Fault Detection Analysis and Diagnosis of Rotor by Six Sigma Methodology: A Review

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Abstract

The purpose of this work is to solve the problem of chronic issue of automobile rotor made by Mahindra Gears & Transmission Ltd. using six sigma methodologies D-M-A-I-C. The current yield loss due to this defect had contributed to the increased production cost due to rejection and rework time. Project objectives were set in *Define* phase to increase the yield of both functionality and rework ability of rotor from current baseline yield to 99.4% (targeted 4-sigma). The baseline data was collected in the *measure* phase and shows that baseline yield for functionality and reworkability was 74% and 62% respectively. Seven QC tool phenomena are associated with the main causes of the rotor which leads the problem to the end solution. Problem formulation was carried out to determine the main causes and impact of those caused on our fault analysis. Selection of this component has depended on the exporting of this part to Eaton industry which is situated at abroad. So the weightage is given to Rotor 1558. Justify those causes step by step and finally define the problem, which is considered in problem formulation chapter. Rejection of this component is depended on main causes like, internal bore grinding tapered and peripheral damages on surface of the speedometer rotor.

1. Introduction

In the early and mid-1980s with Chairman Bob Galvin at the helm, Motorola engineers decided that the traditional quality levels — measuring defects in thousands of opportunities – didn't provide enough granularity. Instead, they wanted to measure the defects per million opportunities. Motorola developed this new standard and created the methodology and needed cultural change associated with it. Six-sigma helped Motorola realize powerful bottom-line results in their organization – in fact, they documented more than $16 Billion in savings as a result of our six sigma efforts. Since then, hundreds of companies around the world have adopted Six Sigma as a way of doing business. This is a direct result of many of America's leaders openly praising the benefits of Six Sigma. Leaders such as Larry Bossidy of Allied Signal (now Honeywell), and Jack Welch of General Electric Company. Rumor has it that Larry and Jack were playing golf one day and Jack bet Larry that he could implement Six Sigma Allied Signal. The results speak for themselves.

Quality level in sigma	Rejection in ppm of products
2 sigma	308537
3 sigma	66807
4 sigma	6210
5 sigma	233
6 sigma	3 to 4

Fig.1 Rejection rate as per sigma level

This table shows the rejection of product per million numbers of products. By this number we can understand the need of the quality improvement. If industry doesn't aware of quality as well as accuracy then it suffered more loss by way of rejection Six-sigma is a quality movement, a methodology, and a measurement. Project decreases as the sigma quality level increases. It is also well understood that the process yield increases (at a decreasing rate) as the sigma quality level increases.

Fig. 2 Six sigma concept

TPM is a critical adjunct to lean manufacturing. If machine uptime is not predictable and if process capability is not sustained, the process must keep extra stocks to buffer against this uncertainty and flow through the process will be interrupted. Unreliable uptime is caused by breakdowns or badly performed maintenance. Correct maintenance will allow uptime to improve and speed production through a given area allowing a machine to run at its designed capacity of production. One way to think of TPM is "deterioration prevention. DMAIC is the basic concept of six sigma quality control methodology. It is a step by step problem solving concept.

D – Define. M - Measure. A - Analyse.
I- Improve. C - Control.

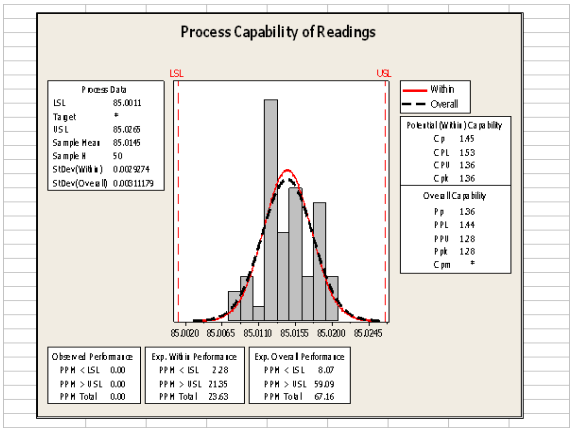

Fig.3 Without six sigma implemented

Six sigma may be characterized by the common "5W+1H" approach, summarized via six Ss (Goh and Xie, 2004):

(1) WHY six sigma? Satisfaction of customers.
(2) WHO does it? Structured top-down hierarchy of trained personnel.
(3) WHAT is it? Statistical thinking using data to combat process variation.
(4) WHERE is it? Standardized framework of "DMAIC".
(5) HOW is it done? Software packages for information analysis.
(6) WHEN is it done? Sustained effort via projects.

