International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Defect Analysis and Productivity Enhancement of Crankcase Casting through Pareto Analysis, POKAYOKE and QC Tools

Mr. Sahil Rajendra Bavdhankar[1] , Mr. Pramod Suresh Patangaray[2], Dr. Sachin Shinde[3]

[1,2,3]Department of Mechanical Engineering, Kolhapur Institute of Technology's College of Engineering,Kolhapur, India

Abstract:
Productivity is very important aspect in any organization. Productivity means output obtained with respect to how much input is provided. To increase the productivity of any organization it is necessary to study and analyze the rejection data of that organization. This research focuses on the need of following a proper methodology in solving any particular problem. The defects were prioritized using QC tools, Pareto analysis. This research emphasizes on the importance of focusing on critical parameters contributing to major rejection and controlling that in order to improve productivity.

Keywords: productivity; POKAYOKE; crank-case; why-why analysis.

I. INTRODUCTION

Many industries aim at improving productivity but having a correct approach at identifying defects and rectifying it is very essential. Productivity can be improved by number of ways such as by identifying the defects and rectifying it, reducing cycle time , reducing material handling time, optimization of plant layout, cost reduction, streamlining the operations, etc.

From the raw material to finished part the material undergoes number of operation so it is essential to make sure that the operation don't deviate from the planned path**.**

Working condition is one of the main factors influencing the productivity of an employee.

The productivity can also be increased by providing the same services at reduced cost or by inclusion of extra services at same cost.

Casting is reckoned as one of the versatile and easiest manufacturing method. Casting can produce products from having simple shapes to complex shapes like engine blocks. One must have proper knowledge about the various processes involved in the casting process and the factors affecting that process.

Any deviation from the standard procedure or negligence can lead to various defects which lead to loss in production ultimately decreasing productivity. So, proper monitoring of processes and preventing the deviations by controlling various factors like temperature, moisture, material properties, time is necessary.

India is third largest producer of casting after china and US.

II. LITERATURE REVIEW

- The crankcase, a fundamental component of internal combustion engines, plays a critical role in the engine's overall functionality and durability. It encompasses the lower part of the engine block, housing essential moving parts such as the crankshaft and connecting rods. The crankshaft, a central element within the crankcase, converts reciprocating motion into rotational motion, essential for driving the engine and, consequently, powering the vehicle.
- Karthik M [7] proposed the paper titled "Reducing rejection and improving productivity of pistons" where the paper focuses on root cause of rejection by studying control chart and cause and effect diagram. The new fixture was designed to remove chips properly so that compression height variation get minimized which was one of the most crucial cause of rejection .
- Franklin Feroze and G P Gokul [8] "Study and analysis of process rejection in output gear". They implemented Six Sigma which is critical to quality. This also ensures business goal, priorities and expectations. Successful implementation caused reduction in rejection rate from 5.3% to 1.2% .
- Manoj Govindharaj and Niresh Jayarajan [3] in there paper "An empirical study on the control of rejection rate in instrument cluster assembly line by using quality control tools and kaizen" used flowcharts block, diagrams, Pareto chart, histogram, check sheet, cause and effect diagram and control chart to analyse entire process and listed the necessary solutions to the defects found. They used why-why analysis diagram to find defects. Kaizen meaning 'continues improvement' helps to reduce rejection with constant efforts.
- R Nievndra ,E Subhash [2] in there paper "Minimization of rejection rate using lean six Sigma tool in medium scale manufacturing industry" wherein the rejection rate of wheel cylinder in drum brake was reduced by implementing six Sigma. Successful implementation helped to met delivery schedule at right time.
- Raghav Pandey in his paper [9] "Casting defect reduction in manufacturing industry" focused on blow holes causes and solution. He found that the ladle cup which is used to pour the molten metal should be product specific or else pouring will happen on workers assumption. Using quality control tools like Taguchi method, method study, TQM, TQC helps to minimize the defects.

III. OBJECTIVES

1. To identify the defects leading to rejection of crankcase in an organization.
2. To analyze the defects and prioritize the one causing major rejection.
3. To reduce the rate of a component and increase the productivity.
4. To identify bottleneck operations and provide a better solution resulting into improved method.
5. To reduce the scrap and rework which will ultimately increase efficiency.

