Implementation of Six Sigma to Reduce Rejection Rate in Screw

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Abstract: The six sigma methodology is most powerful quality improvement technique which is used for achieving, maintaining and maximizing the business success. Six sigma is based on understanding the customer needs and expectation. This study mainly focused on six sigma quality philosophy and other related philosophy that is implemented in these studies to identify the rejection problem which are facing by a manufacturing industry. The six sigma philosophy provides a step-wise quality improvement methodology in which statistical techniques is used for check the changes in the process.

Keywords: six sigma, customer, expectation

INTRODUCTION

Six sigma methodology is a group of techniques and tools which is used for improvement in the process [1-4]. Six sigma was firstly introduced in 1986 by Mr. Bill Smith & Mikel J Harry when they were working with Motorola Company. In the year of 1995 Jack Welch use six sigma for his business program. It is used for quality improvement of the process and process output is identify and remove the causes of defects and minimize variability in manufacturing and business program.

Six sigma aiming at the reduction of defect rate to 3.4 defects for every million opportunities [5-8]. Six sigma as a project based methodology for solving specific performance problems recognized by an organization. Doing things in best possible way and keeping it in right direction by six sigma [9]. Kaushik gives a definition for six sigma“ methodology that offers reliability and giving approach to solve the problem by team and a management system that helps in making leadership and give authority for problem solving in industry ” [10]. Six sigma helps in attracting the manufacturing sector for improving the quality of final product.

Six sigma projects methodology:

Six sigma projects follow two methodologies. These methodologies are DMAIC and DMADV.

DMAIC: - Aim of this process is improving an existing business processes.

DMADV: - Creating new product or process designs by this process.

In this paper we will discuss about DMAIC methodology:
In this methodology has five phases:

#Define: In this phase consider, voice of the customer and about their requirements, and define goals of a project.

#Measure: In this phase measure gauge repeatability & reproducibility of the running process and check the process capability of a project.

#Analyze: Data is collected and develop a flow of process to analyze and verify cause-and effect of a process and what is the root cause of this defect.

#Improve: Improve the running process based upon data analysis using techniques such as DOE, FMEA, Pareto chart is used for improvement.

#Control: Standardize and documented the improvement of the process control chart is a tool which is used in this phase to check the process problem is shift or not.

LITERATURE REVIEW

Now days six sigma has been widely used by different industries. Six Sigma is a methodology that can help an industry to achieve expected goals through continuous project improvement [11]. Six sigma is a methodology which minimize the mistakes and maximize the quality value of the process. Six sigma has been most successful business improvement strategy developed during the last 50 years [12]. Management experts like Walter Shewhart, Joseph Juran gives the idea about continuous process improvement [13]. The example of Process improvement methodology is the Deming cycle of plan-do-check-act [14-16]. The need for continuous improvement within the organization is necessary to sustain in the global market [17]. For this purpose, a number of continuous improvement methodologies were developed based on production system, process improvement, waste minimization and quality improvement [18-22].

According to [23,24] six sigma is most effective quality improvement technique. Six sigma methodology is used for improve productivity in manufacturing industry. DMAIC is the model compatible for nourishing the benefits of six sigma in manufacturing, service and other unconventional sectors [25].

CASE STUDY

Problem formulation:
The study was completely about fasteners(nut bolts) manufacturing industry located in ROHTAK (HARYANA). Project identified is Major Diameter rejection of 4.8×16 Hi-Lo self tap screw is contributing 83% of the problem. The screw major diameter U/S and O/S limit is 4.70-4.90. Starting of the project with Initial observation which shows very high rejection due to “Major diameter problem”. The DMAIC methodology was adopt for solving the project. Initial observation of project showed very bad results and the staff member and management was wants to reduce the rejection rate and implementing these changes.
About Organization:
Lakshmi Precision Screws is a ISO-9002, QS-9000, ISO-14001 certified company. Lakshmi precision screws (LPS) Ltd. is a fasteners (nut, bolt) manufacturing industry which was established in 1972. The company which is providing fastening technology globally. The company is located in ROHTAK (Haryana). The company is one of the global leaders for manufacturing fasteners and cold forged components.

