DEFECT ANALYSIS ON CAST WHEEL BY SIX SIGMA METHODOLOGY TO REDUCE DEFECTS AND IMPROVE THE PRODUCTIVITY IN WHEEL PRODUCTION PLANT

C.Manohar[1], A.Balakrishna[2]

[1] *PG Student, Department of Industrial Engineering & Management, MSRIT, Karnataka, India*
[2]*Associate Professor, Department of Industrial Engineering & Management, MSRIT, Karnataka, India*

Abstract - *The fast changing economic conditions such as global competition, customer demand for high quality product, product variety and reduced lead–time, declining profit margin etc. had a major impact on manufacturing industries. To respond to these needs various industrial engineering and quality management strategies such as ISO 9000, TQM, Kaizen, JIT manufacturing, Enterprise Resource Planning, Business Process Reengineering, Lean management etc. have been developed. A new paradigm in this area of manufacturing strategies is Six sigma. The Six Sigma approach has been increasingly adopted worldwide in the manufacturing sector in order to enhance productivity and quality performance and to make the process robust to quality variations. This project work discusses the quality and productivity improvement in a manufacturing enterprise through Defect Analysis and deals with an application of Six Sigma DMAIC (Define–Measure-Analyze-Improve-Control) methodology in wheel production plant which provides a framework to identify, quantify and eliminate sources of variation in an operational process in question, to optimize the operation variables, improve and sustain performance viz. process yield with well executed control plans to reduce defects happening in Cast wheel production.*

Key Words: TQM, Six Sigma, Defect Analysis, DMAIC, Variation, Process yield.

1. INTRODUCTION

Six Sigma is new, emerging, approach to quality assurance and quality management with emphasis on continuous quality improvements. The main goal of this approach is reaching level of quality and reliability that will satisfy and even exceed demands and expectations of today's demanding customer. A term Sigma Quality Level is used as an indicator of a process goodness. Lower Sigma quality level means greater possibility of defective products, while, higher Sigma quality level means smaller possibility of defective products within process.

1.1 Six Sigma Approach

The Six Sigma Approach is customer-driven. For a business or a manufacturing process, the Sigma Capability is a metric that indicates how well the process is being performed. The higher the Sigma capability, the better, because it measures the capability of the process to achieve defect-free-work (where a defect is anything that results in customer dissatisfaction)
The Six Sigma Approach is also data-driven. It focuses on reducing process variation, centring the process and on optimizing the process. The emphasis is on the improvement of process capability rather than the control of product quality, which includes the improvement of quality and reduction of cost of quality.
In short, The Six Sigma Approach focuses on: Customer needs, Data-driven improvements & the inputs of the process.
And this results in: Reducing or eliminating defects, reducing process variation, increasing process capability.

1.2 Six Sigma Improvement Program

Program	Six Sigma
Theory	Reduce variations
Application guidelines	1. Define 2. Measure 3. Analyze 4. Improve 5. Control
Focus	Problem focused
Assumptions	▪ A problem exists. ▪ Figures & numbers are valued. ▪ System output improves if variation in all processes is reduced.
Primary effects	Uniform process output.
Secondary effects	▪ Less waste ▪ Fast throughput ▪ Less inventory ▪ Improved quality

Fig-1: six sigma improvement program

2. SIX SIGMA METHODOLOGY (DMAIC)

The DMAIC methodology follows the phases: Define, measure, analyze, improve and control. Although PDCA could be used for process improvement, to give a new thrust, Six Sigma was introduced with a modified model i.e. DMAIC. The methodology is revealed phase wise (Fig.2) and is implemented for this project.

