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Implementation of Six Sigma Principles to Improve Supply Chain and Assembly Process

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Abstract - *This study focuses on the importance of the six sigma methodology and implementing of its concepts in supply chain and assembly process of a local automotive industry. The continuous improvement of the quality would be to fully satisfy the need and expectations of the customer. The goal of six sigma is defining, analyzing and improving the variables, which may affect the quality of assembly and supply chain process in order to decrease the number of defects and the failures for improvement of the process. The possible solutions were provided using lean six sigma strategies like DMAIC (Define, Measure, Analyze, Improve, and Control), Cause and Effect diagram, PDCA (Plan, Do, Check and Act), One point lesson, Factor tree analysis etc. tools and techniques. The implementation of proposed solutions have resulted in reduction of non-value added processes in supply chain and assembly line of an automotive industry*

***Key Words*: Cause and Effect diagram, Factor Tree Analysis, PDCA, Process capability, Six Sigma**

1. INTRODUCTION

Six Sigma is a methodology used by organizations all around the world to detect and eliminate defects in any process being followed by the organization. To achieve a six sigma for a process it should not have any defect that is beyond customer specification. Six Sigma has two sub methodologies. DMAIC used for existing processes and DMADV which is used for new processes. DMAIC refers to the five stages of Define, Measure, Analyze, Improve and Control. DMADV stands for Define, Measure, Analyze, Define and Verify.

1.1 Process Capability and Process Capability Index

Cpk (Process capability index) is a statistical tool, to measure the ability of a process to produce output within customer's specification limits. The value should be greater than 1.67 to check whether the process is in center or not.

Cp (Process Capability) is a statistical measurement tool of a process's ability to produce components within specified limits on a regular basis. The value should be greater than 1.33.To determine how our process is operating, we can calculate Process Capability and Process Capability Index.

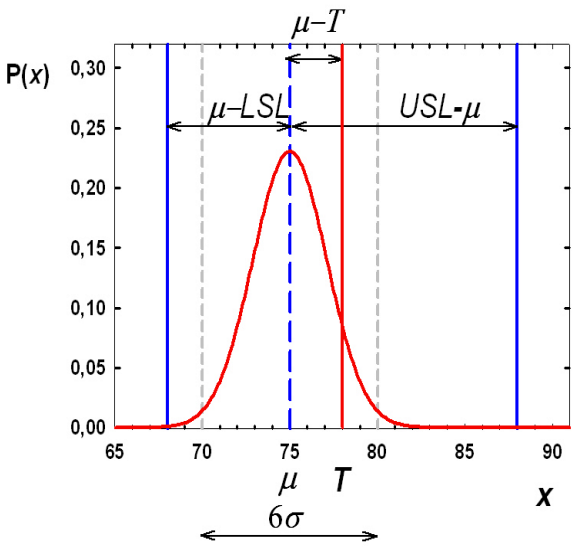

Fig-1: The statistic process

Where, LSL-Lower Specification Limit; USL-Upper Specification Limit; T- Tau Midpoint; μ- X bar; P(x)- Intervals

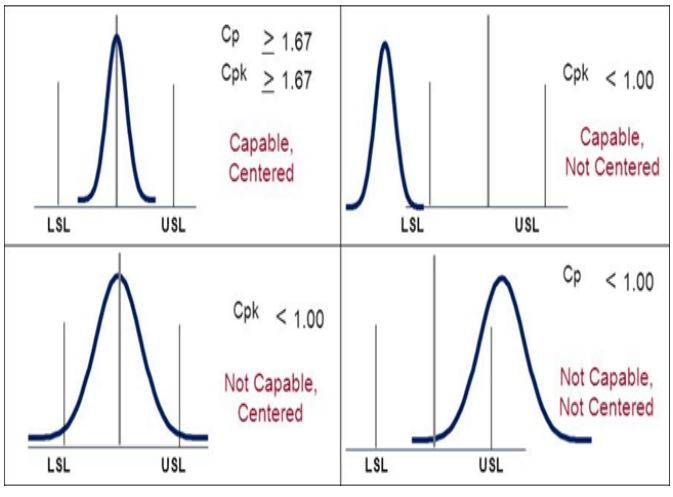

Fig-2: Various statistic process

If the value of Cp and Cpk is >= 1.33/1.67 the process needs no correction hence it is capable centered.

