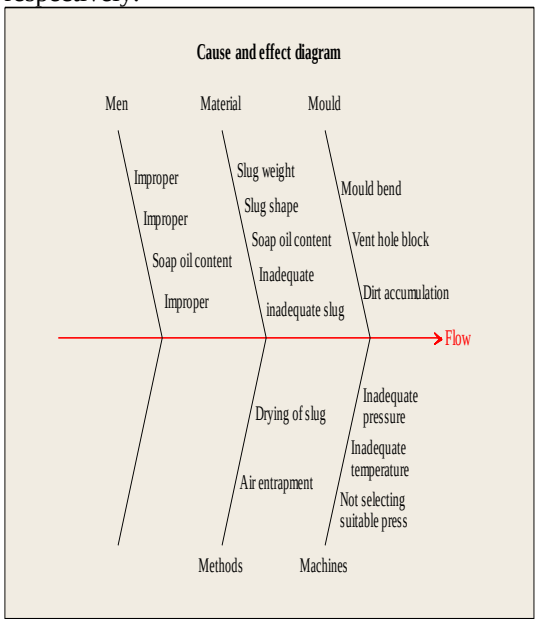

Fig: 4.2

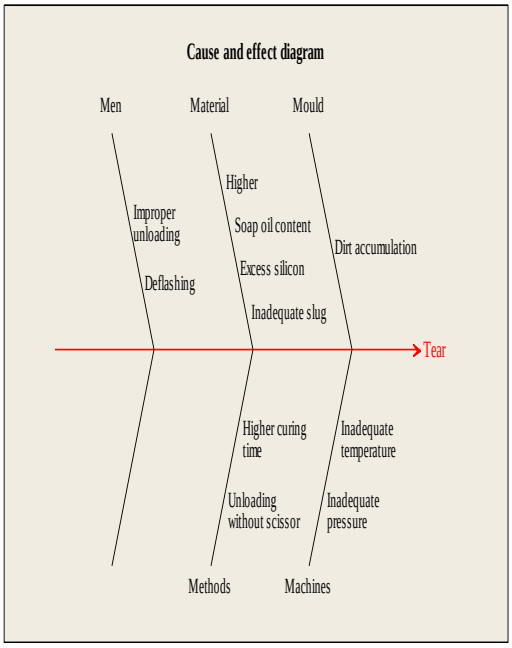

Fig: 4.3

Improve phase

Improved Attribute R&R

First R&R revealed that both the inspectors were of different consent & not in agreement with the expert's standards .The improved R&R has eliminated the difference of opinions among the inspectors and the experts and thus satisfies the required criteria. Limit samples were fixed and training given to Inspectors.

4.4.2 Improved Attribute R&R Results

The improved attribute R&R results show the better consistency among the workers and within the worker.

Control phase

The main objective of control phase is to make sure that our process stays in control after the solution has been implemented and to quickly detect the out of control state and determine the associated special causes so that actions can be taken to correct the problem before non conformities are produced. SPC is a quality control technique in which process generated data is used to help make decisions about the capability of the process to generate conforming hardware. A control chart is utilized to assure that the process is statistically in control, exhibiting only random variation. A process capability study is conducted to assure that the six-sigma spread of the process will comfortably fit within the specification limits.

5.0 CONCLUSION

World is seeing tremendous progress in the field of quality. Gone are the days of quality at any cost. Now quality means not only product or service quality but also cost, delivery.

People expect the high quality product at a low cost. To survive in the global market, every organization is forced to produce the high quality product at a low cost. To achieve this, Six Sigma approach with the proactive methodology (DMAIC) is applied.

The following are the results obtained:

- Customer satisfaction.
- The delivery schedules are met.
- The overall rejection percentage is reduced.
- The cost of Quality is reduced.
- To attain the six sigma level.
- A positive step towards zero defects.

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