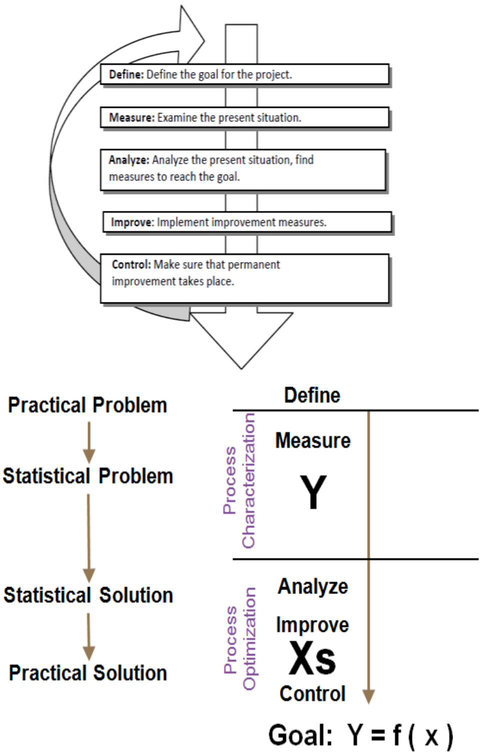

Fig-2: DMAIC methodology

2.1 Define Phase

This phase determines the objectives & the scope of the project, collect information on the process and the customers, and specify the deliverables to customers (internal & external).

Creation of problem Statement: The below equation gives the general six sigma basic premise to the DMAIC methodology to conduct project...

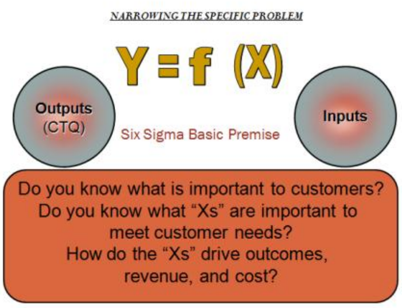

Fig-3: Six sigma basic Premise

With respect to above relation with wheel production plant, the parameters indicating to six sigma basic premise are as follows,

- Y = reducing the critical defects in cast wheel & increasing the productivity & maintaining the consistency in the quality.
- X = causes for defects

Research case: As quality plays a pivotal role in all aspects of life, reducing the number of defectives in manufacturing industry is an important function. Six Sigma project, undertaken within company for production of wheels, which deals with identification and reduction of production cost in the cast wheel manufacturing process and improvement of quality level of produced parts.

Problem statement: The RWF Company is facing 4-5% of rejections of cast wheels for every month for their production.

Goal Statement: To reduce the defects% to minimum level and thereby improve quality, reduce critical defects and increase productivity.

Team: 3 members

CTQ (Critical to Quality): Reducing critical defects in cast wheel.

2.2 Measure Phase

The purpose of the Measure step is to evaluate and understand the current state of the process. This involves collecting data on measures of quality, cost, and throughput/cycle time. It is important to develop a list of all of the key process variables.
This phase presents detailed process mapping, determination of the critical defect. In this phase, after discussions with the section engineers, production engineers and supervisors data is collected with the help of team members.

Data collection period:

Period	Variables (CTQ)	Responsibility
April(2014)-March(2015)	Total No. of Defects	Team

Pareto Analysis:
The Pareto diagram shows the total number of defects on Y axis and Nature of defect on X axis. From the diagram, we can identify the critical defects by 80-20 Rule. They are Ingates (sand and graphite inclusions) and Cracks.

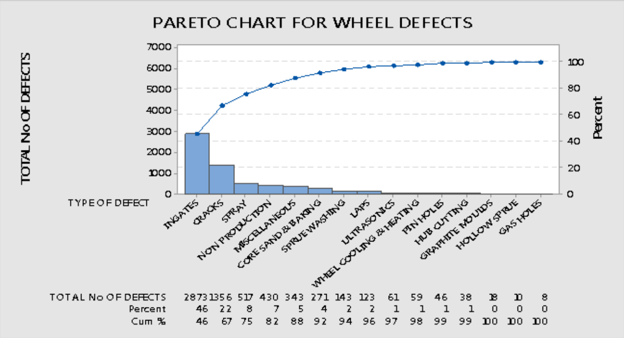

Fig-4: Pareto Diagram for wheel defects

2.3 Analyze Phase

This phase describes the potential cause's identification which has the maximum impact on the crack and Ingates defects. This phase concentrates on the identification of the root causes of the critical defects and helped to examine the processes that affect CTQs and decide which X's are the vital few that must be controlled to result in the desired improvement in the Y's, this leaded to generate ideas for improvement and reduce variation.