IV. METHODOLOGY

To reduce the defect it is very essential to follow the structured approach rather than just randomly overlooking on certain aspects. To establish a simple and sound methodology and train the employees to work in that direction will yield the benefit in more effective manner. To avoid the recurrence of the defect and achieve cost effectiveness ,proper methodology is essential.

1. 1.Initially, all the rejection data is collected from the organization.
2. Then it is critically analyzed , identifying the defects.
3. Using the QC tools like Pareto chart, Histogram, Scatter graph the defect is prioritized.

4. By constructing Fish Bone Diagram all possible causes are identified. Also WHY-WHY ANALYSIS is carried out to locate the root cause.
5. Action plan for minimizing the defect is implemented.
6. A solution is suggested.

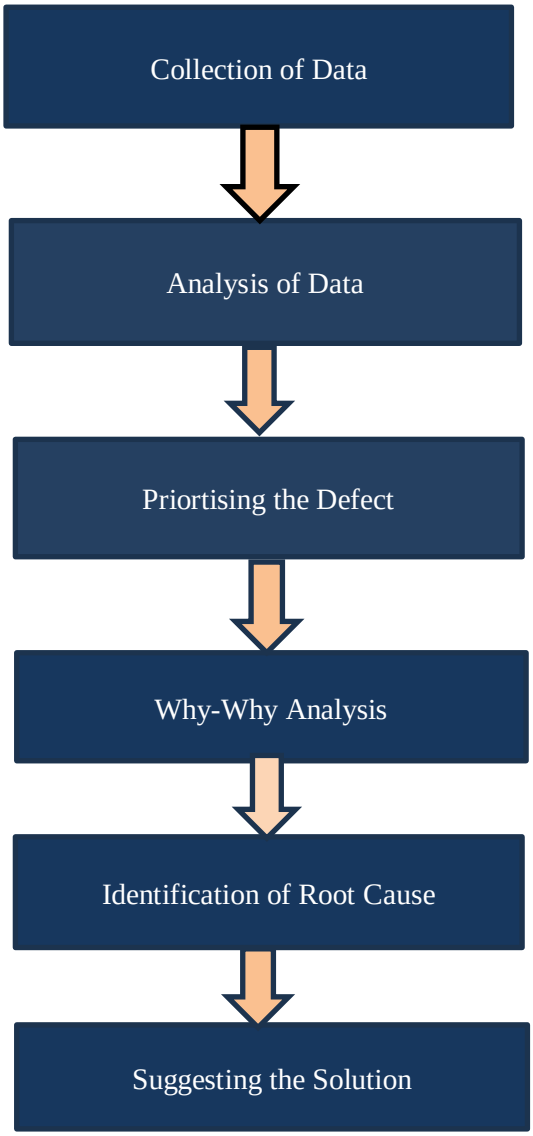
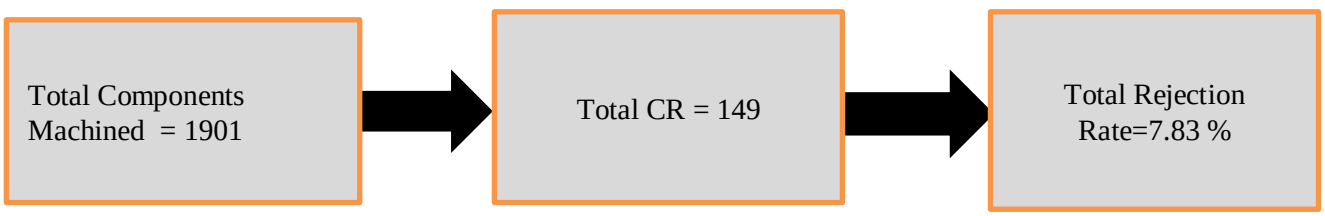


FIGURE.1 METHODOLOGY

V.IDENTIFICATION OF PROBLEM



1. Pareto Chart : Here the principle of Pareto is used which poises that 80 percent of the rejections arise from 20 percent of the defects.

This pareto chart shows the number of defects on primary Y axis and cumulative percentage on secondary Y axis. Blow holes has the major number of defects which can contribute to majority of the rejection .Blow holes account for major 62 percent part of the rejection. Pareto chart thus helps in prioritizing the defect for the process of rejection reduction and overall productivity improvement. It helps the analysts to channel their efforts on the most critical parameters hampering the Quality of the end product.

