APPLICATION OF SIX-SIGMA- A CASE STUDY OF AN AUTOMOBILE LIGHTENING COMPANY

Shrey Mehta(1), CS Jawalkar(2),Naresh Chawla(3)

Center of Total Quality Management (TQM)
(2)Assistant professor, Department of Industrial & Production Engineering
(3)Visiting professor Center of Total Quality Management
PEC university of Technology Sec-12, 160012 Chandigarh India

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ABSTRACT: A vehicle headlamp structure includes a light distribution pattern having a horizontal cutoff line formed by a first reflecting optical system. The structure includes a first light source including a light emitting diode in which a rectangular light emitting chip is covered with a hemispherical mold lens, and a first reflector for reflecting a light emitted from the first light source toward a front part of a lighting unit. The polarization technique applied to powerful upper headlight beams offers a means whereby greatly improved vision during encounters can be achieved. Installation of a polarized light system on a vehicle does not help the driver of the vehicle itself, but only the other drivers. A polarized system would ultimately have to be adopted by all to be of maximum value. The cost and the difficulties likely to be encountered during the transition period of mixed use, however, have so far prevented the introduction of such beams. A possible course of action which would reduce transition difficulties would be first to introduce a polarized lower beam compatible with normal lower beams. In the early stages of such a change, drivers would not need to use a visor, but as more vehicles were equipped the visor would become increasingly beneficial during meetings on both dry and wet roads. Whether or not the absence of glare with such a system would outweigh the disadvantages of a dimmer road surface, loss of silhouette vision and loss of advance warning of an approaching vehicle would need to be determined by a comprehensive driver-appreciation test carried out in a particular locality such as an island, or perhaps in an establishment having under its control a system of roads and a large fleet of vehicles. For the purposes of this test the necessary equipment could be added to existing vehicles. The Quality of a low beam light can be affected if some leakage is being found in the component leading it a defective component . A leak is a flow of gas or liquid that pass through the wall of a vessel i.e. A hole, crack or bad seal. Leaks require a pressure difference to generate the flow; that flows from higher pressure to lower pressure. Leaks are pictured as going from positive pressure (inside an object) to outside (at atmospheric pressure). This is not always the case (a leak could be from atmosphere to inside an evacuated object), but it also helps to think in this way because the units and terminology are based on the model. So the objective of this project is to reduce the leakage in the low beam module using DMAIC approach. The research is aimed to reduce the leakage so as to achieve customer satisfaction. DMAIC consists of 5 stages Define-Measure-Analyze-Improve –Control

KEYWORDS: DMAIC, Six Sigma, World Class Manufacturing, Process Capability

1. INTRODUCTION

Six-Sigma is a business strategy that enables an organization to increase their profits by optimizing their operations, improving quality and eliminating the defects. It is a reference to a particular goal of reducing the defects to "Zero". It Mainly Focus on drastic reduction of the variation in the processes. The companies that adopt Six Sigma approach will have to reduce the process variation to such a level that the number of defective parts per a million of produced parts would be less than 3.4. Implementing a Six Sigma program means delivering top-quality products and service while virtually eliminating all internal deficiencies. Six-sigma speeds up the rate of improvement by promoting learning acros functions. The goals of any organization come from its three major constituencies: Customers, Investors and Employees. It is a quality control program developed in 1986 by Motorola. When employees become more productive naturally their monetary package will get better. So, adoption of Six Sigma means higher benefits to all members in the organization. Six-Sigma implementation uses five steps DMAIC (Define, Measure, Analyze, Improve and Control) Methodology, somewhat similar to Plan-Do-Check-Act problem solving methodology defined by Deming. DMADV (Define, Measure, Analyze, Design and Verify) methodology is adopted for new product developments. The present study was carried out at HELLA India Lightening Limited. The company was established with objective of manufacturing headlamps to satisfy the demand of growing Automobile sector. The Six Sigma methodology of (DMAIC) was used to study the manufacturing process. The focus of the case study is to know each production flow process which was critical to No of defects in the headlamps. The implementation of Six Sigma in Automobile lightening industry not only benefits the industry by increasing the overall profit but also to the environment by optimum utilization of chemicals.

