IMPLEMENTATION OF SIX- SIGMA METHODOLOGY FOR IMPROVEMENT OF PROCESS YIELD BY REDUCTION OF REJECTION (FOR %) IN A MANUFACTURING PROCESS.

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Abstract

Continuous Improvement is one of the prime factor for effective implementation of Total Quality Management in an organization .Continuous improvement encompasses the involvement of people and systematic method for tackling the problems related to the quality of product /services and the processes. There are various methods and techniques available for systematic analysis of the problems and also induce solution of the same. This paper deals with the problem of low yield / higher level of rejection in Glass Neck (used as a part of Picture Tube in TV industry) forming process and improvement of the yield of output through systematic involvement of people as a group and adopting Six- Sigma methodology. As per the methodology of Six Sigma the following phases were followed for the improvement project to reduce the FOR of the process..

Define Phase: The project has been defined as reduction of % Fall Of Rate (Rejection of the process) of Glass Neck production output through Six – Sigma Methodology . In this industry the rejection of output is expressed as Fall Of Rate (FOR)

.Measurement Phase : During the period June, July and August, 2012, the data on rejection have been compiled and the average monthly % FOR found to be 6.34% and the process yield has been 93.66%. Thus the quality performance level as well as the waste generation is not in good stead. This indicates poor viability of the process to continue its operation . To make it viable a project team has been formed to bring down the rejection level to 1,5% within a period of 4/5 months.

Analysis Phase : Analysis on the reasons of poor performance indicator has been carried out and from this certain reasons contributing major portion of the rejection have been pointed out as per Pareto analysis . From the major reasons of rejection, it has been analysed further to find out the possible causes of rejection through Ishikawa Diagram. With the aid of this diagram, root causes have been pointed out through technical and logical considerations and working experience. In the next stage, it has been established the sources related to these causes.

Implementation Phase : Based on source analysis the various related factors concerning man, materials and machine are taken up to initiate action plan for improvement. Action plan has been developed for different stages and actions have been taken up with proper monitoring. Monitoring of FOR revealed continuous reduction in %FOR from 6.34% to 1% after 4 months and also increase in output.

Control Phase : To hold the gain through this study, it was necessary to put in action the control measures at predetermined areas so as to maintain the system as was planned during the improvement phase. At this stage, it has it has been decided to monitor the important control points to sustain the improvement.

After implementation of Six Sigma methodology the following tangible gain could be achieved Reduction of % of F.O.R. from 6.36% to 1.5%. Hence improvement of yield from 93.64% to 98.5%.. Cost Saving was in tune of Rs. 1.3 Crore. Economic viability of the plant could be restored..

Introduction:

Productivity is the ratio of saleable output and the resources used which include labour, raw materials and capital. McCracken Kayank (1996) introduce alternative concept of productivity and it's relationships to quality which indicates that productivity is directly proportional to quality-as quality increases productivity also increases. It is observed that when quality is improved by identifying and eliminating the causes of errors and rework, more usable output is available for the same amount of input. Thus the improvement in quality is bearing a significant effect on productivity and hence, the profitability of any organization. Productivity is now a key issue in national economic policy decisions, and thus the definition and measurement of productivity is important to any country. In the midst of fierce competition in the market place customers do not separate quality from price , they consider both the parameters simultaneously .Improvements in quality that can be provided to customers without the increase in price result in better value. Companies. that have high product quality . achieve superior financial performance –Dr. Juran (2007).

Of the trilogy of quality processes, the process of quality improvement plays a dominant role in reducing the cost of waste. The costs associated with waste are due to both sporadic and chronic quality problems. 'Continuous Improvement' has acquired a broad meaning, enduring efforts to act upon both chronic and sporadic problems and to make refinements to processes. For Continuous improvement, the most effective is "project by project" approach through involving the employees of the organization for achieving the best output. This approach was originally proposed by Dr. Juran in the year 1964 as "break through"sequence for improvement. In Total Quality Management system implementation in any organization, Continuous Improvement and Process Approach are considered to be the prime factors as it enhances quality and productivity of the process or service and in turn adds value to the outgoing product or services to bring in enhancement of customer satisfaction. Six -Sigma methodology, with the adoption of DMAIC, through project approach can be applied to all three processes in the quality trilogy and thus become the basis of total quality initiative. Six Sigma methodology has been used by all the progressing organizations in the world to ripe the benefits of waste reduction and business excellence. Service science ,in general, and science of variation ,in particular, have the potential to make a significant contribution to improvement of service quality through implementation of Six Sigma methodology–Eisenhower et el (1)Cost reduction with the implementation of Six Sigma in a manufacturing sector by W Franchetti et el (2). Enhancement of efficiency and reduction of scrap in a bottling plant through application of SIX-SIGMA methodology.

As per the methodology of Six Sigma a quality improvement project involves the following tasks

1. Define the project need and objective.
2. Measure the present status.
3. Analyze the causes and plan for action
4. Implement planned action for improvement and verify the out come with the target
5. Controls for holding the gain.

