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Application of DMAIC Six Sigma Methodology: A Case Study

Pramod Kamble[1], Dr. Arun Kumar[2]
[1]PG Student
Mechanical Engineering Department, Viva Institute of Technology, Virar (E), Mumbai
[2]Principal
Viva Institute of Technology, Virar (E), Mumbai - India

Abstract- The fastest change in economical condition and global competition, customer demand high quality and variety product that has a major impact on manufacturing organization. To respond these needs of various industries, the quality management strategies such as ISO 9000, Total Quality Management, Six Sigma, JIT, Lean, KAIZEN etc. have been developed. A new paradigm in this area of manufacturing strategies is DMAIC Six Sigma. The DMAIC Six Sigma approach has been increasingly adopted worldwide in the manufacturing sector in order to enhance productivity and quality performance and to make the process robust to quality variations.

The paper deals with an application of Six Sigma DMAIC (Define–Measure-Analyze-Improve-Control) methodology in an industry which provides a framework to identify quantify and eliminate sources of variation in an operational process to optimize the operation variables, improve and sustain performance. DMAIC Six Sigma improves the process performance (process yield) of the critical operational process, leading to better utilization of resources, decreases variations & maintains consistent quality of the process output.

Index Terms- DMAIC, Six Sigma, Total quality management, Process yield.

1. INTRODUCTION

In today highly competitive scenario the markets are becoming global and economic conditions are changing fast. Customers are more quality conscious and demand for high quality product at competitive prices with product variety and reduced lead time. DMAIC is a data-driven quality strategy used to improve processes. It is an integral part of a Six Sigma initiative, but in general can be implemented as a standalone quality improvement procedure or as part of other process improvement initiatives such as lean. The DMAIC technique is an overall strategy to accelerate improvements in its processes, products and services. This approach is a project driven management approach to improve the Organization products, services and processes by continually reducing defects in the Organization. It is a powerful improvement business strategy that enables companies to use Simple and statistical methods for achieving and sustaining operational excellence. When improving a current process, if the problem is complex or the risks are high, DMAIC should be the go-to method.

It is a rigorous data driven method for dealing with defects, waste and quality problems, in manufacturing, services and other business activities. This approach is an upcoming quality improvement process and is proving to be a powerful tool for solving complex problems. It would not work well without full commitment from upper management. It is a scientific method to improve any aspect of a business, organization process. DMAIC is a methodology to identify improvement opportunities, Define and solve problems, Establish measures to sustain the improvement.

The DMAIC is both a philosophy and a methodology that improves quality by analyzing data to find root cause of quality problems and to implement controls. Although DMAIC implemented to improve manufacturing and business, processes such as product design and supply chain management. It is a business improvement strategy used to improve profitability to drive out waste in business process and to improve the efficiency of all operation that meet of exceed customer's needs and expectation. DMAIC is a customer-focused program where cross functional teams works on project aimed at improving customer satisfaction.

2. LITERATURE REVIEW

The basic concept behind the DMAIC approach is to reduce product and process variation. The (DMAIC) quality technique was first applied in manufacturing operations and rapidly expanded to different functional areas such as marketing, engineering, purchasing and servicing. The company Whirlpool has increased its quality by 10% by adopting DMAIC technique (Horel, H., 2001).

Sanders, D and Hilolo, Q., (2007) opined that the DMAIC is a quality improvement process which solves customer problems. It is a way to focus employees on quality and establishing a common language across the company. It also creates clearly defined performance goals.

According to Goh & Xie, (2004) Six Sigma has a major impact on the quality management approach, while still based in the fundamental methods & tools of traditional quality management.

Mike Harry (2000) explained that the Six Sigma is a strategic initiative to boost profitability, increase market share and improve customer satisfaction through statistical tools that can lead to breakthrough quantum gains in quality.

Park (1999) believes that Six Sigma is a new paradigm of management innovation for company's survival in this 21st century, which implies three things: Statistical Measurement, Management Strategy and Quality Culture.

Tomkins (1997) defines Six Sigma as a program aimed at the near-elimi-nation of defects from every product, process and transaction.