1.1 COMPANY PROFILE

Mahindra Gears & Transmission Ltd. has established, documented and maintained a quality management system. The company also ensures to continually improve its effectiveness in accordance with above-mentioned standard. The company has carried out following activities to implement the quality management system.

- Established in the year 1987.
- Located in Rajkot - Gujarat state, India which has been a hub of engineering industries.
- Produces more than 100,000 quality assured gears a month.
- Conforming to German specification DIN 7 to DIN 9 class of accuracy
- Certified to ISO 9002 from TUV Suddeutschland in the year 2000
- Certified to QS-9000 from TUV Suddeutschland in the year 2001
- Annual turnover is more than 4.5 million US

1.2 PRODUCT DESCRIPTION

Mahindra manufactures lots of parts, but here we consider the part as per economical aspects and company goodwill matter. Because Eaton is the foreign company and they purchase ROTOR 1558 from us. Now Rotor 1558 is used in speedometer to sense the rotation of the axle shaft and give the output as the rpm of the automobile vehicle.

1.2.1 Annual Economical loss:

- Now we consider the total cost of our work piece to calculate the loss due to the rejection.
- Rotor 1558 Price Rs. 800/piece
- Rejection 4100 parts/year. Total cost Rs.32840000 Loss/year.

Mahindra Gears & Transmission Pvt. Ltd., must take some steps to reduce this loss. It is important to emphasize that there are certain crucial assumptions, which allow the use of such values to have a meaningful interpretation, which are frequently overlooked. It is the aim of the author to address such issues by the use of discussion and case studies, and to provide some useful guidelines and insights when performing capability analysis using

MINITAB. Procedures when dealing with non-Normal data will be considered in the following edition of extraordinary Sense.

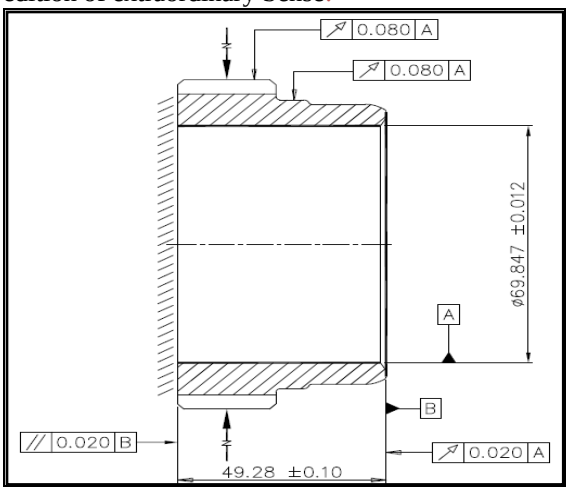

Fig.4 Cross Section of Rotor

1.3 Selection of Six Sigma Methodology

Some of the key reasons to why six-sigma should be implemented by organizations are to be responsive to and focused on the customer base. To improve product and service performance to improve financial performance and profitability of business. To be able to quantify its quality programs.The implications of the links between different cultures and different TQM/Six Sigma practices are discussed. While the relationship between TQM practices and culture has been the subject of prior research, this is the first look at the relationship between organizational culture and a comprehensive set of quality management practices including the new Six Sigma practices.

The understanding of the advantage of each culture type should help managers achieve effective implementation of TQM/Six Sigma practices from a holistic perspective of both quality management and culture. It is the second phase of six sigma quality control methodology. The six sigma methodology is given 100% result with improvement. In measure phase we take the readings of different operation and summarized them. For this purpose prepare different charts and tables of the component dimensions. Because from this data we can analyze the defects during the intermediate process, we can find the exact creation of defects at certain stage. It is well understood that the marginal benefit of any Six Sigma.

