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EXECUTION OF LEAN SIX SIGMA IN EYE BOLT ENGINEERING PRODUCTIVENESS

S. Janaki *[1], M. Perumalsamy[2], K. Sadesh[2], A. P. Senthil Kumar[2]

[1*]Department of Mechatronics Engineering, SNS College of Technology, Coimbatore, Tamil Nadu, India.
[2]Department of Mechanical Engineering, PSG College of Technology, Coimbatore, Tamil Nadu, India.

ABSTRACT
Globalization, advanced technology, and increasingly sophisticated customer demands change the way of conducting business. Old business models not extensive work in the new economy. The defects rate of the product plays an essential role in the enhancement of yield and financial situations of any firm. The objective of this paper is to study and evaluate current processes of the eye bolt manufacturing organization, to find out the current process sigma level and to improve existing sigma level through productivity improvement. According to the customer needs or requirements, the current sigma level of the Eyebolt manufacturing process has been calculated, and suggestions are provided for improvement. This has been done by using Six Sigma DMAIC methodology.

KEYWORDS
Six Sigma, DMAIC, Continual improvement, Process improvement, Control chart and Pareto chart.

Author for Correspondence:

Janaki S,

Department of Mechatronics Engineering,

SNS College of Technology,

Coimbatore, Tamil Nadu, India.

Email: janakis.cbe@gmail.com

INTRODUCTION

Six Sigma is a way to manage a business or organization. It is a quality that equates with only 3. 4 defects for million opportunities for each product or service transaction strives for perfection. It starts a measurable status to achieve and embodies a strategic problem-solving method to increase customers. Satisfaction and intensely reduce costs and increase profits. Six-Sigma gives discipline, structure, and a foundation for stable decision making based on simple statistics. The primary objective of any business or organization is to make a profit. For increasing the profit, the selling price should increase and the manufacturing cost should come down. So, the price is decided by the competition in the market, hence the only way to increase the profit is to reduce the manufacturing cost which can be achieved only through continuous improvement in the company's operation. Six Sigma quality programs provide opportunities for continuous improvement in the process of an organization. Six Sigma uses faces, data, and causes to solve problems. It increases customer fulfillment, retention and produces the best class product from the best process performance. Lean Six Sigma combines the principles of Lean with Six Sigma to improve process effectiveness and alignment with the voice of the customer. Lean Six Sigma is a combination of the two process improvement methods variability and defects by identifying and controlling its causes.

Eye Bolt

An eyebolt is one type of bolt with a loop at one end. They are used to inflexibly attach a securing eye to a structure, so that ropes or cables may then be tied to it. Eyebolt is connected to the motor body that is used to lift the motor from one position to another position by using the help of a crane. There are several types of eye bolts are available depending upon the types of application. The dimensions of the eye bolts are varying according to how much amount of weight to be lifted. Different types of eye bolts are available such as Regular eye bolts, screw eye bolts, Shoulder eye bolts and Machinery eye bolt these bolts are used according to the application. All four of these basic types that E-Rigging offers are manufactured in the drop forged process to ensure high strength. The eye bolts are designed with a shoulder and also designed for angular loading. The difference between eye bolts used in machinery, regular and eye bolts is that the shank and threads of the machinery eye bolt do not protrude through the base metal. Therefore, all of the holding strength of the eye bolt used in machinery is on the threads. Non-Shouldered Eyebolt is Applications that include pulling and lifting, inline loading only. Used in drilled and tapped blind holes or with two nuts in drilled through holes. Shouldered Eyebolt used to applications include inline loading, limited side loading for pulling and lifting. Machinery Eyebolt applications include inline loading, limited side loading for lifting points on equipment, drilled and tapped blind holes.

Problem Statements

The problem is identified in the eye bolt manufacturing organization. The company is located in Coimbatore. In that company, we are a leading manufacturer of fasteners in a particular area and one of the competitors in the area. Number workers are working to meet customer demand. There are many numbers of machines and tools are available in the firm to make the product such as grinding, drilling, cutting, milling, lathe, etc.., they work according to the shift-based system and also, they get the extra time for the work and if the product is continuously a quality means they get the incentive. In the nut and bolt process, they get the raw material from a different supplier, and they start the production. The raw material for the eye bolt is a rod and also there are the different sizes of rods are available for making an eye bolt depending upon the customer order or weight to be lifted. In the initial process, they check the quality of the rod and processed to the next step. They are cutting perpendicular to the metal cutting process. After the cutting process, it proceeds to the facing operation in the facing operation they made to remove the uneven surface in the outer layer to make it as a better surface and made to operate without any damage to the worker and also the finished products. Thread process took place in it the threading act as a significant role, and the thread should be proper according to the specification of the customer. Then the surface finishing or coating is taken place to make the parts to prevent the rust the coating is applied to some type of bolt. These methods are getting over its move to the packing area in there the parts and products are prepared to pack according to the customer location and all other places, and it went to reach in the particular time to made to the delivery wrong time.