Antony & Banuelas (2001) opined that the Six Sigma is a business improvement strategy used to improve profitability, to drive out waste, to reduce quality costs & improve the effectiveness and efficiency of all operational processes that meet or exceed customers' needs & expectations.

Snee (2004) defines Six Sigma as a business improvement approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on process outputs that are of critical importance to customers.

3. THE DMAIC SIX SIGMA METHODOLOGY

The DMAIC methodology follows the phases: define, measure, analyze, improve and control. (Antony & Banuelas, 2002). Although PDCA could be used for process improvement, to give a new thrust Six Sigma was introduced with a modified model i.e. DMAIC. The methodology is revealed phase wise as shown in Fig. 1.

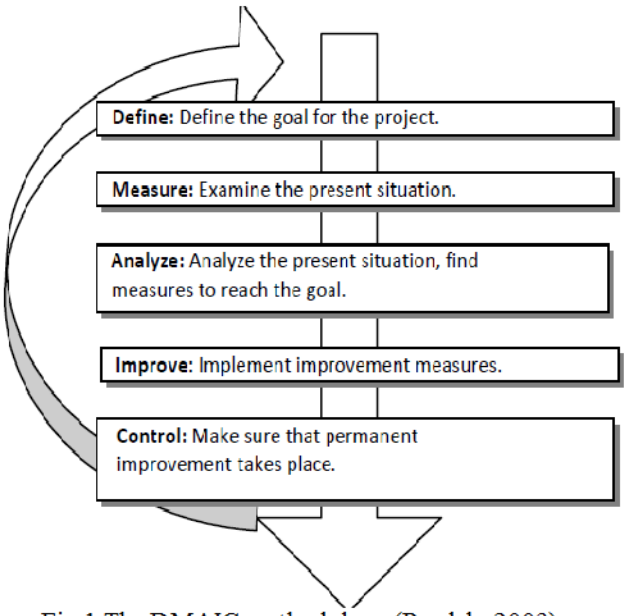

Fig.1 The DMAIC methodology (Pyzdek, 2003)

A. Define Phase

The problem is taper in cross hole of gear box. In Gear box there is a operation of 220mm length and 12mm diameter cross hole (Shown in blue color).The dimension of hole is 197.0+/-0.1mm measuring from A & C as shown in figure 2 and permissible taper is 0.2mm. Suppose distance AB is 196.9 mm and distance CD is 197.35mm, then taper of the hole is 0.45mm.

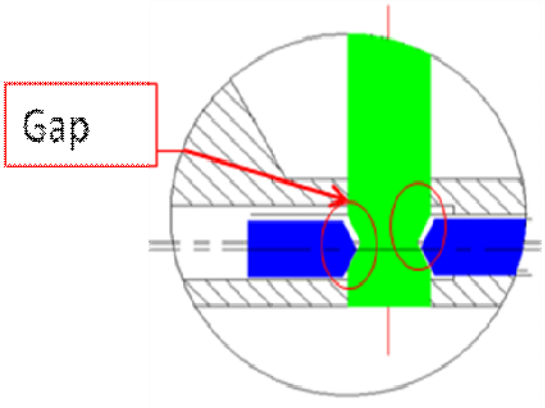

Figure 2. Mismatch of Pins

B. Measure Phase

This phase presents the detailed process mapping, operational definition, data collection chart, evaluation of the existing system, assessment of the current level of process performance etc.

GRR Study

Table 1: Data for GRR Study

Operator	A				B				C			
Sample #	1st Trial	2nd Trial	3rd Trial	Range	1st Trial	2nd Trial	3rd Trial	Range	1st Trial	2nd Trial	3rd Trial	Range
1	197.02	197.01	197	0.02	197.04	197.06	197.06	0.02	197.02	197	197.03	0.03
2	197.02	197.01	197.03	0.02	197.03	197.06	197.04	0.03	197.04	197.04	197.02	0.02
3	197.03	197.06	197.04	0.03	197.05	197.03	197.01	0.04	197.03	197.01	197.03	0.02
4	196.93	196.95	196.9	0.05	196.9	196.92	196.95	0.05	196.91	196.93	196.9	0.03
5	196.94	196.96	196.96	0.02	196.92	196.94	196.97	0.05	196.92	196.92	196.94	0.02
6	196.93	196.96	196.94	0.03	196.94	196.92	196.95	0.03	196.93	196.96	196.93	0.03
7	197.14	197.16	197.16	0.02	197.15	197.11	197.16	0.05	197.17	197.14	197.14	0.03
8	197.13	197.16	197.14	0.03	197.12	197.14	197.13	0.02	197.13	197.16	197.13	0.03
9	197.14	197.14	197.11	0.03	197.16	197.14	197.16	0.02	197.14	197.15	197.15	0.01
10	197.12	197.14	197.16	0.04	197.14	197.16	197.17	0.03	197.16	197.13	197.13	0.03