2. Experiments

Here we have focused on some investigators experiments.

Xiaoli Zhang, Zhen He, Liangxing Shi et al. (2011) found defects per million opportunities (DPMO) to mechanical and electrical industries. This paper gives a clear and effective way to define defect opportunity, which is a key point in deploying DPMO. This paper is based on a project of establishing a quality index system for Siemens Electrical Drives Ltd. Based on the on-site investigation and IPC-7912 calculation of DPMO and manufacturing indices for printed circuit board assemblies which gives a clear definition on DPMO defect opportunities for printing board assembly line, this paper proposes the rules to recognize, categorize and define the defect opportunities in motor production line by the joint efforts of the project members and the engineers[1].

Gülçin Büyüközkan, Demet Öztürkcan et al. (2010) found that Six Sigma is regarded as a well-structured methodology for improving the quality of processes and products. It helps achieve the company's strategic goal through the effective use of project-driven approach. As Six Sigma is a project-driven methodology, it is essential to prioritize projects which provide maximum financial benefits to the organization to prioritize projects which provide maximum financial benefits to the organization. Generating and prioritizing the critical Six Sigma projects, however, are real challenges in practice. This study aims to develop a novel approach based on a combined ANP and DEMATEL technique to help companies determine critical Six Sigma projects and identify the priority of these projects especially in logistics companies. First the six sigma parato analysis. [2].

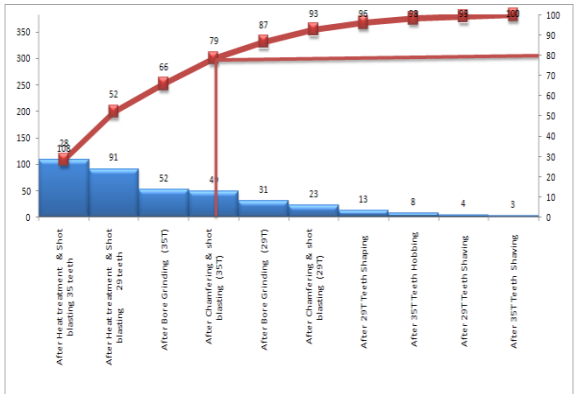

Fig.5 Parato analysis

Jose Emmanuel Ramı´rez-Ma rquezb, Dinesh Verma et al. (2008) found that Six Sigma is at the top of the agenda for many companies that try to reduce cost and improve productivity. Many of the top manufacturing companies implement thousands of Six Sigma projects every year and this

implementation demands a significant investment of capital that requires a careful analysis to make sure that the benefits obtained are much higher than the actual investment. This cost benefit analysis is crucial, especially for companies whose products have a small profit margin. In this paper, two optimization models that will assist management to choose process improvement opportunities are presented [3].

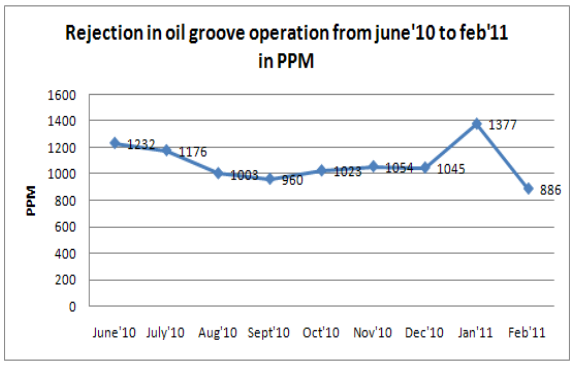

Fig.6 Periodic rejection

Hongbo Wang et al. (2008) found these models consider a multi-stage, asynchronous manufacturing process with the opportunity to improve quality (scrap and rework rates) at each of the stages. The first model is to maximizing the sigma quality level of a process under cost constraint while the selection of Six Sigma alternatives to maximize process returns is considered by the second model.