Defects	No. of defects	percentage	Cummulative percentage
Blow hole	92	62%	62%
Castmark	35	23%	85%
Sand drop	11	7%	93%
Shrinkage	6	4%	97%
Porosity	5	3%	100%

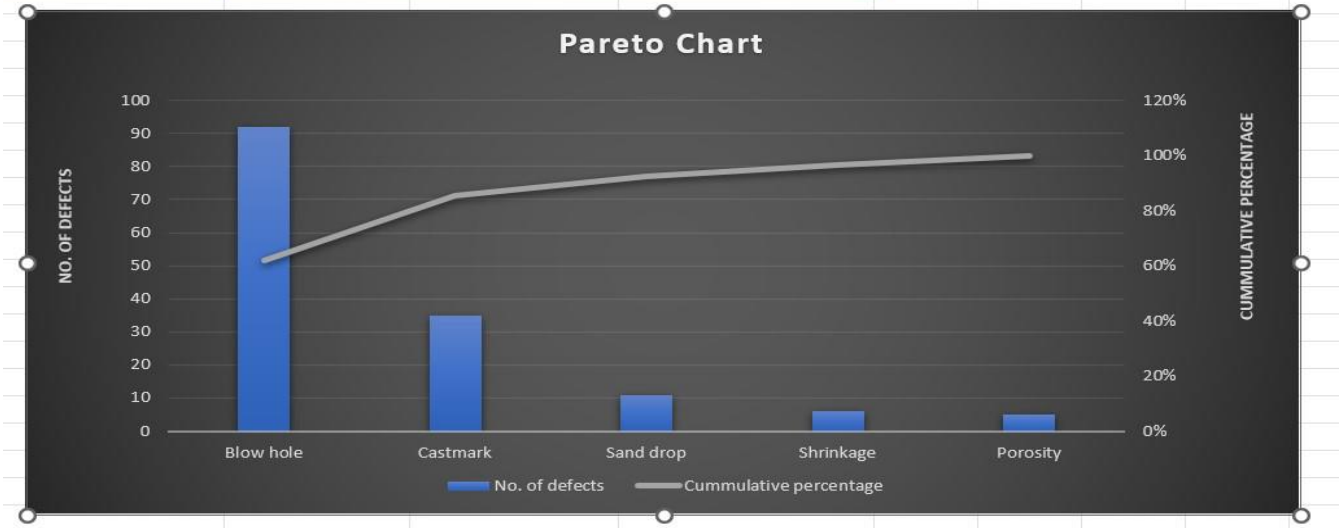


Figure 3. Pareto chart

2.CONCLUSIONS FROM PARETO CHART:

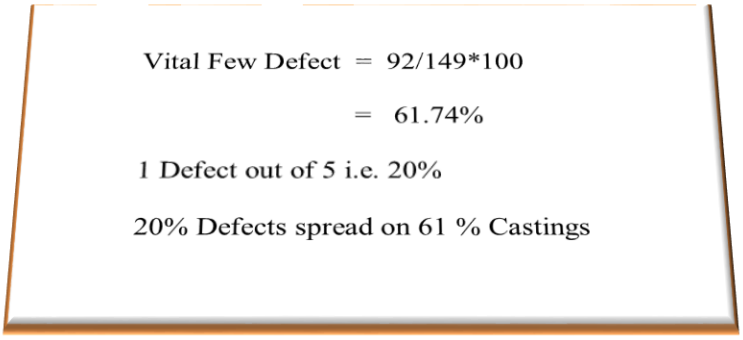


Figure 4. Inferences from Pareto Chart

VI. Q.C. TOOLS :

Here ,the defect is prioritized which is the major contribution to the rejection using the quality control tools.

