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Case Study

Minimizing Product Rejection in Small Scale Industries using Six Sigma Approach-A case study

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Abstract

Six sigma is an approach to improve manufacturing process continuously. It is a disciplined and data driven approach for eliminating defects whose main purpose is to minimize the deviation between mean and target values. The numerical goal is to is to reduce defects less than 3.4 parts per million (PPM). Also known as defects per million opportunities (DPMO), reducing cycle time and reducing cost dramatically. In the present investigation, six sigma quality philosophies has been used in reduction of weld line defects in automobile tail light manufactured at Hella india lighting limited. In order to study the problem a research has carried out with the help of an engineer, by study of the six sigma and PDCA philosophies and other reference for this analysis and research method. This process include study of "Weld line" rejections utilising quality control tool, to identify the root cause of the "Weld line" rejects and to recommend action to improve the weld line reject. Before using six sigma programs, company was working at a sigma level of 4.0952. After the implementation of six sigma program sigma level was increased to 4.207, which implies that a considerable decrease in weld line defect has been achieved.

Keywords*: six sigma, DMAIC, automobile tail light, defects, variations*

What is six sigma and why to use it

Six sigma is a quality tool that was developed by Motorola Corporation to achieve the world class product quality. It is a quality philosophy that tends to minimize the defects by minimizing the variation from the target values (Park et.al, 2000). It measures the process variations that causes defects in the product and subsequently leads to the rejections. Six sigma tends to reduce defects to almost zero value (Bellows, W.2004). It has wide range of application in the fields of banking, accounting and finance, sales and marketing, engineering, production, health and care etc (Young H. Kwak 2006).

Six sigma is a newer quality approach which is widely replacing the TQM, TQC and other quality approaches. It is quite useful in those firms in which above mentioned techniques have not been found successful. In this investigation, it would be implemented in order to identify the current problem or rejection criteria facing by the company. The six sigma philosophy is used because, it provides a step by step quality improvement methodology and uses statistical methods to quantify variation (Kaushik P. and Khanduja, D 2008).

*Six sigma methodology***:** Six-Sigma is employed in a systematic project-oriented fashion through define, measure, analyze, improve, and control (DMAIC) cycle.

*Define phase:*Define the project's objectives by identifying customer requirements often called "CTQs" "critical to quality", develop a team charter and define process map.

1. Identify the process or product for improvement, identify customers and translate the customer's needs into CTQs.
2. The team charter involves selection of team members and defining of roles, developing the problem and goal statements, determining project scope, setting project milestones and preparing a business case to gain management support.
3. Does a high level process map connecting the customer to the process?

The most applicable tools in this phase are Trend Chart, Pareto Chart and Process flow Chart.

Measure phase: Measure the existing system and establish valid and reliable metrics to help monitor progress towards the project goals.

1. Identify and describe the potential critical processes/products. List and describe all of the potential critical processes obtained from brainstorming sessions, historical data, yield reports, failure analysis reports etc and model the potential problems.
2. Determine precision, repeatability accuracy, and reproducibility of each instrument of gauge used in order to ensure that they are capable.

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The most applicable tools at this phase include Fishbone Diagram, Process Mapping, Preliminary Failure Mode & Effect Analysis (FMEA).

Analyze phase: Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal. Statistical analysis is used to examine potential variables affecting the outcome and seek to identify the most significant root causes and develop a prioritized list of factors influencing the desired outcome.

1. Isolate and verify the critical processes. Narrow the potential list of problems to the vital few. Identify the input/output relationship which directly affects specific problems. Verify potential causes of process variability and product problems
2. Perform process and measurement system capability studies. Identify and define the limitations of the processes. Ensure that the processes are capable of achieving their maximum potential. A process is to be considered capable when it is in control, predictable, and stable. The most applicable tools for this stage are Tests for normality, Correlation/Regression Analysis, Analysis of Variances (ANOVA), FMEA (Failure Mode and Effect Analysis) (P Subramaniyam 2011, S Koziołek 2012).

Improve phase: In this phase, project teams seek the optimal solution and develop and test a plan of action for implementing and confirming the solution.

The process is modified and the outcome is measured to determine whether the revised method produces results within customer expectations.

1. Conduct design of experiment. Select design of experiment factors and levels, Plan design of experiment execution. Perform design of experiment to find out the most significant factor
2. Implement variability reduction design/assessments implement permanent corrective action for preventing special cause variations.

The most applicable tools at this phase are Process Mapping, Process Capability Analysis, DOE (Design of Experiment).

Control phase: Ongoing measures are implemented to keep the problem form recurring. Institutionalize the improved system by modifying policies, procedures, operating instructions and other management systems.

1. Specify process control methods. Establish on-going controls for the process based on prevention of special cause variation using statistical process control techniques.