Advantages:

- Process capability can have large impact on supply chain.
- Process is used to track and compare process capabilities across the entire supply chain.
- Cp and Cpk are influenced by unit operation complexity
- Useful in detecting problem of a product at a supply chain level.
- Useful in identifying problem materials and suppliers for remediation

2. RESULTS AND DISUCSSION

2.1. Cause-and-Effect Diagram

The Cause-and-Effect Diagram helps organize ideas and understand the relation between potential causes and an effect on the process by organizing potential causes into categories and sub- categories in preparation for a cause the identification. It helps stimulate ideas when developing the list of the potential causes of a problem.

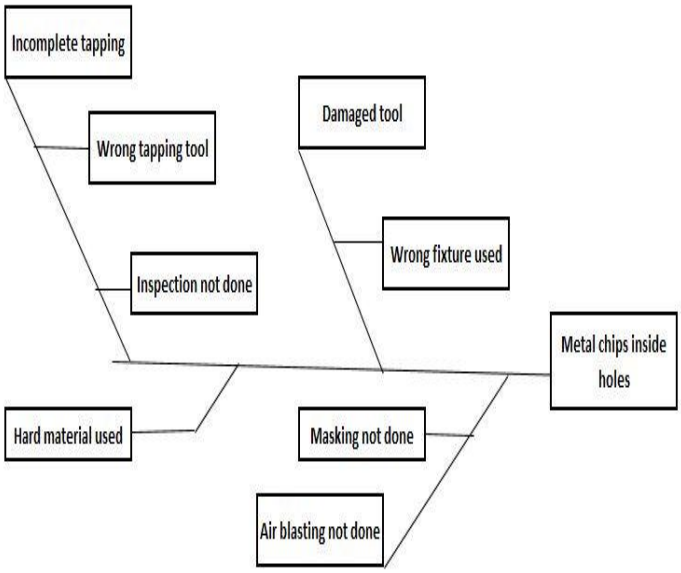

Fig-3: Cause-and-Effect Diagram 1

Over the span of a year the rejections was observed and this problem "Metals chips inside holes " was seen many times and has caused rework several times. So, root cause analysis was performed .The above diagram 1 categorizes the causes into four categories - Man; Machine; Method; Material. The problem was found out to be caused by method followed.

The diagram 2 below depicts the cause and effect diagram for 5S and 3T principles not being maintained by a vendor of this automotive industry.

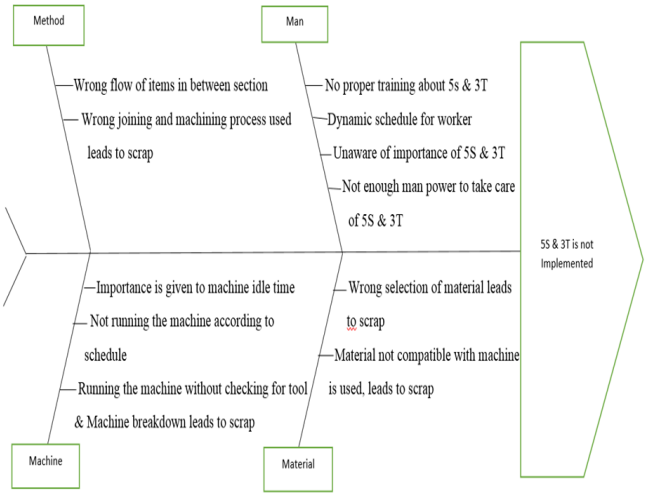

Fig-4: Cause-and-Effect Diagram 2

2.2. Pareto Charts

Pareto chart is used to categories the contributors which make the largest impact on a problem. A Pareto chart is a tool to focus attention on priorities while trying to make decisions. It is a good statistical tool that describes the data in a simple bar diagram. The chart helps to study and analyse the frequency or occurrences of an event in a process and identify the biggest contributors. These diagrams communicate the principle of 80:20. It depicts that 80% of an effect comes from 20% of the potential causes. In the below Pareto chart, parts rejection data of the previous year has been analysed and the potential reasons have been again sub-categorised into Man, Machine, Method, Material and Management.