1. Histogram:

a.) A histogram is a graph that shows the frequency of Numerical data using rectangles.

b.) The histogram identifies blow holes as the root cause which is causing the major portion of rejection. Histogram is similar to bar graph wherein responses are plotted against frequencies. The height indicates the frequency of occurrence. The main advantage of histogram is that peak values can be directly obtained and necessary steps can be taken. The histogram can be symmetric, skew left , skew right, uniform, bimodal, multimodal. Due to the continues number ranges one can easily predicts the behavior over the particular period. They are very much helpful in performing statistical analysis

Table.1 Defects and their percentage

Defects	**Percentage of defects**
Blow Hole	61.35
Cast Mark	23.07
Sand Drop	7.69
Shrinkage	3.84
Porosity	3.84

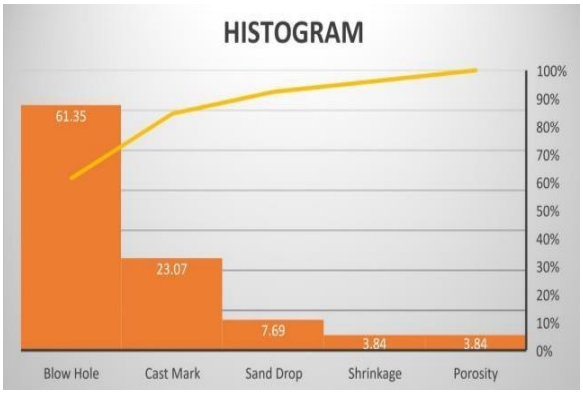


Figure 5. Histogram

2. Scatter graph:

a.) Scatter graph represents the relationship between 2 variables.

b.) Scatter graph is the graph that gives mathematical relationship between two values which are to be compared. If the points obtained on graph are along a line showing somewhat similar relation at every point shows that two variables are directly proportional.

c.) At the same time if the points are scattered over the long range and there behaviour is not similar for each point then two variables are not in any relationship with each other. Interpolation or exterpolation are done to get the values within or outside the seet of data.

Table.2 Defects and their percentage

Defects	**Percentage of defects**
Blow Hole	61.35
Cast Mark	23.07
Sand Drop	7.69
Shrinkage	3.84
Porosity	3.84

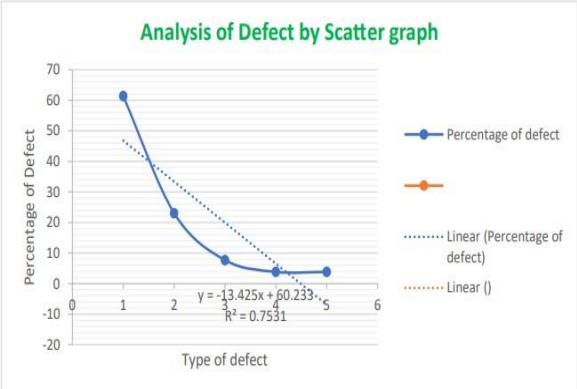


Figure 6. Scatter graph

3. Pie-Chart:

In a pie chart, the arc length of each slice is proportional to the defects occurred.

Table.3 No. of Defects contributing to rejection

Defects	Number of defects
Blow Hole	52
Cast Mark	38
Sand Drop	29
Shrinkage	19
Porosity	11

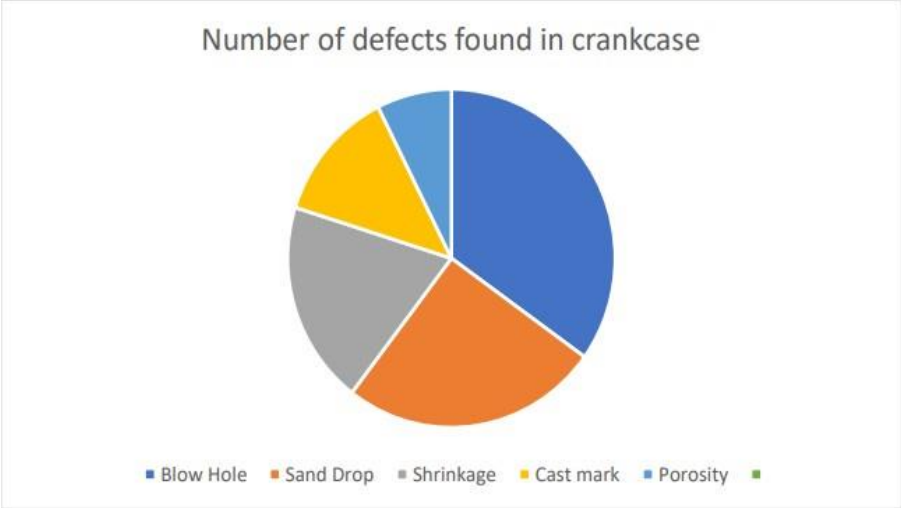


Figure 7. Pie Chart

4. Fish-Bone diagram:

Cause and effect diagram was introduced by Mr. Kaoru Ishikawa. To find the root cause of one particular problem, for brainstorming purpose ,he introduced this diagram and named as cause and effect diagram.