Document the improvement processed

Implementation of six sigma in Hella India Lightning Limited:

Hella india lightning limited was facing the problem of weld line defect which was contributing towards the maximum rejections of the products. Table no. 1 shows the inline rejection based on part produced. Data was collected for 4 months from February to May 2013 for output line reject that occurred in the 60 tone injection Moulding part production that focused on the production of part named Tail lamp housing-005.883 to track down the problem encountered by this particular part. Since there are four machines producing the same part, the reject data were collected for each machine.

Table 1 In- line rejection based on part produced

Model no.	in line rejection	inline rejection k per unit	%age	Acc.
005.883-00	757	0.757	31.15	31.15
329.011-01	308	0.308	12.67	43.82
329.041-01	291	0.291	11.97	55.79
329.081-04	213	0.213	8.76	64.55
074.484-03	198	0.198	8.14	72.69
161.609-00	142	0.142	5.84	78.53
329.002-01	126	0.126	5.18	83.71
193.205.00	113	0.113	4.65	88.36
1516-00	80	0.08	3.29	91.65
1378-00	74	0.074	3.04	94.69
4777-00	66	0.066	2.71	97.2
W-0394	62	0.062	2.55	100

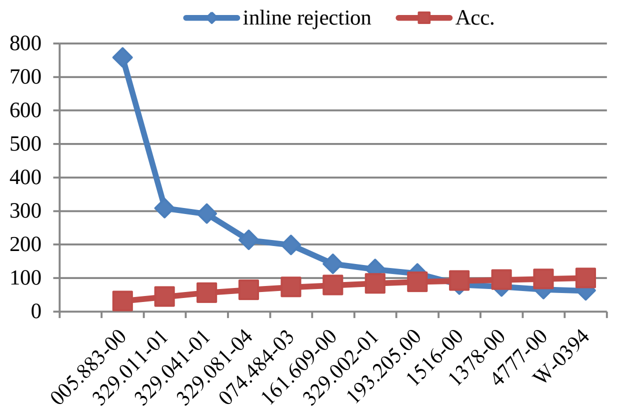

Fig: 1 A plot showing In- line rej. based on part

These data were used to calculate defect per million opportunities (DPMO) for each month. Table 2 shows the total output, reject quantity, DPMO and sigma level for each month from February to May 2013.

Table 2 Total output and Sigma level

		Machine(reject quantity)						
Month	Output	E01	E03	E04	E06	R/mth	DPMO	σ
Feb	28000	45	263	223	129	660	4714.3	4.0952
Mar	28000	48	247	211	121	627	4478.6	4.1126
April	28000	53	226	187	93	559	3992.9	4.1337
May	28000	32	197	161	82	472	3371.4	4.207
Total	112000	178	933	782	425	2318		

Sigma level was computed using the following formula.

Sigma level (Z)=0.8406+√{29.37-2.221ln(DPMO)}

Where DPMO is defect per million opportunities.

A bar graph was constructed as in Figure 2, for each month based on reject Quantity. Figure 2 shows that the highest rejection rate was identified in the month February 2013.

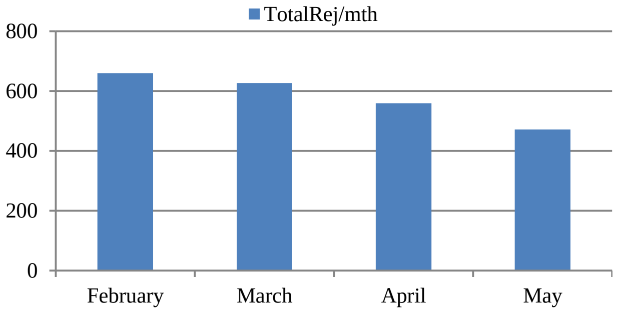

Fig 2 A plot showing total rejections per month

Based on the data in table 2, the sigma level for the process were calculated and illustrated as in figure 3.The figure 3 explains that the sigma level from the month February to May ranging from 4.0952 to 4.207. This shows the average sigma level for the whole process is 4.1371. The lowest sigma level was recorded for the month February and the highest sigma level was recorded on the month May. Since the sigma level for month February has the lowest sigma level, the studies or research will be focused on the month February.

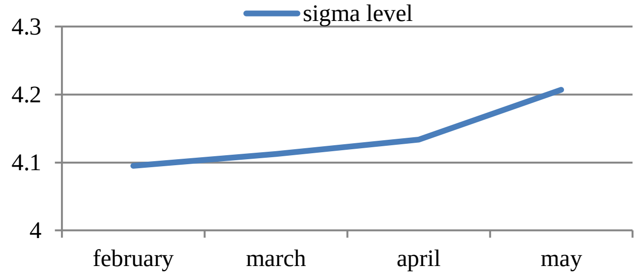

Fig 3. Plot between month vs sigma level

There are four machines which produce the same part which known as Tail lamp housing-005.883 and the data for defects was collected based on machines. Machine E03 contributes to the highest rejection rate. The defects which are recorded in Table 3 are the common types of defects which normally occur on plastic parts which produced by using injection Moulding. Weld line defects are the major contributor for the rejection rate for the month February which contributes almost 42% of the total rejects. If defect data compared by machine, still weld line contributes the highest defects compared to others and for the machines, machine E03 contributes to highest weld line defect compared to other machines. Machine E03 will be used to analyze the root cause for the weld line defects since it shows the highest rejection rate.