2. METHODOLOGY OF SIX-SIGMA

The main objective of the study is to reduce the number of non-conforming products produced. Six-Sigma has five phases that were implemented in HELLA India Lightening Limited with the application of most suitable Six Sigma tools at various processes. This application with the help of Flow Chart is shown in **figure 1**

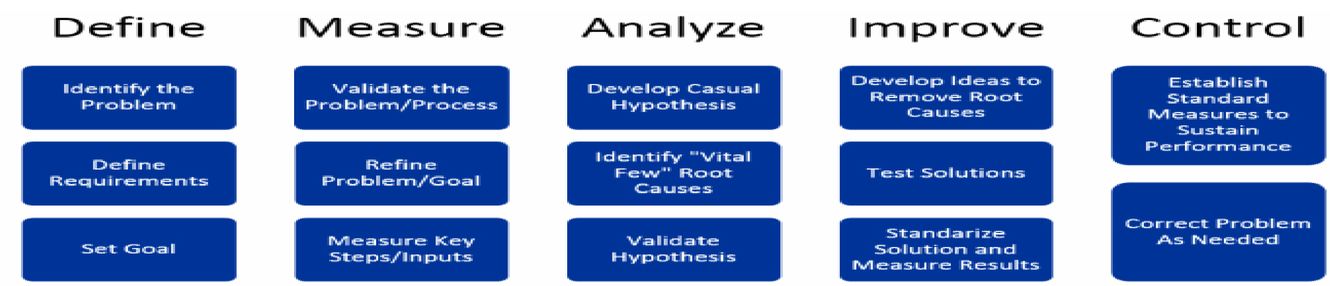


Figure-1. DMAIC Process

2.1 DEFINE PHASE

Although all stages of the DMAIC cycle are equally important, but this stage will rule the others, because it defines directions, goal as well as problem statement and desired quality Characteristics.

Project Team Charter	
Black Belt Name:	**Champion Name :**
Head – TQM Facilitation & Industrial Engineering Deptt.	, Neeraj Arora
Project Start Date : feb, 2017; **Project Completion Date :** june 2017	**Project Location :** A small scale manufacturing unit, Derabassi Mohali(Punjab), India
Business Case: Improvement in Module 60 Low Beam Headlamp which will reduce delay in delivery of jobs; which will satisfy the customers (internal & external), which will lead to improvement in quality, productivity & corporate health.	
Project Title: water ingress in M60 Headlamp	
Problem Statement: water leakage in the M-60 Module low beam headlamp	
Team Members: Rohit guria, rohtash kumar, shrey mehta, arjun chaudhary, sandeep, puneet	
Goal Statement: To reduce the leakage in the M-60 Module low beam headlamp	
Stake holders : Employees of TQM Facilitation & Industrial Engg. Deptt.	
Experts Head – TQM Facilitation & Industrial Engg Deptt., Sr. Managers	
Project Milestones :	
Define phase :jan. 22 to feb 18 2017	
Measure Phase : feb 19 to march. 15, 2017	
Analyze Phase : mar 16 to Apr 11, 2017	
Improve Phase : .Apr 12 to May 2, 2017	
Control Phase : May. 3 to June. 4, 2017	

Table-1 Project charter

In the (**Table-1**) The business case, goal as well as problem statement have been included in the project charter in the beginning phase of the DMAIC. It gives the path for other phase and helps to know what actually upon which thing we need to focus.

2.2.1 SIPOC Diagram:

In SIPOC process map The Detail study of the whole process of manufacturing is described step by step that helps in finding out the key area of critical problem

Table-2 SIPOC Process

supplier	input	process	output	customer
source from where the child parts are coming	store and electricity	cleaning of the reflector component in zeta coating area → metalizing of the reflector component → plasma of the the child parts → gluing on the child parts → manual pressing of the components after gluing → water test of the component assembled	M-60 Low Beam Headlamp	Escorts

2.2 MEASURE PHASE

In this second phase, The process capability tool that will be used to measure the number of non-conforming that doesn't meet the specifications defined by the customer needs. The process capability analysis answered following questions:

- Is the process meeting customer expectations?
- Were the improvements needed in the process?