Binomial Capability Analysis for critical defects:

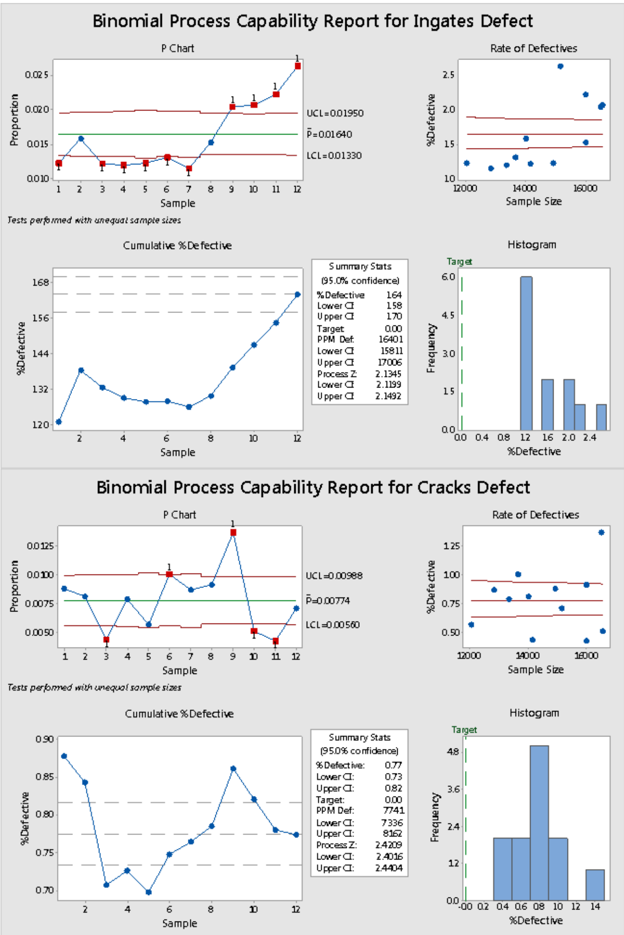

Fig-5: Binomial process capability report of Ingates and cracks

Cause and effect diagram for Critical defects.

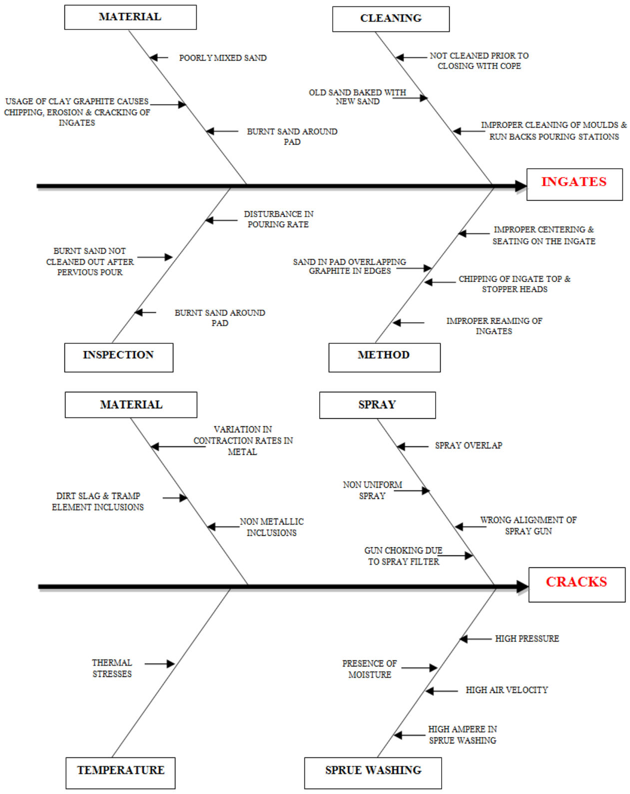

Fig-6: cause & effect diagram of critical defects.