1.0\Six Sigma based approach on reduction of Fall of Rate and improvement of process Yield of Glass Neck formation process.

As per Six Sigma methodology, DMAIC route has been considered to be adopted for improvement of process performance by reduction of FOR and in turn enhancement of process yield. The detailed procedure has been given under.

1.1 Define phase:

In this phase it is required to identify the chronic problem with higher potential of contribution to performance improvement in quantifiable form, wherever it is possible and the prerogative of the management of the organisation. In turn, it will infuse customer's satisfaction and hence strive for business excellence. In this case the problems, as per the above nomenclature, have been defined as "Reduction of % Fall of Rate (FOR) to increase yield of the process of Glass Neck Production output through Six Sigma methodologies in an Indian Industry'. In this industry, the rejection of output is expressed as Fall of Rate (F O R) which is defined as the % of total rejection of the process output which can not be salvaged in any form afterwards.

2.0 Process:

Glass tubes of different sizes are fed into the Fabrication machine which in turn cut and formed into the required predetermined sizes through cutting with hydrogen flame and mechanical cutter. Subsequently, it is flared and pass onto glazing machine through mechanical support and finally heat treated in annealing line to remove stress. The output is then inspected and good products are taken as output. The rejection at the final stage decides the yield of the process which is the point of concern of this project.

1.2 Measurement phase:

The second phase is the assessment phase, where the existing performance of the process is measured through collection of relevant data from the process and collated so as to indicate the quantitative performance index for progressing to next phase. In this particular case the index of the process is percentage in rejection of output of the process (denoted as FOR) and data were collected from the process report sheets for a specific time period. In this case as the installation of the machine was completed in the moth of April,2012 and production was stabilised during April and May,2012,it was decided to take next three months data on production quantity, rejection quantity, % of rejection and reason wise quantity of rejection were collected and collated. The details of the data along with nomenclature of rejection is given below in Table-1 Nomenclature : 1.Stone, 2.Bad Cutting, 3.Scratch, 4.Crack Top/Bottom, 5.Bump Check, 6.Chip, 7.Flare Crack, 8. Air Line,9. .Other Defects,

From the above Table -1 it is indicative that average FOR (% of rejection is in tune of 6.34% and in turn the yield is 93.

66% . Thus it is obvious that the performance level of the process was very poor and felt it was necessary at the beginning to take up the Six Sigma methodology to improve the existing performance of the Process.

1.3 Analysis phase:

In this phase, analysis on the reasons of the poor performance indicator are carried out in no of steps. The first step is to assess the contribution of each reason of rejection on overall rejection which is calculated as the % ratio of quantity of rejection due to the particular reason and overall rejection quantity. From the data shown in Table-1 the % contribution of each reason of rejection is calculated and given in table-2.

In the next step, it is required to find out the reasons which were contributing dominantly on overall rejection. For this ,the % contribution of each reason is tabulated in descending order and the cumulative % contribution or reasons are calculated by cumulative addition of each row of the Contribution column and shown in Table-3

In the next step, cumulative % of each reason is plotted against each reason to pinpoint the dominant reasons

Contributing on overall rejection and given below in Diagram-2.

Based on the above Diagram-2 , Pareto principle , which states that about 20% of causes / reasons affect on 80% of output /result, was applied and it was evident that the following 5 reasons are contributing on 87..97% of overall rejection/FOR.: 1.0 Bad Cutting ,2.0 Scratch, 3.0 Crack, 4.0 Stone, 5.0 Bump Check

From the above findings of major reasons of rejection, it was to analyse further to find out the possible causes of rejection with the aid of technical reasoning and ISHIKAWA DIAGRAM). .

Based on the ISHIKAWA Diagram further analysis was taken up trough discussions considering technical parameters of the process, machine considerations and logical reasoning to pinpoint the root causes. From this analysis the following root causes were detected.

1. Malfunction of Fabrication Machine.
2. Improper adjustment of Glazing Conveyor.
3. Improper action of Gripper.
4. Inadequate training.
5. Improper setting of Annealing Lehr.
6. Poor quality of Glass Shell.

From the above findings of the root causes ,further it was analysed .. The reason of rejection and the sources are given in Table -4.

1.4 Improvement phase:

Based on the source wise analysis as shown in Table -4,it was observed that the various sections of the Neck forming machine, handling of tube and neck, human factor, material quality, maintenance performance including monitoring and training are the areas of concerned in this case. Accordingly, action plan was initiated through discussions with the cross functional groups with due consideration on the factors stated above. The trend of FOR was monitored. It was evident that there was phenomenal improvement in the process performance as FOR came down from 7.2% in June,2011 to 1,5% in January,2012 and hence, increment in yield of the process from 92.8% to 98.5% in the respective period of concerned.

1.5 Control Phase:

To hold the improvement as shown in Table -5, it was necessary to put in action the control measures so as to maintain the system as was planned during the improvement phase. At this stage, it was decided to stick to the following steps for controlling action on the system to maintain the performance at desired level.

