IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 9, Issue 9, September 2020

DOI 10.17148/IJARCCE.2020.9905

Analysis of Automobile Industry: Six Sigma Approach

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Abstract:Six Sigma is a method that provides organizations tools to improve the capability of their business processes. This increase in performance and decrease in process variation helps lead to defect reduction and improvement in profits, employee morale, and quality of products or services. In the era of cut-throat competition, especially in automobile sector, success of an organization resides in its ability to respond quickly to the needs of its customers. These customer needs must be attended with minimum manufacturing costs, minimum lead time to launch the product in market, and delivering better performance than the existing competitors in the market. Six Sigma is a powerful methodology which ultimately helps in cost reduction. Because of defect prevention and improved product and processes, it leads to increase in profitability and market share. This is accomplished through the use of two Six Sigma sub-methodologies. By adopting Design For Six Sigma methodology in the design stage itself leads to launch of a product with maximum quality performance, with tighter tolerances, and with reduced or no defects. This paper considers cost of poor quality as the loss imparted to society from the time the product is shipped, and deals with the applications and benefits of Six Sigma methodology and its positive impact on cost of poor quality. A case study is presented, which enabled application of six sigma methodology in wider range of manufacturing activities. This paper is of value to the researcher in the field of quality management, as well as professionals in the manufacturing industry, wherever the quality improvement is an issue. Quality costs or Cost of Quality is a means to quantify the total cost of quality related efforts and deficiencies. 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. A case study is carried out in automobile casting industry, where Six Sigma tools i.e. Taguchi approach for the defect reduction is applied, which analyses various significant process parameters of the casting process at a foundry, based at north India. This study aims to develop a novel approach to create Six Sigma projects and identify the critical parameters of these projects. The optimized parameters obtained using Taguchi method will then be tested in an industrial case study and a trade-off will be made to finalize the recommended process parameters used in manufacture automobile parts.

Keywords:Define Measure, Analyse, Improve and Control (DMAIC), Quality costs or Cost of Quality, Taguchi approach, Six Sigma, automobile parts, minimum manufacturing costs, minimum lead time and increased market share.

I.INTRODUCTION

Six Sigma is a quality-control methodology developed in 1986 by Motorola, Inc. The method uses a data-driven review to limit mistakes or defects in and process. Six Sigma emphasizes cycle-time improvement while at the same time reducing manufacturing defects to a level of no more than 3.4 occurrences per million units or events. In other words, the system is a method to work faster with fewer mistakes. True believers and practitioners in the Six Sigma method follow an approach called DMAIC which stands for Define, Measure, Analyse, Improve and Control. It is a statistically driven methodology that companies implement as a mental framework for business process improvement. The ideology behind DMAIC is that a business may solve any seemingly unsolvable problem by following the DMAIC steps. Figure 1 shows the DMAIC methods in Six Sigma.

1. A team of people, led by a Six Sigma champion, defines a faulty process on which to focus, decided through an analysis of company goals & requirements. This definition outlines the problem, goals, & deliverables for the project.
2. The team measures the initial performance of the process. These statistical measures make up a list of potential inputs, which may cause the problem and help the team understand the process's benchmark performance.
3. Then the team analyses the process by isolating each input, or potential reason for the failure, and testing it as the root of the problem. Through analysis, the team identifies the reason for process error.
4. From there, the team works to improve system performance.

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5. Finally, the team adds controls to the process to ensure it does not regress and become ineffective once again.