Define Phase

In the Define phase of the project is to focus on defining the current state of the Eyebolt by defining the problem statement. The problem statement specifies what the team wants to improve upon which demonstrates the need for the project and possible benefit.

The type of things that are determined in this phase includes the Scope of the project, the Project Charter. SIPOC means Suppliers, Inputs, Process, Outputs, and Customers. These types of approaches help us to identify features that are key to the process, which in term enables identifying appropriate metrics to be used to effect improvement.

Measure Phase

The Measure phase is the second step of the Six Sigma methodology. A baseline measurement is taken using original data. This measure converts the origin from which the team can gauge improvement. It is within the Measure phase that a project begins to take the profile and much of the hands-on activity is performed. The primary goal of the Measure phase is to establish a clear understanding of the current state of the process you want to improve.

To identifying process performance measures and setting their targets according to the VOC data. The current process is then evaluated against the goals. Process measures related to the effectiveness and efficiency of the resources necessary to transform inputs into outputs, such as labor hours, training, and equipment. Efficiency is providing the desired outcome utilizing as few resources as required. Histograms are graphical representations of data distributions.

The graphical representation helps visualize patterns in the data variables that are not readily apparent in tabular forms of the data, especially the shape of the data distribution.

Histogram of the head size of the component variation is higher in dimension on the right side of the mean value and more than the specification limit. The distribution of value is not in specified limit this makes a poor-quality product.

Analyze Phase

In this step, the lean six sigma team identified the several causes (Critical X's) of defects or variations that are affecting the outputs (Y's) of the process. One of the most frequently used tools in the analyze phase is the Cause and Effect Diagram. The Cause and Effect (C and E) Diagram is a technique to graphically identify and organize many possible causes of a problem (effect). They help determine the most likely ROOT CAUSES of a problem. This tool can help focus problem-solving and reduce subjective decision making. The cause is the number one team deliverable coming out of the analysis step. Causes can be validated using new or existing data and appropriate statistical tools such as hypotheses testing, scatter plots, ANOVA, regression or Design of Experiments.

Hypothesis testing is stated in the form of a null hypothesis and an alternative hypothesis. The null hypothesis asserts that the data belong to one population and the alternative states the data belong to a different population.

The null hypothesis (H0) asserts that the sample data are representative of the population from which they were drawn (same mean and standard deviation) and the alternative hypothesis (H1) states that the sample data are not representative of the greater population (different mean and standard deviation).

Improve Phase

The main purpose of the Improve phase is to identify Scope for improvement suggestion, design the future state, implement pilot projects, train, and file the new processes. The activities performed and tools applied during the Improve phase are discussed below.

- Identify improvement recommendations
- Perform cost/benefit analysis
- Design future state
- Establish performance targets and project scorecard
- Gain approval to implement, then implement
- Train and execute

A VSM is an end-to-end collection of processes/activities that create value for the customer. A value stream usually includes people, physical facilities, communication channels, tools and technologies and policies, and procedures.

A value stream is all the activities (both VA and NVA) currently required to bring a product through the main flows vital to every product: (a) The production flow from the raw material into the hands of the customer, and (b) the design flow from concept to launch. Symbols, Terminology with standard, and improvement methods allow VSM to be used as a one communication tool for both sharing techniques and internal communication and results with the broader lean community. Value stream mapping is the process of visually mapping the flow of information and material as they are preparing a future state VSM with better methods and performance.

The objective of an affinity diagram is to develop meaningful ideas from a list of many unrelated ideas. It is helpful when different random ideas need to be clarified to reach team consensus or when a massive, complicated issue needs to be broken down into smaller categories.

Control Phase

The purpose of the Control phase is to measure the results of the current process against the target value or customer needs and manage the change on a broader scale, report scorecard data and the control plan, identify replication changes and develop strategies for improvement.

The control chart is a graphical representation of the data obtained reveal the occurrence and extent of differences from established values. Control charts are a simple tool to construct and infer. They inform the quality controller at a glance when the process is out of control, or in a state, i.e. within the tolerance limits stated by the customer or product engineer.

A control chart consists of three lines.

- Central line (CL)
- Upper Control Limit (UCL).
- Lower Control Limit (LCL).