With the help of process capability analysis we can know in which fixture the gluing is not done in a proper way. **Figure-2** shows the fixtures marked (A, B, C, D) on which the reflectors are placed for gluing.

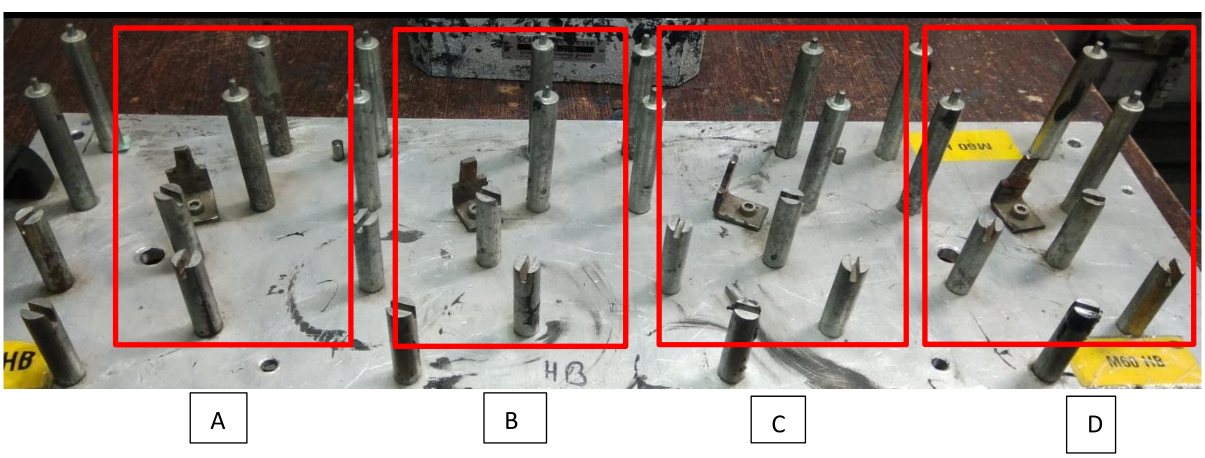


Figure-2 Old fixture

GLUE WEIGHT- 12+2 grams is the specification which is being kept and data was being collected for all the four fixtures and capability analysis was done to know in which fixture the quantity of glue is least.
In the **fixture 3** the sample mean is within the specification limits that indicates that the gluing is done in a very proper way

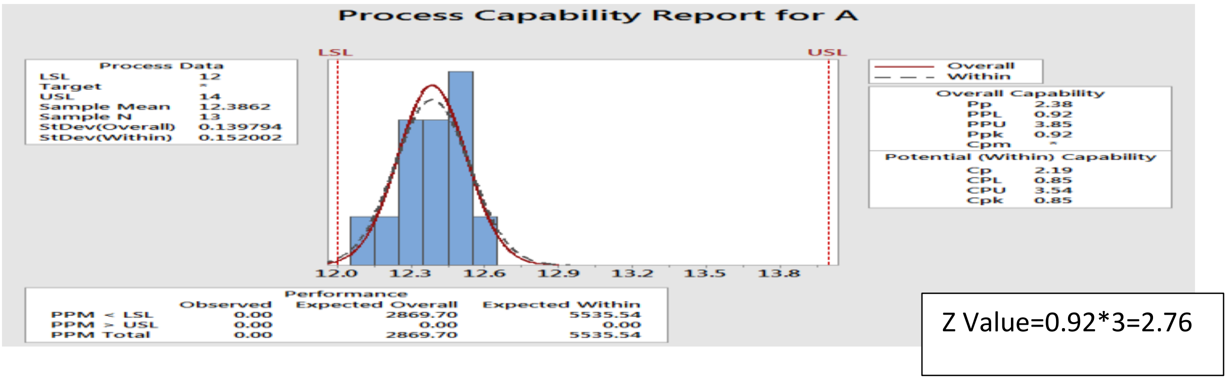


Figure-3 process capability report for fixture-A

In the **fixture 4** the mean is within the specification limits so that also indicates that the gluing is done in a proper way.