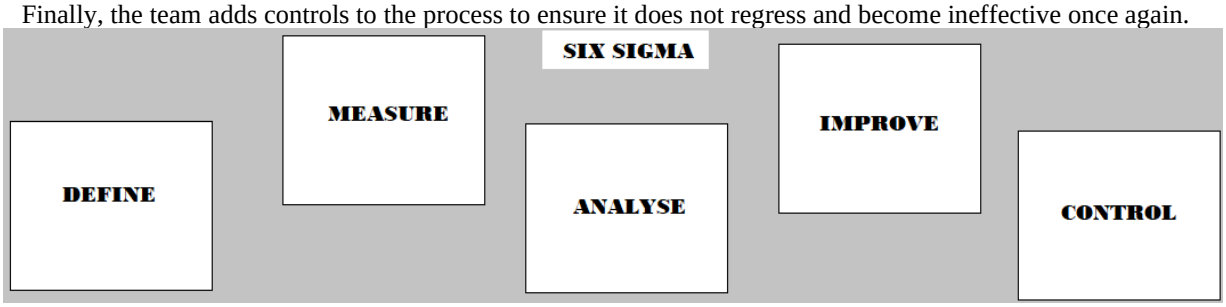

Figure 1 shows the DMAIC methods in Six Sigma.

II.MOTIVATION

A Six Sigma philosophy generates top box customer satisfaction and repeat customers by reducing the cost of products because it is based on the principle, "Do right the first time". Six Sigma is a set of statistical tools to help companies to measure, analyse, improve and control processes. It is also a commitment to all customers and consumers of products and services that an organization continually works on improving its products and processes to reduce the defects. Six Sigma also provides an atmosphere for solving many CTQ (critical-to- quality) problems through team efforts. CTQ could be a critical process/product result characteristic to quality or a critical reason to quality characteristic.

III.CASE STUDY OF MSIL

Maruti Suzuki India Limited (MSIL), the country's largest passenger cars manufacturer has implemented principles of Poka Yoke, TQM and by extension, 6σ principles since its inception in 1984. MSIL started a programme called Maruti Centre for Excellence (MACE) – involving 21 of its component vendors -- to replicate best practices from the shop floor of MSIL which translates into better quality and better productivity, to combat the issues of recalls and defective components that other car manufacturers were facing. MACE was started with a corpus fund of ₹10 crore from MSIL and the vendors contributing ₹25 lakh each and identified areas where the vendors can improve in quality on global levels and also follow some parameters of operations. The company helps the suppliers deploy lean processes to improve productivity and reduce resource wastages. There are four main activities -- training, audit, implementation and up-gradation of smaller vendors who supply to these tier-I suppliers so that the quality is maintained in the chain of products. Based on some basic requirements, MSIL decides on certain topics and train both blue collared as well as the white collared employees in the vendors' factories. Then, the team audits which quality systems are to be followed in every operation. For every operation, there is a prescribed way of doing it as the quality standard is the backbone of the company in how it operates. It is the implementation of lean manufacturing system at its vendors -- based on what Maruti has in-house production systems -- based on Suzuki Motor Japan and Toyota Quality Management (TQM), [1] [2] which means improving the productivity, eliminating the waste and reducing the defects. The company through implementing lean manufacturing systems has 720 projects completed so far for productivity improvement, quality, inventory control and energy conservation. MACE has worked with 146 tier-II vendors for overall improvement in performance resulting in reduction in rejections from 10,933 to 1,180 products per month and defect reduction from 432 to 146 per month. The MACE program also aims at achieving Zero Defects and has been successful. It has been able to address the issue of ensuring high quality even at the hands of contract labourers. One of the steps taken was the installation of visual and audio alarms at the production lines which would go off whenever a worker took an incorrect component during assembly. Through such programmes, many of its vendors have now got 'zero rejection' in its parts and wastage is also controlled. For example, part of the MACE since its inception, Superfine Components is been supplying parts to MSIL with zero rejection, continuously over the last three years. MSIL through MACE sends its counselors to other factories as part of the MoU with Ministry of Micro, Small and Medium Enterprises (MSME). MACE has also become part of Quality Council of India for such activities and has tied up with Kaizen Institute India in Ahmedabad, Gujarat. [3] [4]

IV.DMAIC APPROACH

A. Define Phase

1. The main material used in manufacturing the inner wheel housing part is cold rolled continuous annealed steel material in the form of metal sheet.
2. These metal sheets are bought from their vendor companies mainly from Tata Steel, Bhushan Steel and Essar etc.