R & R Summary

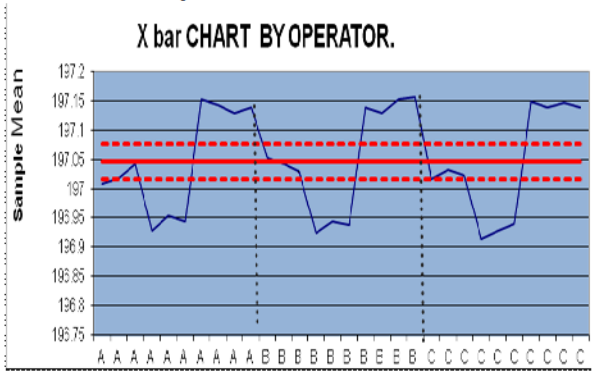

Figure 3: X bar Chart

Number of operators----------3
Number of parts checked ---30
Number of Trials----------3

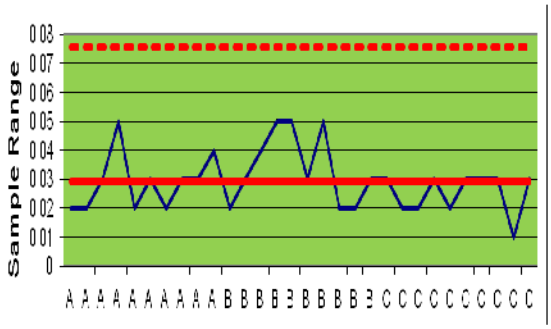

Figure 4: R Chart

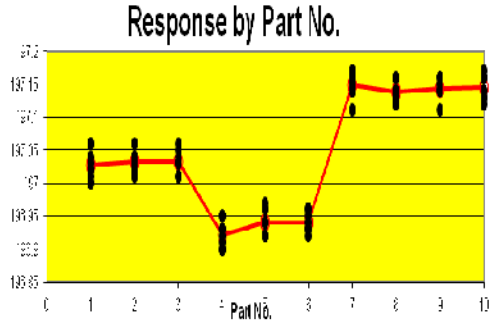

Figure 5: Response by Part Number

GRR = 6.41%

C. Analyze phase

This phase describes the potential causes identified which have the maximum impact on the low process yield, cause-and-effect diagram, Pareto analysis of the causes, the Why-Why analysis, FMEA analysis which leaded to identify the vital few factors in order to identify the root causes of the defects / problems and helped to examine the processes that affect the CTQs and decide which X's are the vital few that must be controlled to result in the desired improvement in the Y's, this leaded to generate ideas for improvement.