2.4 Improve Phase

The objectives of the Improve step are to develop a solution to the problem and to pilot test the solution. The pilot test is a form of confirmation experiment; it evaluates and documents the solution and confirms the solution attains the project goals. Through discussions with the Production, quality department and supervisors the following remedial actions were implemented for the critical defect which is indicated below.

Ingates (sand & graphite Inclusions)

1. Ensure effective cleaning prior to closing with core and hub.
2. Avoid burnt sand around pad.
3. Burnt sand not cleaned out after pervious pour.
4. Avoid old sand baked with new sand.
5. Avoid cold copes.
6. Avoid poorly mixed sand.
7. Proper chipping of stopper stops should be done.
8. Proper centering, seating and reaming of ingates should be done.

Cracks

1. Ensure for correct and uniform spray over the mold surface with required volume of spray.
2. Ensure correct amount of sulphur or phosphorous not over than 0.040.

3. Avoid using eroded and damaged moulds.
4. Pressure and current for electrodes should be checked before doing sprue washing.
5. Use good Quality Gaskets

Implementation: Based on the Cause and Effect diagram, the operators and production department are informed to focus on the major causes that develop cracks and Ingates defect and given the remedial measures or strategic control plans in all aspects of the production process.

Binomial Capability Analysis for critical defects for April month:

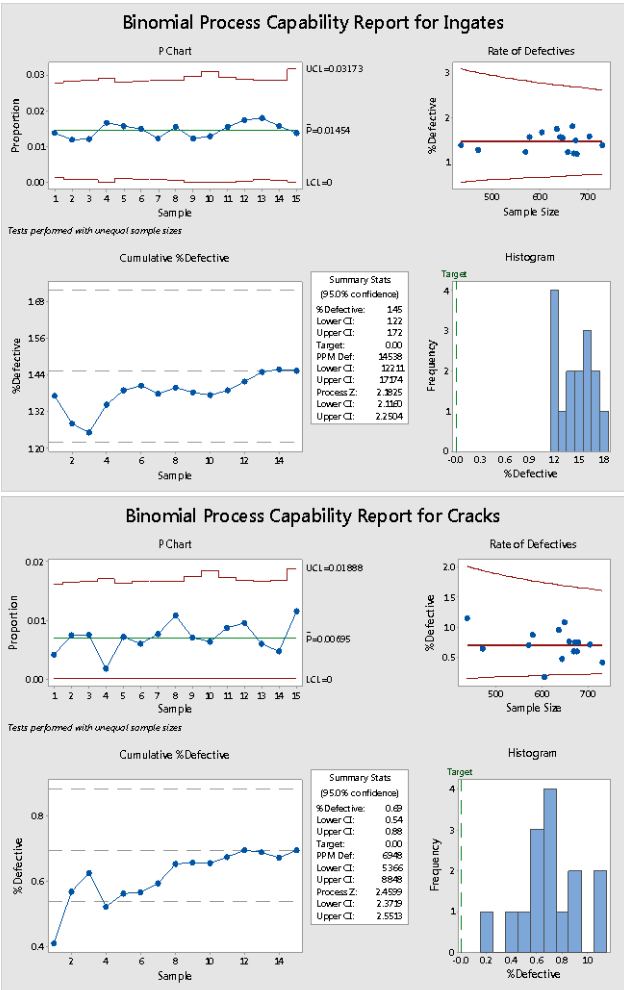

Fig-7: Binomial process capability report for April month

2.5 Control Phase

This last step is the sustaining portion of the Six Sigma methodology. The process is monitored to assure no unexpected changes occur. In this phase of DMAIC methodology, a control plan was developed to ensure that the processes and products consistently meets our and customer requirements.

The positive results are discussed with the production department of the plant. The major defects are identified and reduced. The real challenge is to sustain the improvements made in improving the process.