Cause and effect is one of the generalized problem solving tools of 7 QC Tools. Cause and Effect diagram is also known Fish Bone diagram or Ishikawa diagram .Fishbone diagram is also recognized as 6M or 5M++1E. It is not just restricted to quality purpose but it can be applied for many other different departments such as production, HR, manufacturing, maintenance, marketing. Any issue can be effectively analyzed and the problem can be solved .The effect is plotted on the right side and causes are located to the left side of the diagram.

Any product is made with the help of 4 resources Man , Machine, Material and Method. So any problem if occurs would be due to errors in the utilization of these resources. Environment or mother nature also plays an important role as it is the conditions in which the component is being produced.

So, having favourable environmental conditions is necessary. Measurement is different techniques through which some parameters are checked or in other words inspected. Basically, measurement is a part of method in which the temperature, speed, feed , depth of cut is measured and controlled.

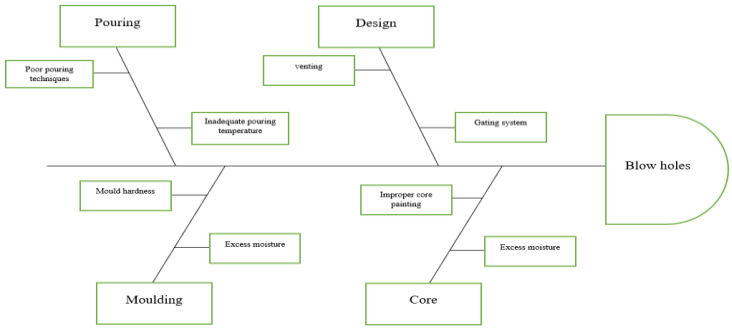


Figure 8. Fish-Bone Diagram

VII. WHY – WHY ANALYSIS:

Toyota used this technique of why why analysis to solve the problems. Sakichi Toyoda developed this method and this was first used within Toyota motors. It is a very important and critical component of problem solving. It was a very important part of induction training into the Toyota production system for the new employees. It prevents the recurrence of the problem or failure and helps in proper monitoring of the critical parameters contributing to the defect.

This method of why why analysis implies asking 5 times why for any problem which is to be analyzed. It states that after repeating why 5 times the causes due to which problem is occurring is clearly defined.