$\bar{x}$ Chart

$UCL = \bar{\bar{x}} + A2\bar{R}$

$LCL = \bar{\bar{x}} - A2\bar{R}$

R Chart

$UCL = \bar{R}D4$

$LCL = \bar{R}D3$

$\bar{R}D3$ is the mean of the ranges in the sampling process. A2, D4, and D3 are variables in the appropriate statistical (SQC) table.

It has been observed that, the process capability analysis of all parameters; it is evident that the process is out of control.

Cp=0.40 for Thread Length indicates that the process is not capable (Cp< 1).

Cpk =0.32 is less than Cp=0.40.

This means that the process is off-centered.

Similarly, for length Cp=0.57 indicates that the process is not capable (Cp< 1).

Also, Cpk =0.55 is less than Cp=0.57.

For head size Cp=0.75 indicates that the process is not capable (Cp< 1).

Also, Cpk =0.67 is less than Cp=0.75.

For head diameter Cp=0.59 indicates that the process is not capable (Cp< 1).

Also, Cpk =0.52 is less than Cp=0.59.

Table No.1: Project Charter

Project Charter	
Project Name	Defect Rate Reduction
Business Unit	Quantity
Department	Production
Start Date	13-12-17
Project Budget	10000
Project Stakeholder	**Name**
Project Champion	Kumar
Process Owner	Praveen
Black/ Green Belt	Vishnu Kumar
Team Members	Karthik
Business Case	
The number of orders for the eye bolt is vast, but there is a problem of high rejection due to more defect in the threat cutting. If this continues the cost of production will increase, and cost of rework also increases	
Problem Statement	
Eyebolt Defect Rate is high due to the quality of the tool and skill of the operator. Rejection of component is more.	
Goal Statement	
The goal of the project is to reduce the number of defective items.	
Project Scope	
The scope of the Project is to examine all processes, identify the cause for defective items and suggest the alternative method to reduce defects.	
Benefits	
Satisfy customer	
Produce good quality products	
Reduce defects	
Avoid rework	

Table No.2: SIPOC

S.No	Supplier	Input	Process	Output	Customer
1	Raw material Machinery Coolant	Manpower Machines Equipment	pressing Facing Turning Thread cutting Drilling Surface finishing Polishing	Eyebolt	Pump Manufacturer Retailer

Table No.3: Eyebolt Measurement

S.No	A (Thread Length)	B (Length)	C (head size)	D (head diameter)
1	20.01	27.00	7.00	16.00
2	20.05	27.03	6.99	16.01
3	19.98	26.98	7.00	16.04
4	20.01	27.04	7.04	15.97
5	20.03	26.95	6.98	15.99
6	20.01	26.99	7.02	16.05
7	19.99	27.03	6.99	16.04
8	19.98	27.03	7.00	16.03
9	20.20	26.98	7.04	15.98
10	20.05	27.04	6.98	16.00
11	19.98	26.97	7.02	16.01
12	20.01	26.99	6.99	16.04
13	20.01	27.04	7.00	16.04
14	19.99	27.03	7.00	15.97
15	20.03	26.98	7.04	15.99
16	20.01	27.00	6.98	15.98
17	19.99	26.98	7.02	16.00
18	19.96	27.04	6.97	16.01
19	20.01	26.97	7.04	15.99
20	20.04	26.99	6.98	15.95
21	19.96	26.98	7.00	15.99
22	20.03	27.04	7.04	16.04
23	20.05	26.95	6.99	16.03
24	19.98	27.03	7.00	16.03
25	20.01	26.98	6.98	16.00
26	19.97	27.04	7.02	16.00
27	20.02	26.98	6.99	16.04
28	19.98	27.04	7.04	15.97
29	19.99	26.97	6.98	16.00
30	20.03	27.04	7.02	16.00
31	20.03	27.03	6.99	16.04
32	19.98	27.00	7.04	15.97
33	20.01	26.98	6.98	15.97
34	19.97	27.04	7.02	15.99
35	19.96	26.97	6.99	16.05

CONCLUSION

This paper describes various steps in Six Sigma methodology of the Define phase, Measure phase and Analyse phase, Improve phase and control phase used for solving the problem. In the define phase, problem selection using process mapping, project charter analysis is carried out, and tool used for problem-solving paired comparison and multi vary study in measure and analyze phase are also explained in this paper. All the charts and diagrams used here are drawn carefully to show the real scenario of the case organization. The organization is trying itself to improve its productivity, but without using appropriate tools and techniques, it is almost impossible to make that happen.

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CONFLICT OF INTEREST
We declare that we have no conflict of interest.

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