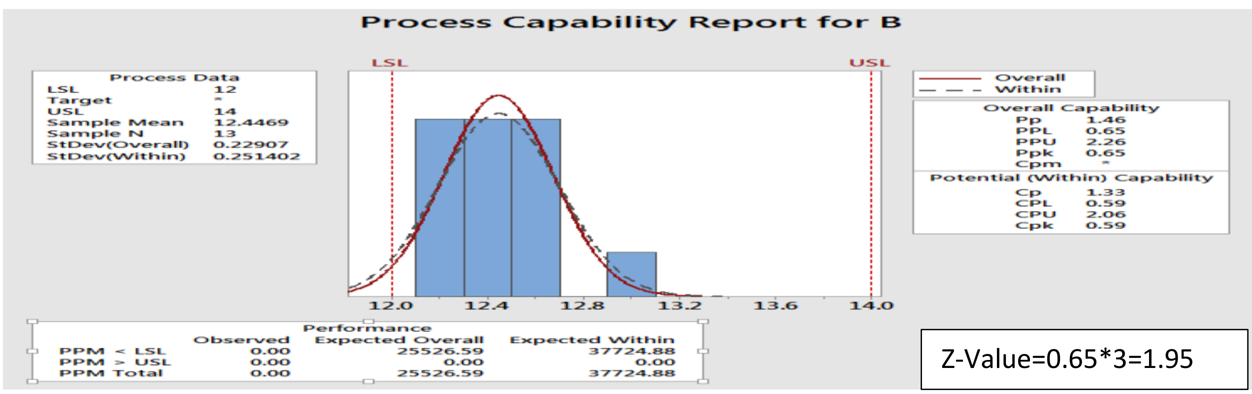


Figure 4 process capability report for fixture-B

In the **Figure 5** the sample mean was still within the specification limits that also implies that gluing is being done in a proper way

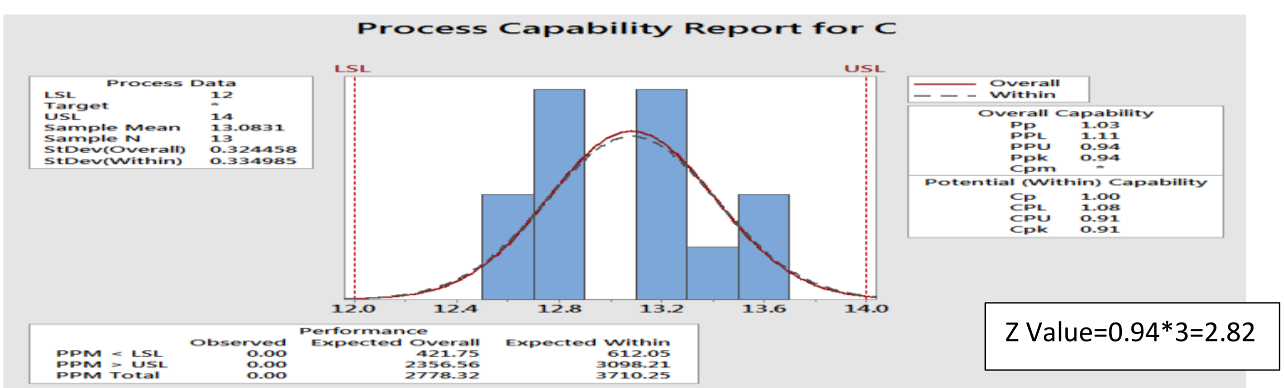


Figure-5 process capability report for fixture-C

In the **figure 6** the sample mean is found to be less than the specification limits that indicates that in fixture D the glue content is being less as compare to other fixtures leading to non-conforming of the product.