After collecting and analyze the data, the identified defect was the Weld Line defect which caused major quality problem. Two suggestions were recommended to reduce the defects. These are:

1. Screw and barrel cleaning
2. PP and special material for cleaning screw and barrel by purging

Table 3. Reject data based on the defect type for month February 2013

Tail lamp housing-005-883	Machine no						
Defect	E01	E03	E04	E06	Sub-total	%age	Acc.
Weld Line	12	103	87	75	277	41.96	41.96
Scratches	2	85	63	16	166	25.15	67.11
Dented	3	47	49	8	107	16.32	83.43
Burn mark	3	24	3	4	34	5.15	88.58
Oily/Dirty	1	6	9	10	26	3.93	92.51
Short Mould	0	1	7	14	22	3.33	95.84
Sink Mark	9	5	1	3	19	2.87	98.71
Parting Burr	0	2	2	1	7	1.01	99.72
White mark	0	0	0	1	1	0.14	99.86
Others	0	0	1	0	1	0.14	100

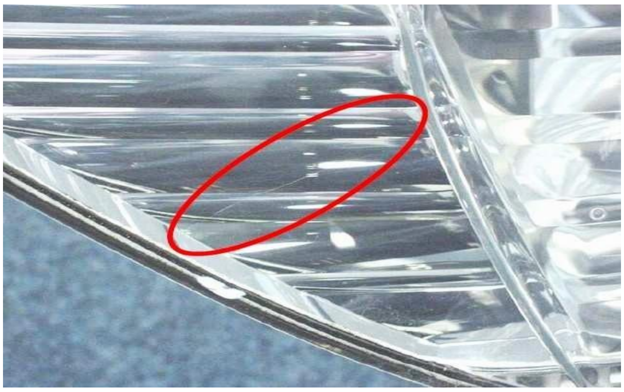

Fig 4: Housing with Weld Line defect

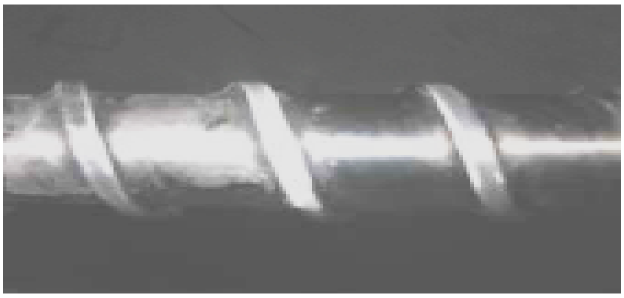

Fig 5: Barrel screw after cleaning

Results and discussions

Six sigma was implemented successfully in Hella India lightening Limited. Sigma level of the company was increased from 4.0952 to 4.207 and DPMO was reduced from 4714.3 to 3371.4. Current DPU reduces from

0.0235714 to 0.0168571. Unit quantity passed first time accelerates the rate of improvement. The root cause for the Weld Line defect had been successfully determined. Corrective action to overcome this quality problem was suggested.

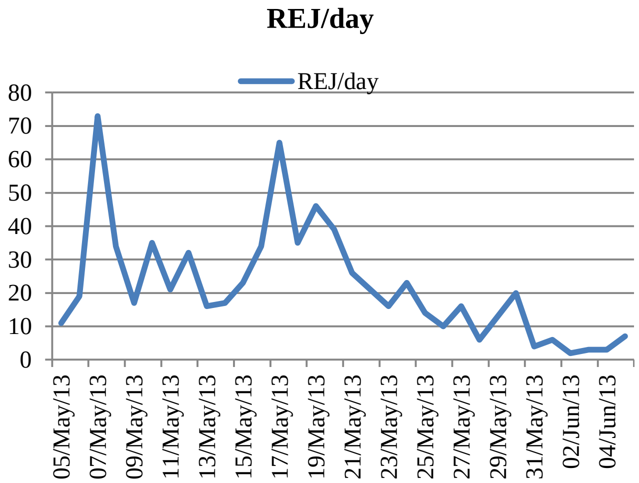

Fig 6 Comparison between rejection with and without barrel cleaning

Conclusion

Target of 3.4 defects per million opportunities as per six sigma quality strategy is not so easy. Selecting root cause of the problem & preventing the reoccurrence of any hindrances, company can achieve this goal. However Japanese have several goals like zero defects etc. and believe that all targets must be ambitious so as to stretch our abilities. Six sigma provides a structured methodology to achieve this goal.

Therefore if Indian industries have sincere approach for purpose they can surly reduce their rejections.

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