Cause and Effect Diagram

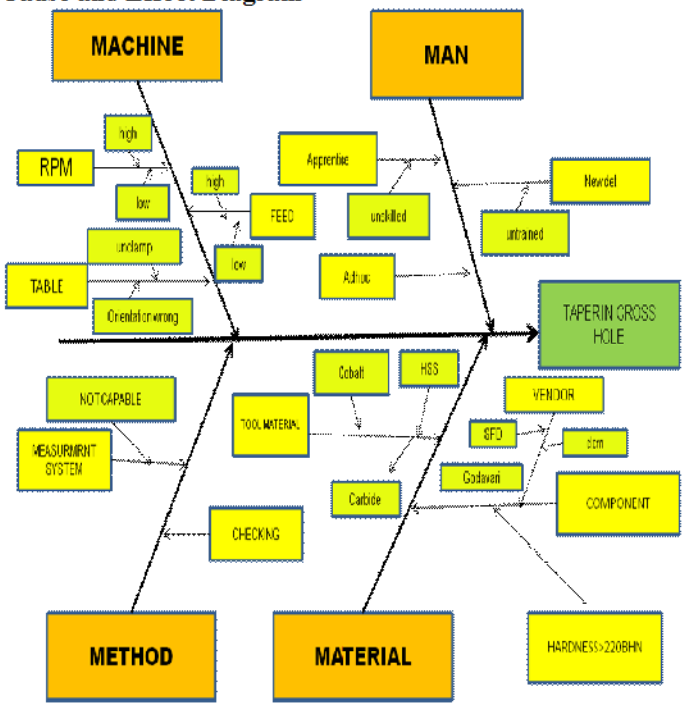

Figure 6: Cause and Effect Diagram

D. Improve Phase

The project team identified the risks for vital 'Xs' or input variables identified from various tools and took actions to optimize these input resources or the 'Xs' and thus developed process requirements that minimize the likelihood of those failures. The team members generated ideas for improving the process, analyzed and evaluated those ideas and selected the best potential solutions, planned and implemented these solutions.

Optimize the Parameter

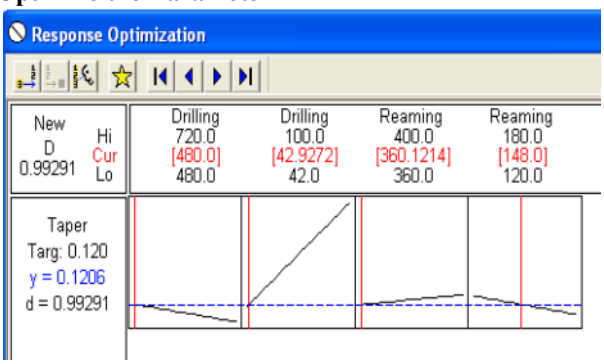

Figure 7: Optimization of the Parameter

Optimize setting:

Drilling rpm: 480, drilling feed: 43 mm/min, reaming rpm: 360, reaming feed: 148mm/min
This setting will give mean response y=0.1206 and achievement of target d= 99.29%.

Predict the Response

Predicted Response for New Design Points Using Model for Taper

Point	Fit	SE Fit	95% CI	95%PI
1	0.120567	0.030203	(0.058596,0.182538)	(-0.066824,0.307968)

Sigma Level Calculation (After Process Optimize)

DIMENSION= (197+TAPER)MM			
-0.05	-0.04	-0.01	-0.02
-0.07	-0.07	-0.06	0
-0.06	-0.06	-0.02	0.02
-0.06	-0.13	-0.02	-0.09
-0.04	-0.03	-0.05	-0.1
-0.03	-0.03	-0.03	-0.1
0	-0.08	-0.06	-0.02
-0.07	0.03	-0.04	-0.04
-0.16	-0.06	-0.02	0
-0.02	-0.06	-0.04	-0.1
-0.11	-0.03	-0.07	-0.05
-0.11	-0.02	-0.02	-0.02

CP =(USL-LSL)/6 SIGMA	0.871
CPL =(X BAR - LSL)/3SIGMA	0.45
CPU =(USL-XBAR)/3SIGMA	1.29
CPK =MIN(CPL,CPU)	0.45
XBAR	-0.05
USL	0.1
LSL	-0.1
STD DEV	0.038

SIGMA LEVEL = 2.85

Fool Proofing

Steps involved in fool proofing:

1. POKA YOKE is msde to reduce the chips disposition on component resting pad (Unwanted pad removed from fixture).
2. Feed and rpm can not be increased by the operator using feed over ride knob.
3. Automatic program will be called as per the fixture in side the machine
4. PLC has modified to conform operator second time when he will go for reworking.
5. Maintaining the gap in between fixture and component to avoid fouling.