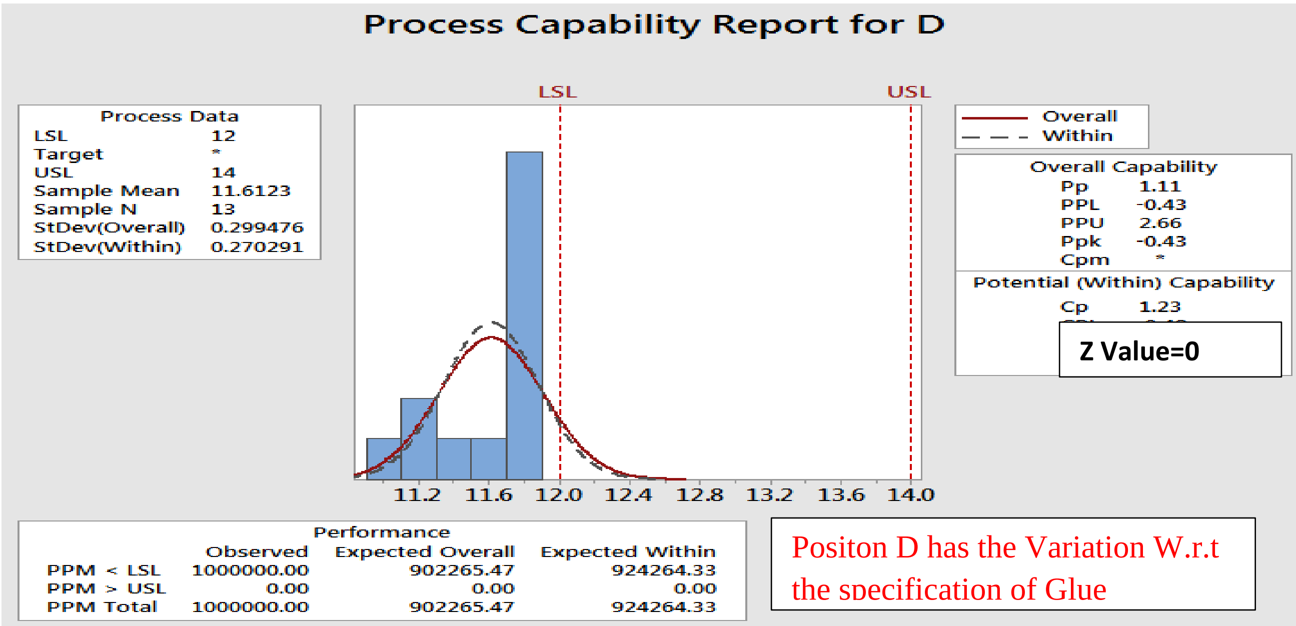


Figure-6 process capability report for fixture-D

According to the process capability analysis it was found that the Fixture D has a variation with respect to the specification of Glue since the specification limits lies within (12-14). So in Fixture-D its coming around in 11. So this variation is needed to be reduced.

2.3 ANALYZE PHASE

In the third stage of the DMAIC cycle an analysis was made with the information obtained using quality Tools such as process mapping, Cause & Effect Diagram. Initially determined and recognized reasons for the purpose of finding which factor has relatively affect. After the Detail study of the critical causes of the defective low beam module cause and effect diagram was made. Process mapping was done for the different process including glue and assembly parts.