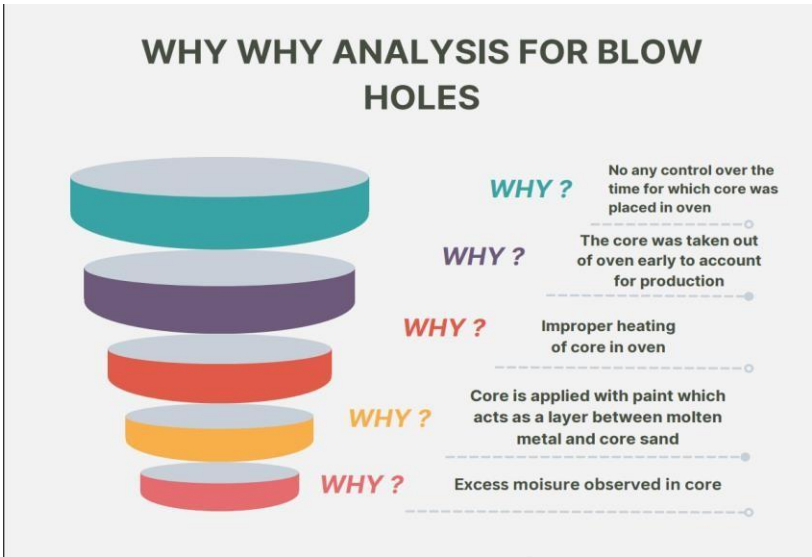


Figure 9. WHY-WHY Analysis

VIII. Results and Discussion:

The moisture content in core is found to be one of the major concerns leading to blow holes. The core need to be heated properly to reduce the moisture content and eliminate the blow holes.
The core is given a paint to prevent a direct contact between core sand and molten metal but this introduces moisture into the core and this needs to be eliminated.
This reduction in moisture is done by heating the core to a required temperature of around 40 degree Celsius. Initially it was observed that the there was no any control over the core heating process in oven. The operation was handled manually by a worker of handling the trolley of cores and putting it into oven. Sometimes the core was taken out of oven early to account for the need of production. This would lead to improper or insufficient removal of moisture from a core. So the heating of core to proper temperature was not monitored.

IX. Solution :

Table.4 Implementation of POKAYOKE

POKAYOKE IMPLEMENTATIOM		
Root Cause	**Temporary action**	**Permanent action**
Core was not heated to the specification temp (35-45 degree Celsius).	Core was passed through the core gasifier for torching to heat to the required temperature or it was allowed to cool down if it was overheated.	The manual operation of heating of core in oven is replaced by operating it automatically so that the trolley containing core will be heated for the required time and it will come out automatically after preset time through time sensor

One activity was performed where the temperature of core at different time intervals was noted at 6 trials. And the required time to achieve the proper and desired temperature of core is figured out .It is observed that at 30 minutes of time the core temperature is achieved around 40-50 degree celsius which ultimately leads to reduction in blow holes in a component.

So, the POKAYOKE was implemented to ensure that the trolley containing cores comes out of oven at 30 minutes only by incorporating time sensors .This also reduced the human effort of monitoring the process .

Table.5 Activity results

Minutes	Temperature Obtained (in °C)
10	29°C
20	37°C
30	45°C
40	53°C
50	64°C
60	75°C

X. Conclusion :

The reason behind carrying out this research was reducing the casting rejection in Wabco crankcase whichwas occurring majorly due to blow holes. It can be concluded that by implementing proper tools and techniques and following a structured approach any problem can be encountered. The implementation ofPOKAYOKE helped to reduce rejection rate from 7.83 % to 5.68%.

IX.References:

[1] U.Patil, Dr. K.H. Inamdar, "Numerical Simulation for Casting Defect Prediction. of Steel Casting", International Journal of Creative Research Thoughts, Vol 5, pp. 1489-1493, 4 November 2017.
[2] S. Nallusamy, R. Nivedha, E. Subash, V. Venkadesh, S Vignesh and P. Vinoth Kumar, "Minimization Of Rejection Rate using Lean Six Sigma Tool In Medium Scale Manufacturing Industry "International Journal of Mechanical Engineering and Technology, Vol.9, pp. 1184-1194 January 2018.
[3] M. Govindharaju, N Jayarajan, " An Empirical Study On The Control of An Rejection Rate In Instrument Cluster Assembly Line By Using Quality Control Tools and Kaizen", International Journal of Engineering Technologies and Management Research, Vol 7, pp. 14-23 , September 2020 .
[4] M. Latte, P. Chougule, "Blow - hole Defect Analysis of Cylinder Block " International Journal of Engineering Research and Technology , Vol 10, pp. 626-631, 2017.
[5] V.Nerle and S. Shinde, "Analysis of the Sand Drop Defect to Reduce the Rejection level of Cylinder Block Casting - A Case Study", International Journal of Engineering Research and Technology , Vol 2, pp.2183-2188, 9 September 2013.

[6] A Ghubade and A. Kumar , "Review on Casting Defects and Methodologies for Quality Improvement" , Journal of Emerging Technologies and Innovative Research , Vol 6, pp. 1008-1019, April 2019.
[7] Karthik M and S.Halesh,"Reducing the rejection and Improving Productivity of Pistons", International Journal of Innovative Science and Research Technology, Vol 4,pp. 81-85, January 2019.
[8]J.Feroze,G.Gokul,G.Kavin,J.kaleshwarah,"Study and Analysis of Process rejection in Output Gear",

International Journal of Research in Engineering Science and Management , Vol 3,pp. 373-376 ,June 2020.
[9] R.Pandey , V.upadhayay " Casting Defect Reduction in a Manufacturing Industry ",International Journal of Science ,Engineering and Technology.