	Frequencies	Cumulative relative frequencies %
MAN	8	40
METHOD	5	65
MATERIAL	3	80
MACHINE	2	90
MANAGEMENT	2	100

Chart -1: Pareto chart data

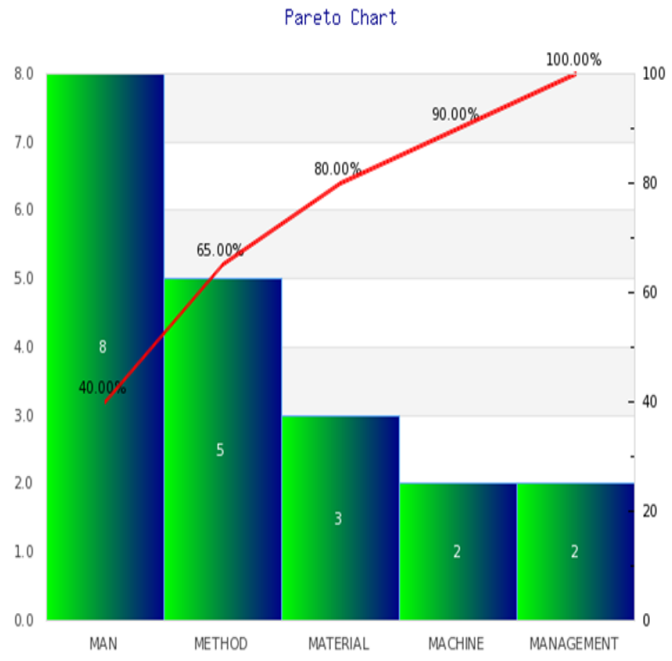

Fig-5: Pareto chart

2.3. One Point Lesson

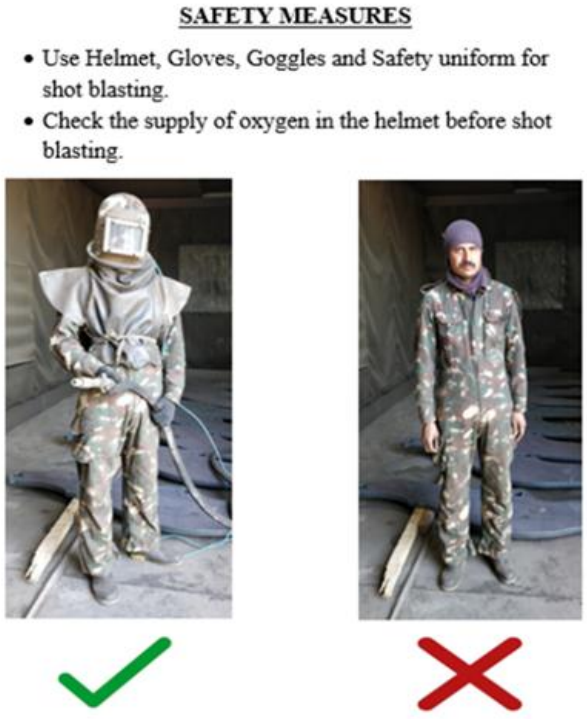

Fig -6: One Point Lesson

One point lesson (OPL) is a visual and operational tool used to educate workers in an organization for the improvement of a product or a service quality. The important point of learning of a particular process is written in one to two sentences, along with the simplified but explanatory images or pictures.

The above one point lesson is created for the workers at the industry to educate them regarding the safety measures to be followed during shot blasting which includes wearing of safety equipment.