PROCESS MAPPING

KPIV VS KPOV – Gluing Process (Y=F(X)) – Relation

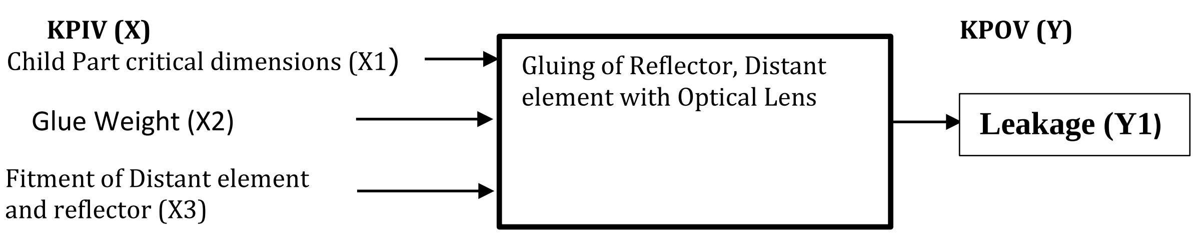


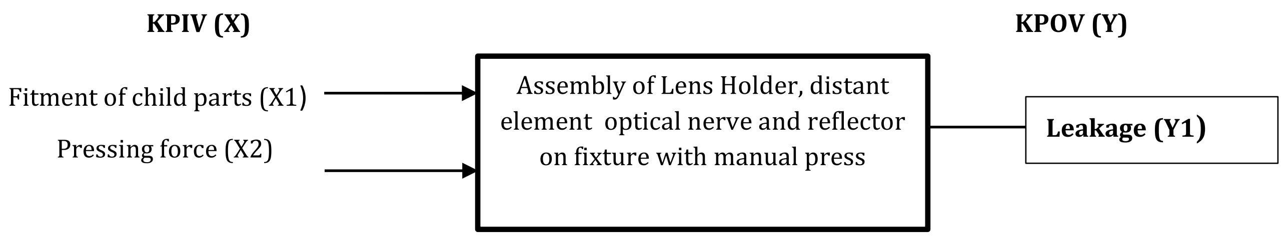
figure-8 Gluing process relation

KPIV Prioritization Table – Scale 1,3.9

KPIV's	Rohit	Raman	Abhi	Overall Rating
Child Part Dimensions	9	9	9	27
Glue Weight	9	6	9	24
Fitment of Distant element and reflector	6	6	6	18

Table-3 Prioritization table

KPIV VS KPOV – Assembly of Child Parts(Y=F(X)



KPIV Prioritization Table – Scale 1,3

KPIV's	Rohit	Raman	Abhi	Overall Rating
Fitment of Child Parts (X1)	9	9	9	27
Pressing Force (X3)	6	6	6	18

Table-4 Prioritization Table

This factor can also be consider as if the child parts are not fitted properly so chances of leakage can occur and if they are not properly press then the same issue can be seen.

KPIV vs KPOV – Glue Curing(Y=F(X)) Relation

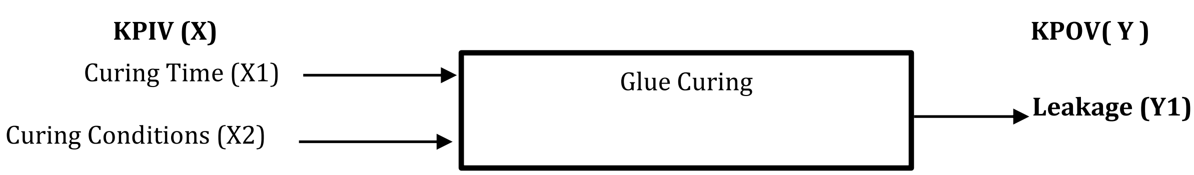


Figure-10 Glue curing relation

KPIV Prioritization Table – Scale 1,3,9

KPIV's	Rohit	Raman	Abhi	Overall Rating
Curing Time (X1)	9	9	9	27
Curing Conditions (X2)	9	9	9	27

Table-5 Prioritization Table

Curing Temperature and Time

Parts after Gluing cured for 4 hours in ambient temperature and 2 cured parts for 15 minutes in Oven at around 80 degrees to check for any Leakage Failure from the Lamp
Parts after Curing both at Ambient temperature and oven have been checked in Water for leakage and found to have zero leakage in water hence it is not a cause of failure
Curing time is being controlled through check sheets and further checked through leakage tester hence not a cause of failure.

Cause & Effect Diagram

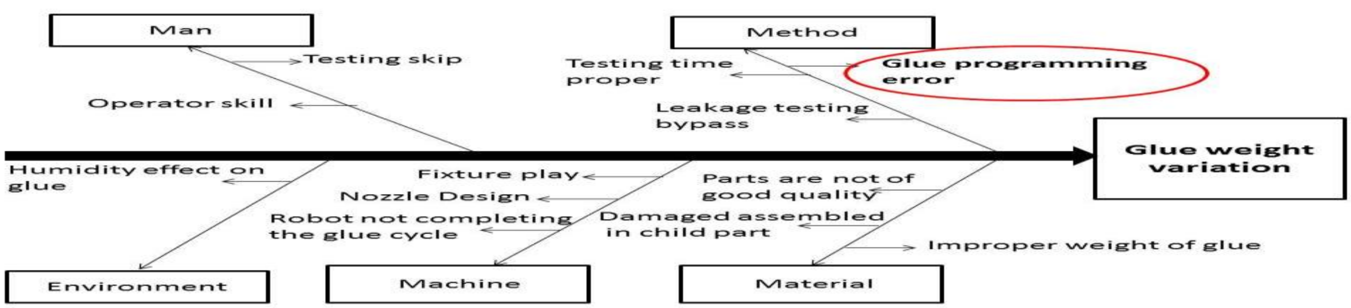


Figure-11 Cause & Effect diagram

Glue Weight variation resulted because of the **Glue programming error** generated within the gluing program w.r.t the Robot speed.