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3. Major steps for making the inner wheel housing part, we have to do various operations on the metal sheets in different compartments or shops
   - Drawing (Press Shop)
   - Trimming & piercing (Press Shop)
   - Trimming & Cam piercing (Press Shop)
   - restrike & parting operations (Press Shop)
   - Projection and Spot welding (Weld Shop)

B. Measure Phase

1. All the finished inner wheel housing parts were tested for quality by using visual inspections.
2. Mainly three types of inspections are conducted on all the parts before dispatching to customers.
   - On processing visual inspection
   - fitment inspection by manually checking fixture
   - pre- dispatch visual inspection
   - Data on the basis of these inspections was collected for 10 months.
   - Out of the 283470 units tested, 283305 units passed all the tests and 165 failed in tests.
   - major defects come mainly due to poor environmental condition regarding to sheet metal parts, press & welding failure are in

(a) Red rust
(b) Nut out
(c) Part bend or damage
(d) Spot Dent
(e) Part mismatch
(f) Spot Burn
(g) Cracking & Necking
(h) Welding offset

C. Analyze

1. The Pareto diagram and Line diagram reveals major defect is red rust appearance on sheet metalpart.
2. This defect occurs on metal sheets mainly due to a long contact with moisture air.
3. This type of defect comes under appearance related category.
4. This defect may be produced on both raw material sheets and manufactured parts which may be easily known only by visual inspection.
5. The potential failure mode of inner wheel housing parts due to red rust are:-
   - Rusty sheets metal part gives a red appearance which indicates that corrosion must be produced on partsThroughout the life.
   - Part will become functionally weak in strength after some time
   - Part life will become small as compare to others
   - Other defects may have occurred like cracks in part
   - Painting defects will occur
6. These potential effects of failures occur on the surface of inner wheel housing parts which is very critical mainly for maintenance, accidental & safety purposes throughout the life.
7. If we are able to eliminate the major failure which may be occurred due to red rust, the defective level can be brought down to 0.0243 % from the present level of 0.0582%.
8. The principle of Pareto diagram also states that investment in improvement of vital few yields better than compared to investment in trivial many. Hence inner wheel housing defect, red rust appearance on sheet metal surface was taken up for investigation.
9. The major causes for red rust appearance was:-
   - Lacking of awareness regarding to inventory stock.
   - Store supervisor negligence or improper arrangement of raw material sheets in inventory stock.
   - Raw material storage in open space
   - Due to bad environmental condition like rain.
   - Due to moisture presence in surrounding of raw material.
   - Storage method not good.
   - More carbon presence in component

D. Improve

1. The causes for red rust were analyzed and found that it is due to the bad environmental conditions like due to rain and moisture air only.

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2. The material used is high quality cold rolled continuous annealed steel sheets as a raw material bought from their reputed vendor companies, mainly from Tata Steel Ltd. and others. Firstly, this raw material must be deeply examined before it is introduced in the manufacturing process. Hence defects due to material will be ruled out.
3. The improvement can be brought into the product by using anti rust oil spray techniques on raw material if necessary, before introducing in manufacturing process by which we can improve quality of our product.
4. If only the red rust appearance failure in inner wheel housing parts were eliminated, the improvement in Sigma level will be from 5.393 to 5.5.

E. Control

NEW DPMO = (69* 1000000)/ (8* 283470) = 30

1. Sigma level of Approximately 5.5 Defective level can also be brought down to 0.0243% (From 0.0582 %).
2. Once the solution is implemented, the next step is to place the necessary control to assure that the improvements are maintained long-term. This involves monitoring the key process metrics to promote continuous improvement.