2.4. Process Capability

The capability factors can be determined and calculated by manually and even by some software's available. For this example we will make use of software Excel which can be used to determine the Statistical Process capability. A few things need to be remembered are:

- Our data is quantitative and variable
- Our data consists of 50 measurements
- The target dimension is 48.995mm
- USL (Upper Specification Limit) = 49.001 mm
- LSL (Lower Specification Limit) = 48.989mm
- Range = 0.006 mm

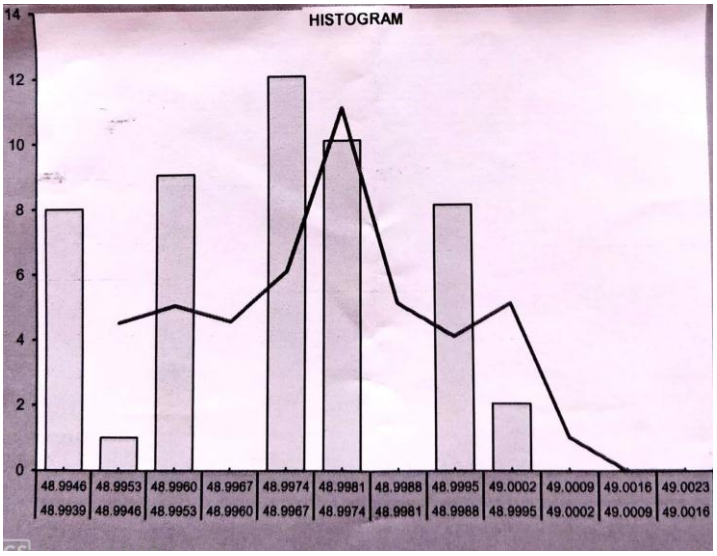

Fig-7: Mean value of the readings of sample dimensions

By this calculations we obtain the graph, we can further evaluate process capability by comparing the spread or range of the product specifications to the spread of the process data, as measured by Six Sigma (process standard deviation units).Hence, the above obtained value of Cp and Cpk is 0.96830 and 0.68020 which is less than 1.33 hence the process needs correction.

INTERVAL		FREQ.	CU. FREQ.
48.9939	48.9946	8	8
48.9946	48.9953	1	9
48.9953	48.9960	9	18
48.9960	48.9967	0	18
48.9967	48.9974	12	30
48.9974	48.9981	10	40
48.9981	48.9988	0	40
48.9988	48.9995	8	48
48.9995	49.0002	2	50
49.0002	49.0009	0	50
49.0009	49.0016	0	50
49.0016	49.0023	0	50
U.C.L.XBAR	=	48.99923375	
L.C.L.XBAR	=	48.994366	
U.C.L.RBAR	=	0.00870375	
L.C.L.RBAR	=	0	
Std.Dev."s"	=	0.00208	
Cp=(S/6s)	=	0.96830	
Cpk={1-K}xPp)	=	0.68020	

Fig-8: Calculated value of Cp and Cpk

2.5. PDCA

The Plan–Do–Check–Act cycle is a four-step tool for carrying out change or to improvise an existing process. It is a cyclic process and has no end, the PDCA cycle should be repeated again for continuous improvement and needs to be standardised. The Plan-Do-Check-Act cycle is considered a project planning and improvement tool. The below chart was developed for the improvisation of the existing assembly process at the industry so as to increase the efficiency of the assembly process and reduce the cycle time of each product.

Use the PDCA cycle when:

- Starting a new improvement project
- Defining a repetitive work process
- Plan for the collection of data and analyse in order to prioritize the problems and their root causes
- Implementing any change
- Working toward continuous improvement