2.4 IMPROVE PHASE

In this stage it was observed that as comparison with the other factors the Glue programming is the most critical to the defect as shown in the fishbone diagram. With the large variation in the glue programming, the final product would have large variation. So as to remove this defect, necessary improvements were implemented in the process where gluing was done.

It was observed that in some of the parts gluing was present in excess and in some it was done in a lesser quantity. So the product with less glue were found to have water vapors when gone for the water test which was leading for more number of raw materials which in turn leading to the increase in the cost factor of final product. The following necessary improvement were implemented.

1. Glue weight will be optimized for Position D to have glue with in specification of 12 + 2gm and the program error to be corrected
2. Air blowing gun will be used on assembly station to clean the parts before Gluing operation to remove foreign particles if any
3. New fixture will be introduced with new programing
4. Leak Testing time needs to be optimized, if required
5. Next production parts will be monitored with fixture wise marking 1-4 and same will be shared to Escorts with analysis
6. Parts produced for next six lots will be checked 100% under Water testing after air leakage testing to establish leakage issues if any.

2.5 CONTROL PHASE

In the final stage of DMAIC process a revision of the originally stated goals is completed, to observe if the goal is achieved otherwise, to analyze the reasons why it was not possible to achieve the goal set and propose a new goal because it is a process of continuous improvement, so pretend it is not advisable to get a Six Sigma level at a single event.

So to control this issue following steps were taken:

1. Setup verification / In Process Inspection Check sheet Modified for leakage testing was done in water
2. Control Plan, PFMEA related document were modified.
   So around **360** components were tested after the improvement phase out of which none of the component was found to have any issue related to the leakage during the water test.

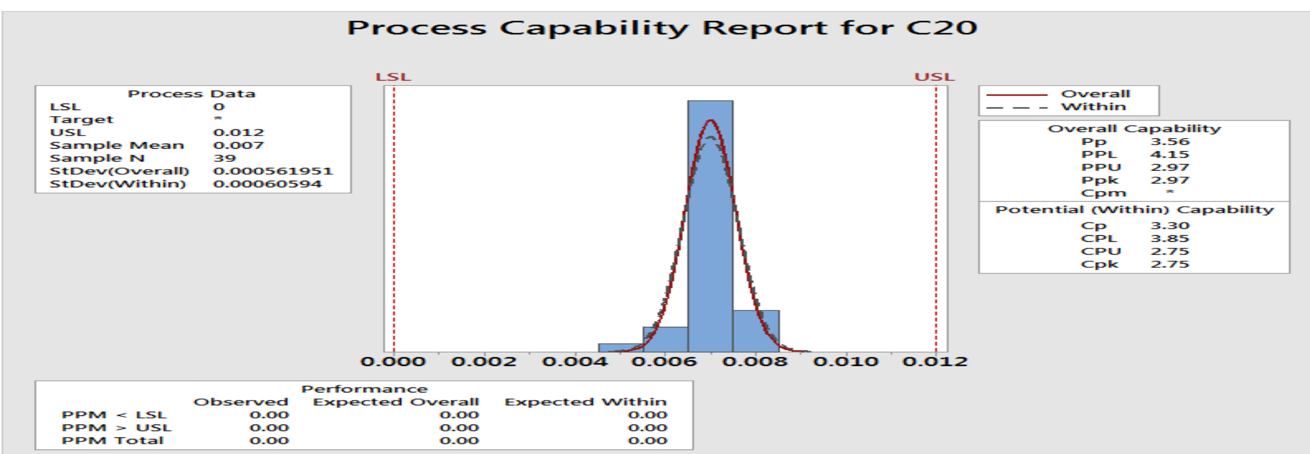


Figure-12 Improvement in process capability report for fixture-D

3. CONCLUSION:

With the implementation of the successful application of Six Sigma in HELLA India Lightening Limited, the issue was resolved. The benefits resulted in

- The overall profit to the company.
- The reduction in the number of defective low beam module headlamps

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