Control Plan: The following are the mandatory action that has to be taken by the Quality and production department to sustain the results after six sigma methodology.

1. All concerned are counseled to clean the moulds properly, ream ingate properly & tighten the inspection of ingates and stoppers.
2. Close monitoring of pouring rate should be carried out by Elec. & Mech maintenance department.
3. Over life Moulds & ingates should be sent to MRS for Replacement.
4. Spray filters should be replaced for gun choking.
5. All spray dispensing problems should be attended by maintenance department, Defective guns/ cups should be replaced with service one, gun nipples should be opened & cleaned by flushing with water.
6. Cope cleaner problems are to be attended immediately & solved by maintenance department.

3. CONCLUDING REMARKS

The Six Sigma method is a project-driven management approach based on the theories and procedures to reduce the defects for a specified process. This work presents the step-by-step application of the Six Sigma methodology for reducing the rejection level of the cast wheel production process. Several statistical tools and techniques were effectively utilized to make inferences during the project. As a result of the project, the rejection level of Ingates and Cracks after the six sigma methodology has been reduced to 1.45% from 1.64% for Ingates and 0.69% from 0.77% for Cracks.

Summary Stats (using 95.% CI)				
Defect	INGATES (SAND & GRAPHITE INCLUSIONS)		CRACKS	
	BEFORE DMAIC	AFTER DMAIC	BEFORE DMAIC	AFTER DMAIC
% defective:	1.64	1.45	0.77	0.69
No. of Defectives	2713	136	1356	65
DPMO.	16401	14538	7741	6948
Sigma:	3.635	3.68	3.92	3.96
dpo:	0.016401	0.0145	0.007741	0.0069

Fig-8: summary stats of project results

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 03 | June-2015 www.irjet.net p-ISSN: 2395-0072

4. PICTURES OF CRITICAL DEFECTS

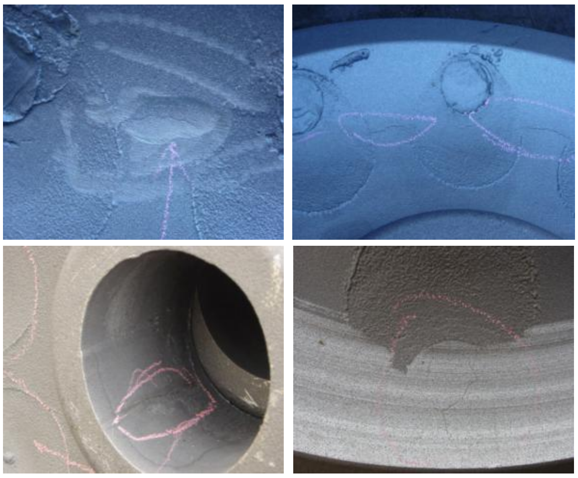

Fig-9: cracks

Fig-10: sand inclusions

Fig-11: Graphite inclusions

REFERENCES

[1] Dr. Chethan Kumar C S, Dr. N V R Naidu, Dr. K Ravindranath, "Performance improvement of manufacturing industry by reducing the Defectives using Six Sigma Methodologies" , IOSR journal of Engineering Vol-I issued page no-001-009.

[2] Bhavani, T.A. Suresh D. Tendulkar (2001), "Determinants of firm-level export performance: A case study of Indian textile garments and apparel industry", Journal of International Trade and Economic Development, 10:1, 65-92.

[3] Keller, P, (2001), "Recent Trends in Six Sigma", ASQ"s 55th Annual Quality Congress Proceedings, pp 98-102.

[4] Forrest W. Breyfogle Implementing Six Sigma: Smarter Solutions Using Statistical Methods :

[5] 6-s OJT Six Sigma Application – GEPS Playbook, GE Power Systems.

BIOGRAPHIES

Manohar C, PG Student (Industrial Engineering), Department of IEM, MSRIT, Bangalore, India.

Balakrishna A, Associate Professor, Department of IEM, MSRIT, Bangalore, India.