Measure Phase

Defects per Million opportunities:-

DPMO= (165 * 1000000)/(283470 * 8)

= 73

i.e Sigma Level of Approximately 5.393

Conformance Level (%)	Defects per Million opportunities	Sigma Level
30.85	691500	1
69.15	308500	2
93.3	66800	3
97.73	22700	3.5
99.38	6200	4
99.795	2050	4.375
99.87	1300	4.5
99.94	600	4.75
99.977	230	5
99.997	30	5.5
99.99966	3.4	6

$$DPMO = \left(\frac{\text{total number of defects found in a sample}}{\text{total number of defect opportunities in the sample}}\right) \times 1{,}000{,}000$$

Figure 2 shows the tabulated results of sigma and DPMO

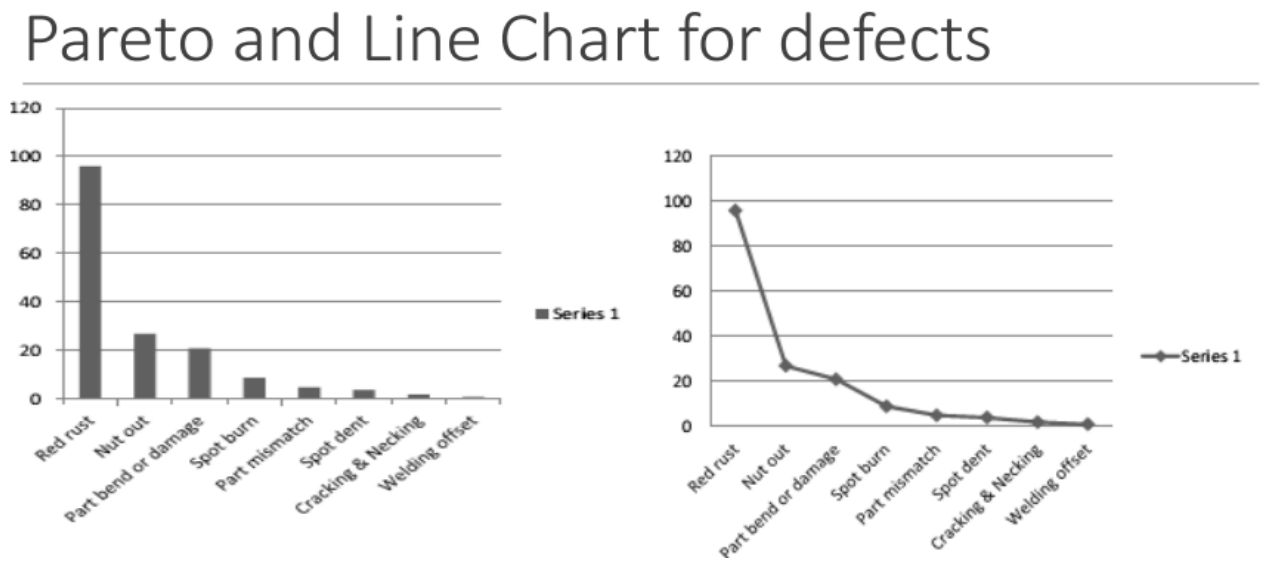

Figure 3Shows Parteo and Line chart for defects

V.CONCLUSION

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Pareto diagram revealed major failures in red rust appearance test. 58.18% inner wheel housing parts failed in red rust appearance test. Substantial improvement in the process can be achieved through the elimination of red rust appearance failures. Reasons for red rust appearance failures were identified and solutions were recommended to the management for improvement. This may improve the process from Sigma level of 5.393 to 5.5. [5] [6]

VI.FUTURE ENHANCEMENTS

Business Intelligence combined with Six Sigma procedures can predict the business in the automobile industry. [7]Business Intelligence (BI) platforms help organizations aggregate and report on data from a wide range of sources. Users of BI platforms can create reports and dashboards that help them gain insights based on their data. For example, a car business (Automobile segment), consists of many manufacturers doing business in the market. They can track the contracts each month, and then use its CRM data to identify which VEHICLE type gives them the most business. Using a business intelligence platform, a user can create a report from this data that will help the business make more informed decisions on the types of clients to advertise to. We have identified several fields in the data set [8]

- Engine size
- Engine power
- Sale amount
- Resale amount
- Vehicle type
- Total price in units
- Manufacturer

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