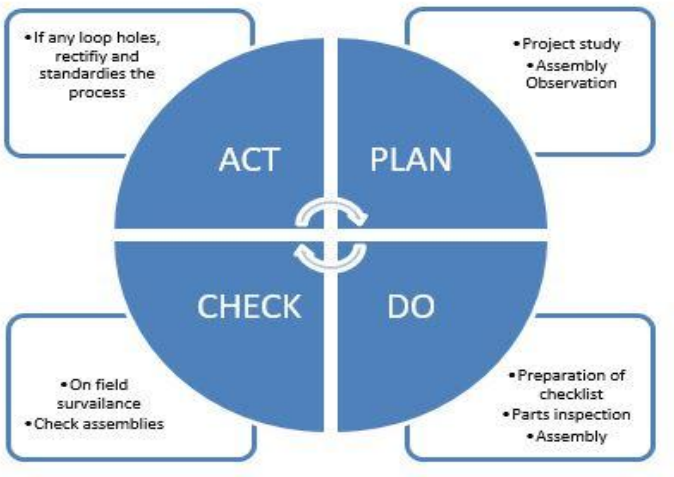

Fig -9: PDCA chart

3.6. Factor Tree Analysis

Factor tree analysis is basically prepared to know about multiple reasons which are responsible for the defects, the preventive action what should be taken care in order to overcome those Defects. In the below factor tree the factors effecting the shot blasting is analyzed and their potential factors at different stages have been noted.

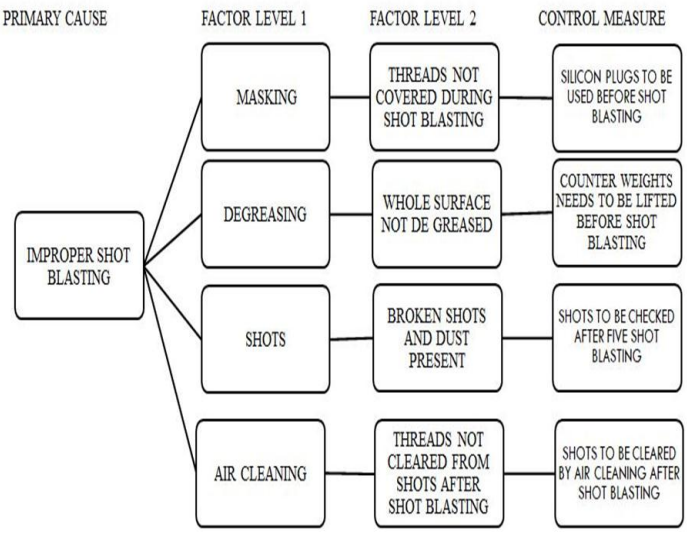

Fig -10: Factor Tree Analysis

4. CONCLUSIONS

As a result of the conducted study, six sigma methodology is being adopted in all departments of the organization. The first step taken in the Six Sigma tools and strategy resulted in the increase of the productivity of the organization. Within the scope of six-sigma implementation, the relevant potential and real time defects have been found and analyzed through

statistical methods and real time causes of the defects have been found, documented, reduced and arranged in order of priority to be solved. The result is the product which fulfils the customer needs in the effective manner. To conclude, one point lessons for visual improvements and Pareto diagrams have been generated on the found causes and improvement actions are being recommended for initiation by the organization

REFERENCES

[1] Pugna, A., Negrea, R., & Miclea, S. (2016). Using Six Sigma Methodology to Improve the Assembly Process in an Automotive Company. Procedia - Social and Behavioral Sciences, 221, 308–316. https://doi.org/10.1016/j.sbspro.2016.05.120

[2] Bloj, M.-D., Moica, S., & Veres, C. (2020). Lean Six Sigma in the Energy Service Sector: A Case Study. Procedia Manufacturing, 46, 352–358. https://doi.org/10.1016/j.promfg.2020.03.051

[3] Krishna Priya, S., Jayakumar, V., & Suresh Kumar, S. (2020). Defect analysis and lean six sigma implementation experience in an automotive assembly line. Materials Today: Proceedings, 22, 948–958. https://doi.org/10.1016/j.matpr.2019.11.139

[4] Costa, J. P., Lopes, I. S., & Brito, J. P. (2019). Six Sigma application for quality improvement of the pin insertion process. Procedia Manufacturing, 38, 1592–1599. https://doi.org/10.1016/j.promfg.2020.01.126

[5] Pereira, M. T., Bento, M. I., Ferreira, L. P., Sá, J. C., & Silva, F. J. G. (2019). Using Six Sigma to analyse Customer Satisfaction at the product design and development stage. Procedia Manufacturing, 38, 1608–1614. https://doi.org/10.1016/j.promfg.2020.01.124