Study and Analysis of the 4.8×16 HI-LO Self Tap Screw rejection due to Major Diameter Problem utilizing six sigma DMAIC Methodology: DMAIC is problem solving methodology is used for problem analysis. (M. Shanmugaraja and M. Nataraj) (2011)

The registration of a project was the first activity, which showed approval from the management to start the project. Without their help & support it was never possible to involve people and implement suggestions. The rejection problem of HI-LO self tap screw was studied and the five phases of six sigma (DMAIC) methodology i.e. (Define, Measure, Analyze, Improve and Control) have been successfully implemented to achieve the quality level of 5.79σ from 1.12σ (as explained below in fig 7 & 10).

Define
In Define phase, where define the voice of customer and goals of a project [26]. Tool used for defining project was used process flow diagram and a SIPOC diagram were drawn for HI-LO self tap screw (as shows in fig 3 & 4). Process flow diagram shows the various stages of the inherent operations and the flow of material within the shop. The SIPOC diagram shows the information flow within the industry as well as the role of customer and manufactures.

Fig: 2(Hi-Lo self tap screw)
**Process Flow Diagram**

```
Raw Material  Inspect  Forging  Inspect  Rolling  Inspect  Plating  Inspect  Heat Treatment  Dispatch  Packing
```

Fig-3: (process flow diagram for screw)

**SIPOC**

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Inputs</th>
<th>Process</th>
<th>Outputs</th>
<th>Customers</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mukund</td>
<td>Raw Material</td>
<td>Manpower</td>
<td>Finished Parts</td>
<td>JDPW</td>
<td>Fitment as per customer specification.</td>
</tr>
<tr>
<td>Moder India</td>
<td>Forging Machine</td>
<td>Rolling Machine</td>
<td>Heat Treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power</td>
<td>Micrometer</td>
<td>Thread Ring Gauge</td>
<td>Snap Gauge</td>
<td>Process card</td>
</tr>
<tr>
<td></td>
<td>Plating</td>
<td>Packing material</td>
<td>Flap</td>
<td>Bins</td>
<td>Identification slip</td>
</tr>
</tbody>
</table>

Inference:- There are 7 steps in This Process

**Measure**

In measure phase, a measurement system analysis (MSA) is used by its accuracy, precision and stability (capacity of the measurement system). In MSA includes a statistical tool which is Gauge R&R (Gauge repeatability and reproducibility) studies. Gauge R&R study where the amount of variation arising from the measurement device measure. In this experiment Two persons are required to perform this experiment, which in this case were the inspector and the investigator. The sample size was five and two readings were taken on each sample, thereby a total no. of readings is 50.

Available Online: [http://scholarsmepub.com/sjet/](http://scholarsmepub.com/sjet/)
gauge which is used for this experiment was a micrometer.

In this experiment Gauge R&R study, which gives result to be 26.03 percent and 0.00 percent of repeatability & reproducibility and put the percentage study variation to be 26.03 percent, which is < 30 percent, means that micrometer was correct.

Analysis:

The analyze phase where investigation of the data collected. In this phase Process capability analysis was performed to find the actual state of the process. Sub-grouping of sample was done and ten samples were drawn in a group of five. Minitab software was used to check the process capability analysis (which is shown in fig 7v&10).

In analysis phase where analyzing 4 factors:
1. TRD (Thread rolling diameter)
2. Total length (3) Gap b/w die

Quick wins in FMEA (which improve product quality and reduce rejection rate of screw)
1. Training to operator
2. Die life to be set.
3. Pusher life to be set
4. Preventive maintenance of machine
5. Profile projector to be used for setting approval
6. DOE to be done after every six months
7. Work instruction for setting of machine
### FMEA

