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Six Sigma Applications to Eliminate the Play Issue in K2 Slider

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***Abstract*: Six Sigma in the small and medium-sized enterprises (SMEs) is one of the emerging issue. Evaluation the implication of applying Six Sigma over the small and medium-sized enterprises is the main purpose of this research work taking a particular case of automobile industries. In the present work, DMAIC methodology of Six Sigma is used to a small seat slider lock nut manufacturing unit to reduce the play issue in K2 seat slider lock in automobile units by reducing defects inherent in the process. Process capability analysis and two sample t-test are statistical technique used to establish the process capability before and after the six sigma application.**

***Keywords*: Six Sigma, Quality, Process Improvements, Phases of Implementation, Indian Automobile Sector, Quantitative Tools.**

1. Introduction

Six Sigma is a systematic, well-disciplined data-driven approach which is used to eliminate the defect from the any process from manufacturing to dealings and from product to service. As a program, it presents a "structured and systematic approach" to process improvement, aiming at reduction of defect rate to 3.4 defects for every million opportunities (Harry and Schroeder, 2000[1]; Henderson and Evans, 2000[2]). Hammer (2001) [3]. simplified the definition of Six Sigma is a methodology to solve particular performance problems recognized by an organization. Evans, J. (2000) [4] stress the need for a common definition of Six Sigma and defined it as 'An organized and systematic method for strategic process improvement and new product and service development that depend on statistical and scientific methods to make salutatory reductions in client defined defect rates. However, over the years, numbers of studies have projected Six Sigma as change management approach at strategic level, beyond its initial statistical definition.

Johnson, A. (2006) presented three main definitions for Six Sigma:

1. A metric that helps with managing procedure variation, key performance indicators and continuous improvement verge;
2. A methodology that presents a relevant model and approach to team-based problem solving; and
3. A management system that assists executive leadership drive, metric based governance system across the effort.

However, Schroeder et al. (2008)[6], have opinioned that in the literature of six sigma there are many of the definition are very general and do not provide elements – or factors (variables, constructs, concepts) and defined "Six Sigma as an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method and performance metrics with the aim of achieving strategic objectives".

According to Zhang et al. (2011) [7], it is nearly impossible to develop formal conceptual definition of Six Sigma because it is driven by the changing needs of the organization and consultant needs to always offer something new and distinctive. It is evident from the fact that, "Six Sigma continues to draw tools and concepts such as Kano Analysis from marketing research, change management from Organization Behavior, Supply Chain Optimization from operations research and Hosin Planning from Toyota". Companies may choose from the existing variations of this base definition while deploying Six Sigma in order to customize it to their situation. The Deployment Strategy may be different among them & also within, at various levels of organizations.

2. Process capability analysis

Process capability analysis was performed to find out actual state of the process. Rational sub-grouping was done and 100 samples were drawn, in a group of two.

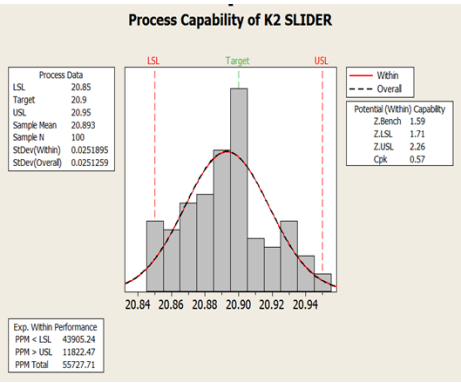


Fig. 1. Process capability analysis of k2 slider

Minitab was used to draw process capability analysis curve for seat slider lock nut as shown From the process capability

analysis curve, it was found out that Z- Bench sigma value of process was 1.59 and existing DPMO level of the process came out to be 56396.75, which is remarkably high and this shows that there are lot diagram of opportunities for improvement in the process.

A. Fish-Bone

Using process capability analysis, the DPMO level and sigma level of the slider play issue rejection was known. Now it was the time to find out the causes of slider play issue rejection. Using expert experience and critical analysis of actual process, a fish bone diagram (as shown in Figure 2) was drawn to find out the causes of more slider play issue rejections.

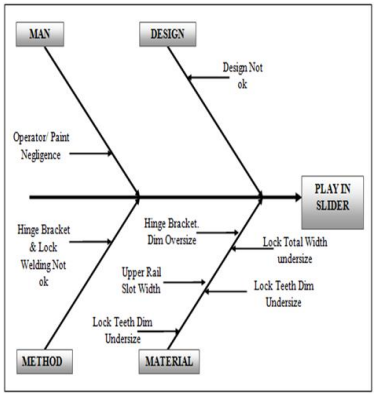


Fig. 2. Fishbone diagram

B. Study and analysis of the to eliminate the play issue in k2 slider utilizing six sigma DMAIC methodology

1) Two Sample-T test

An important factor from the two sample-t test were taken for study identified from fishbone diagram. A test of two sample t test was done in first case for operator skill (unskilled and skilled) taking 50 sample size each for both skilled and unskilled. To perform Two Sample T-test we have to select Stat>Basic Statistics>2-Sample-t on the Mini-Tab software.
Two Sample T-test uses for the analysis to:

- To determine whether the means of two independent groups differ.
- Difference between the populations means calculate a range of values that is likely to include.

It is a hypothesis test to find the difference between two observations means and calculate a confidence when standard deviations are unknown and sample are drawn independently from each other. It is t-distribution based procedure and best work for small samples if the data distribution drawn normal or close to normal. Confidence increases with increasing the sample size results. For a Two Sample T-test there must be two independent observations. Minitab was used to show the relation between main effect plot and interaction plot. In this phase, design of experiments was done to find out the optimum conditions for the vital few factors found out after the two-sample t-test.