1. Introduction of modified work instructions at different working points ..
2. Development of preventive maintenance schedule and execution of the same on Regular basic.
3. Maintenance of inventory of spare parts so as to ensure immediate replacement. .
4. Review on F.O.R. level and condition of the machines on weekly basis.
5. Periodic training of operators of the machines.
6. Continuous feedback to the supplier on quality of glass tube. .
7. To monitor the condition of hand gloves used by operators on daily basis .

2.0 Results and Discussion:

From the above trend and other process performance reports , the comparison of performance parameters before application of Six Sigma methodology and after implementation of the same were derived and found to be in significantly better situation.

Cost – Benefit Analysis :

Before application of Six Sigma Methodology:
Loss of value per month due to rejection in neck processing (projected value)= Production volume per month (effective from January,2012) x FOR% x Price of each Neck = Rs.14.7Lacs/ month
After implementation of Six Sigma methodology
Loss of value per month due to rejection in neck processing (projected value) =Rs. 3.37 Lacs
Yearly saving =Rs. !.3 Crores (Approx.)

Tangible Gains:

After implementation of Six Sigma methodology the following tangible gain could be achieved

1. Reduction of % of F.O.R. from 6.36% to 1.5%. Hence improvement of yield from 93.64% to 98.5%.
2. Increase in Production volume from 9000 Pcs./Shift to 10000 Pcs./Shift.
3. Cost Saving of Rupees 10.8 Lacks/Month or Annualized Rs. 1.3 Crores..
4. Economic viability of the plant could be restored.
5. Infused motivation for improvement

3.0 Conclusion :

In the present business scenario ,there is fierce competition at one side and on the opposite side there is hike in all input costs i.e. raw materials, labour, etc. which are beyond the control of the organisation. At this juncture only one option is left with the organisations to reduce the internal waste which will in turn contribute considerably to the profitability of the organisation and hence survival of the organisation as well as long term continuity of the business. From the above case study it is very much established that by adopting the concept of continual improvement in process and product by eliminating the internal wastes of the organisation through systematic implementation of SIX-SIGMA methodology to improve the process efficiency and also to accrue the financial contribution which will bring in increment in profitability of the organisation.

6.0 Acknowledgement:

The authors are thankful to the management of KAIL LTD, Kolkata to provide opportunity to implement the SIX –SIGMA methodology in a manufacturing sector and to prove its contribution for continuous improvement.

Table -1 : Data on production ,rejection, % of rejection and reason wise rejection of the process

PARTICULARS				REASONS									
Month	PRODUCTION QUANTITY (PCS)	REJECTION QUANTITY (PCS)	%OF REJECTION	1- STONE	2- BAD CUTTING	3 SCRATCH	4 CRACK	5 BUMP CHECK	6 CHIP	7 FLARE CRACK	8 AIR LINE	9 OTHERS	TOTAL
JUNE-12	302000	21744	7.20%	3413	4783	4457	3695	3044	652	1152	543	5	21744
JULY-12	501050	32568	6.50%	4949	6774	6839	5862	4429	977	1628	1107	3	32568
AUG-12	703040	41479	5.90%	7465	8295	7881	7465	4977	2073	1659	1655	9	41479
TOTAL	1506090	95791	6.36%	15827	19852	19177	17022	12450	3702	4439	3305	17	

Table- 2 : Data on contribution of each reason on overall rejection

	REASONS								
MONTH	1	2	3	4	5	6	7	8	9
JUNE'11	15.7%	22%	20.5%	17%	14%	3 %	5.3 %	2.5 %	.02 %
JULY'11	15.2%	20.8%	21%	18%	13.6%	3 %	5 %	3.4 %	.01 %
AUG'11	18%	20%	19%	18%	12%	5 %	4 %	4 %	.02 %

Table-3 : CONTRIBUTION OF EACH REASON ON OVERALL REJECTION

SLNO.	REASONS	%CONTRIBUTION	CUMULATIVE % CONTRIBUTION
1	BAD CUTTING	20.72%	20.72%
2	SCRATCH	20.01%	40.73%
3	CRACK	17.76%	58.49%
4	STONE	16.52%	75.01%
5	BUMP CHECK	12.96%	87.97%
6	FLARE CRACK	4.63%	92.60%
7	CHIP	3.86%	96.46%
8	AIR LINE	3.45%	99.91%
9	OTHER	0.09%	100%

Table - 4: Reason of rejection and the corresponding source

SL. NO	REASON OF REJECTION	SOURCE
1	SCRATCH	1. Handling of tube and Neck at different points 2. Improper Gripper action 3. Bumpy movement of neck on glazing conveyor
2	BAD CUTTING	1. Improper flow of Hydrogen gas 2. Misalignment of cutter 3. Improper adjustment of heating element
3	CRACK	1. Improper adjustment of gas flow for heating the tube 2.Dumpy movement of glazing conveyor 3. Improper temperature adjustment in annealing 4. Mishandling of tube and neck at different points 5. Misalignment of cutting tool and transfer mechanism
4	STONE	1. Poor quality of tube
5	BUMP CHECK	1. Misalignment of transfer mechanism in forming machine and glazing conveyor 2. Misalignment in glazing conveyor chain

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