<table>
<thead>
<tr>
<th>Process Function</th>
<th>Characteristics</th>
<th>Potential Effects of Failure</th>
<th>Severity (S)</th>
<th>Occurrence (O)</th>
<th>Detection (D)</th>
<th>Risk Priority Number (RPN)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>M5P</td>
<td>Major dia O/S</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>343</td>
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<tr>
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<td>Forging</td>
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<td>7</td>
<td>5</td>
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<tr>
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<td>Cleaning</td>
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<td>Total length</td>
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<td>7</td>
<td>5</td>
<td>343</td>
</tr>
<tr>
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<td>Material</td>
<td>Major dia O/S</td>
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<td>7</td>
<td>5</td>
<td>343</td>
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<td>Die grade</td>
<td>Major dia O/S</td>
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<td>7</td>
<td>5</td>
<td>343</td>
</tr>
<tr>
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<td>Hardness of A</td>
<td>Major dia O/S</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>343</td>
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<tr>
<td>Rolling</td>
<td>Instrument</td>
<td>Major dia O/S</td>
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<td>7</td>
<td>5</td>
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<td>Rolling</td>
<td>Checking and</td>
<td>Major dia O/S</td>
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<td>7</td>
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<tr>
<td>Rolling</td>
<td>NMA</td>
<td>Major dia O/S</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>343</td>
</tr>
</tbody>
</table>

**Process Capability analysis:**

It is important techniques which is used to determine how well a process meets with specification limits. Process capability analysis check the actual state of the process. Sub-grouping of sample was done and ten samples were drawn, in a group of five. Minitab software was used for draw a process capability analysis curve (which is shown in fig)

**Z-Bench sigma:**

Z-Bench sigma value was found in this analization to be 1.12 and existing DPMO level of the process which is 132044.64.so opportunity for improvement in the process is higher.

**Fig-6 ( FMEA diagram)**

**Fig-7 : ( Process capability)**
Analysis of screw major diameter rejection ata before implementing DEMAIC methodology

Fishbone diagram.
DPMO level and Z-Bench of major diameter rejection of screw was known by process capability analysis. Now it was the time to find out the more causes of rejection of major diameter of screw. A Fishbone diagram (as shown in fig. 8) was drawn to find out more causes of screw rejections.

![Fishbone diagram](image)

Fig-8: (fishbone diagram)

**Improvement results**
Improve the process to remove cause of defects. This is the stage where the root cause of the problem is removed and the solution is standardized.

In improve phase, The two factors that come out to be the key reasons for the high rejection of Hi – Lo self tap screw rejection are TRD and speed of machine.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>INPUT VARIABLE</th>
<th>ACTION</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Thread rolling diameter</td>
<td>TRD has been revised from 3.45-3.48 to 3.47-3.50</td>
<td>Major diameter found within specification</td>
</tr>
<tr>
<td>2.</td>
<td>Speed</td>
<td>Speed of AF-6 machine kept 190 RPM</td>
<td>Major diameter found within specification</td>
</tr>
</tbody>
</table>

**CONTROL**
In control phase, X bar/R control chart was drawn to check the possible cause of Variation after implementing the changes in TRD and Machine speed and ensuring that the process continues to be in a new path of optimization. Size of 50 sample was taken for drawing X bar/R chart (as shown in fig 9).
RESULTS
Sigma level which improve up to 5.79 from 1.12 (as shown in fig 10). Application of six sigma is successfully implemented in this case study which definitely encourage the other manufacturing industry to use six sigma to reduce the losses in their processes.

Fig-9: (X/R charts for screw major diameter after improvement)

Fig-10: Process capability chart of screw major diameter rejection data after implementing DMAIC methodology)
CONCLUSIONS

Various case studies have been reported by different industrialists and researcher that show the capability and the remarkable results of applying six-sigma methodology. The above case study was also one of them but different in some context. As the study used a mixed approach in usage of the tools i.e. tools used are of mix category. There is the use of Minitab software which requires a high skill level and some tools as fishbone diagram process flow, FMEA etc. which is comparatively low skill level. The aim of the study was to reduce the rejection PPM of the industry which fulfilled by improving the sigma level of the process.

REFERENCES