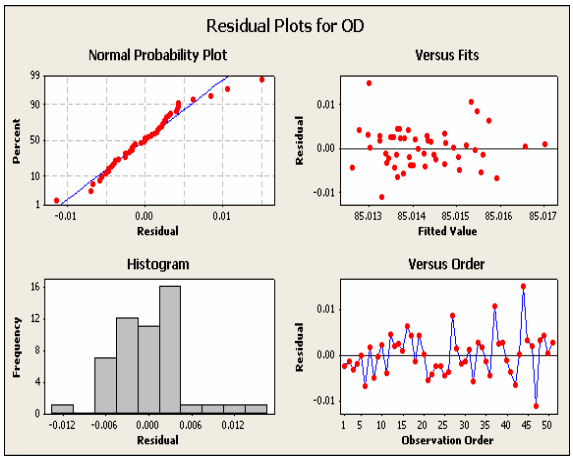

Fig.7 Different six sigma tools

Process quality improvement usually results in costs associated with the purchase of new technology, modification of existing equipment, training employees, hiring new employees and investment in information technology infrastructure, and the management information system concept is also being used by the analyst of the organization to get better output.

The proposed models recognize that a company competes for funds and that benefits can result in either improved revenue or reduction in costs. An example illustrates the application of the optimization models developed and results show that in some scenarios implementing Six Sigma may not be financially beneficial. The transcriptions were entered into NUD*IST, a software program that permits analysis and manipulation of qualitative data. Each transcript was coded according to the key issues discussed by the informant.[4].

Abbas Saghaei , Hosein Didehkhani et al. (2011)studied In each company we asked interviewees a series of questions. At the corporate level we asked questions about the history of Six Sigma deployment in the company, the company's definition of Six Sigma, the approach used, what they thought was new about Six Sigma compared to previous quality approaches, top management support, and the training and benefits of Six Sigma.

We also asked extensive questions about knowledge creation, diffusion, and retention as a result of Six Sigma projects; however, this part of the interview is outside the scope of the present paper. The interviews at the project level followed a similar format, starting with a description of the origin of the specific project, followed by a description of the project team and method used, an explanation of benefits and costs, an update on what is new, and an overview of the learning that occurred from the project. We also asked about knowledge created, diffused, and retained from the project. All of the interviews were tape recorded with the permission of the respondent on a confidential basis and then transcribed after the meeting [5].

Gopesh Anand, Peter T. Ward et al. (2009) considered this study investigates how organizational culture influences the implementation of different practices incorporated in the recent Six Sigma approach as well as those associated with traditional total quality management (TQM). We employed the competing values framework to capture the underlying value orientations of organizational culture. Using survey data collected from 226 US manufacturing plants, the relationships between four culture types and 10 TQM/Six Sigma practices were examined via the structural equation modeling technique.

The results reveal the differential effects of the culture types on the implementation of TQM/Six Sigma practices. The implications of the links between different cultures and different TQM/Six Sigma practices are discussed. While the relationship

between TQM practices and culture has been the subject of prior research, this is the first look at the relationship between organizational culture and a comprehensive set of quality management practices including the new Six Sigma practices. The understanding of the advantage of each culture type should help managers achieve effective implementation of TQM/Six Sigma practices from a holistic perspective of both quality management and culture [6].

3. Conclusion

To implement the six sigma concept we are using following tools. In the future work they will consider the below actions and solve the chronic issue of this component.

- SIPOC diagram
- Check sheet
- Control charts
- Pareto charts
- Stratification

Nicks and Damage during material cleaning plant, we are working on all causes which are shown in SIPOC chart and will try to short out and justify the chronic problem of this part rejection.

But at this intermediate stage I only suggest some proposed methods which can be helpful to minimize the rejection of ROTOR. Among those methods metal to metal contact removal may become main cause by which we can reduce the maximum rejection in great way. If we reduce the metal to metal contact then we can reduce the damage on periphery visually. The other effect of corrosion can be avoided of the parts at handling stage. One thing is also considered that here we use some alternative method to raising the parts in liquid, so we can also reduce the metal to metal contact also.

4. References

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