Table 1
Two-sample t-test operator skill

Operator	N	Mean	SD	SE mean
Operator 1	50	20.8992	0.0239	0.0034
Operator 2	50	20.9022	0.0187	0.0026

Difference = mu (Operator 1) - mu (Operator 2),
Estimate for difference: -0.00300
95% upper bound for difference: 0.00412,
T-Test of difference = 0 (vs <): T-Value = -0.70 P-Value = 0.243 DF = 92

Table 2
Two-sample t-test: Gap Maintain

Operator	N	Mean	SD	SE mean
Initial reading	50	20.8992	0.0239	0.0034
Final reading	50	20.9022	0.0187	0.0026

Difference = mu (Initial Reading) - mu (Final Reading),
Estimate for difference: -0.00800
95% upper bound for difference: -0.00055,
T-Test of difference = 0 (vs <): T-Value = -1.78, P-Value = 0.039, DF = 89

Table 3
Two-sample t-test: Shaft size

Operator	N	Mean	SD	SE mean
Shaft size Initial	50	20.8992	0.0239	0.0034
Shaft size Final	50	20.9022	0.0173	0.0025

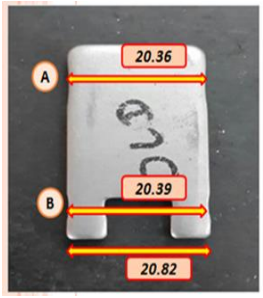
Difference = mu (Shaft size Initial) - mu (Shaft size Final)
Estimate for difference: -0.00320
95% upper bound for difference: 0.00374
T-Test of difference = 0 (vs <): T-Value = -0.77, P-Value = 0.223, DF = 89

Using Minitab, the Two Sample T-Test shows that as the P-value for component alignment comes out to be less than 0.05 therefore Component Alignment can be a factor for seat slider lock shaft rejection. As taking the reading of these three tables in operator skill and shaft size doesn't effect on the result but in case of the gape maintain there is a significant difference so we need to change in gape maintain dimension.

2) Improve

In improve phase, the counter measures of these causes is developed and been applied to reduce the play issue in seat slider and productivity improvement. Root cause and its remedy is shown it and the two factors that comes out to be the key reasons for the high rejection of seat slider lock shaft are component alignment. Two suitable countermeasures are implemented

Before



After

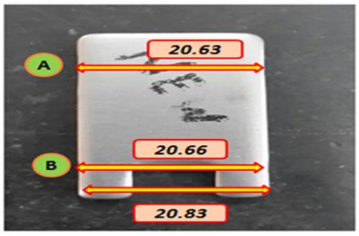
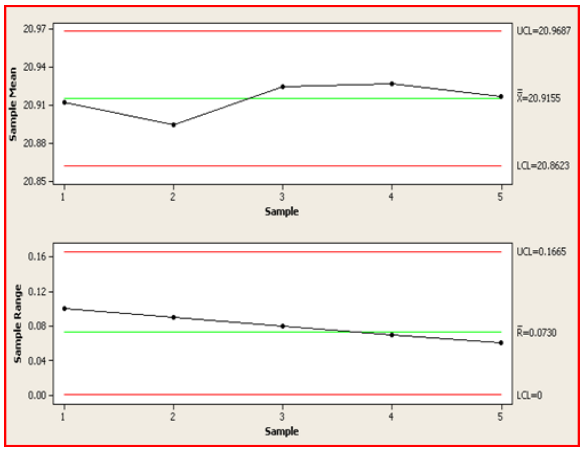


Fig. 3. Lock nut dimension before and after

Lock blank modified by increasing the width (at areas "A" & "B") to maintain dimension of Tip of Lock, Root of Lock, Root of blank. The width of lock has been increased in such a way that it would compensate the increase in width during bending operation and maintain 20.8 mm dimension.

3) Control

In Control phase, X bar/R Control Chart was drawn to visualize the presence of assignable cause of variation after implementing the changes lock shaft and for ensuring that the process continues to be in a new path of optimization. 100-sample size was taken for drawing X bar/R chart. The X bar/R chart is as shown in figure.



Dim 21 -0.05/+0.15 mm

Fig. 4. X bar/R chart

3. Result appraisal

Application of project recommendation brought up the sigma level up to 5.53 from 1.59 which is equivalent to monetary saving of Rs. 6.82 lakh per annum and is substantial for a small organization.

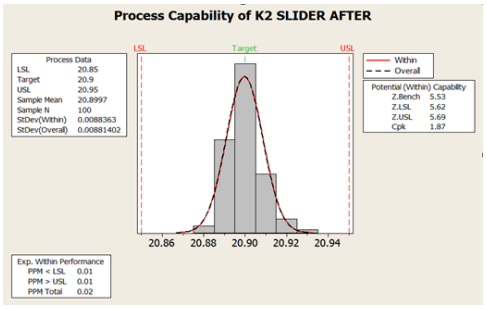


Fig. 5. Defect due to horizontal play eliminated & zero defect at customer end

4. Future scope

- In present study, survey was done in only 10 Major Automobile Industries of North India due to lack of time. The study can be extended in all Major Automobile Industries of India.
- Other Sector Industries can be included in the study.
- Mono-Respondent Approach was adopted to keep Cost & Time as Minimum as possible. However, Future Researchers may consider 'Multi-Respondent Approach' for better results.

5. Conclusion

This paper presented an overview on six sigma applications to eliminate the play issue in K2 slider.

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