Calculations for financial benefits:

Project Name	To reduce the taper in cross hole
Financial Benefits	
Rejection per month Cost/Component Potential Saving per annum	4.5 component Rs 4400.00 / =4.5 X4400 X 12 = Rs 237600.00

E. Control Phase

This is about holding the gains which have been achieved by the project team. Implementing all improvement measures during the improve phase, periodic reviews of various solutions and strict adherence on the process yield is carried out. The Business Quality Council (a group of Black Belt, Champion of team, Sr. Managers including project team members) executed strategic controls by an ongoing process of reviewing the goals and progress of the targets. The council met periodically and reviewed the progress of improvement measures and their impacts on the overall business goals.

4. RESULT AND DISCUSSION

The Six Sigma based methodology has been used to problem of taper in cross hole of gear box. The results obtained after implementing the improvement measures at various stages of the operational process are described below:

1. ***Sigma impact*** – The sigma level has been increased to 2.85 from -0.6. The higher the sigma level, the better the process is performing and the lower the probability that a defect will occur. The DMAIC methodology of Six Sigma has resulted into a quantum improvement in Sigma value.
2. ***Cost/benefit impact*** – Previously the rejection rate was 4.5 components/month, whose cost per unit was Rs. 4400/- so total financial benefits achieved per annum was Rs. 237600/-. A company that reduces its cost of doing business, meets the expectations of its customers more effectively and efficiently, inspires its employees, fosters a culture of dedication and pride, and earns a reputation for quality.
3. ***Customer satisfaction impact*** – Customer satisfaction is achieved by providing the products

and service of right quality, in the right quantity at the right time, right place and right cost, fulfilling customers'(external as well as internal) stated and implied needs. By providing defect-free products and services of consistent performance and quality, the Six Sigma practice definitely enhanced the customer satisfaction.

4. ***Time impact*** – Considerable time is saved by eliminating non-production (idle) time and by not producing the defective product and by eliminating rework/reprocessing.
5. ***Top line impact*** – Organizational reputation in the market and society at large is improved by providing products and service of good quality without any deviation in terms of performance and reliability.

5. CONCLUSION

Industries have to deal with a host of problems related to productivity and quality control. Substandard productivity hampers the internal customer demand of the products which directly affects the company targets. Organizations have to suffer huge losses which are not easy to cope up with. Thus there is a need to improve the process simultaneously keeping in mind the quality and the productivity of the product. Six Sigma DMAIC can be effectively applied and the existing business processes can be improved and made error free, downtime free. Six Sigma DMAIC provides statistical proof to each and every action, thus helping making decisions more efficient. It can work even with less number of readings in the database. Thus Six Sigma is completely an industry oriented methodology of quality and productivity improvement.

Six Sigma DMAIC provides business leaders and executives with the strategy, methods, tools and techniques to change their organizations. Six Sigma as a powerful business strategy has been well recognized as an imperative for achieving and sustaining operational (process) effectiveness, producing significant savings to the bottom line and thereby achieving organizational excellence. If implemented properly with total commitment & focus, Six Sigma can put industries at the forefront of the global competition.

REFERENCES

[1] Antony, J. & Banuelas, R. (2001). *Six Sigma: A Business Strategy for Manufacturing Organizations*, Manufacturing Engineering, Vol. 8 No. 3, pp. 119-121.

[2] Goh, T. & Xie, M. (2004). *Improving on the Six Sigma Paradigm*, The TQM Magazine, Vol. 16 No. 4, pp. 235-240.

[3] Harry, M. & Schroeder, R. (2000). Six Sigma: The Breakthrough Management Strategy Revolutionizing The World's Top Corporations, Doubleday, New York, NY.

[4] Horel, H., (2001). *Putting Six Sigma in Prospective, Quality Engineering Magazine*", Vol. 40, No. 10, 2001, pp. 58-62.

[5] Snee, R. (2004). *Six Sigma: the Evolution of 100 years of Business Improvement Methodology*, International Journal of Six Sigma and Competitive Advantage, Vol. 1 No. 1, pp. 4-20.

[6] Sanders, D and Hilolo, Q., (2007). *Six Sigma on Business Processes: Common Organizational Issue*, Journal of Quality Engineering, Vol. 12, No. 2, 2007, pp. 5-8.

[7] Tomkins, R. (1997). *GE Beats Expected 13% Rise*, Financial Times, pp. 22, October 10.