

Cause & Effect Analysis on Defectiveness in Aluminum Component during Vertical Milling Centre Machining

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Abstract: Manufactured Components needs process capability index (C_{pk}) to appraise the quality of their items in order to improve quality and cut down the operating costs which enhance the productivity and help them to stay competitive market. In this work statistical quality control tools are used to evaluate the process capability in machined component. Causes for the occurrence of defect should be addressed during the process itself. Understanding the process and its parameter's effect and influence the manufactured component is necessary to detect the deviations. Reducing the inspection time and number of rejections during manufacturing is addressed using the Lean-Six Sigma principle. Lean six sigma principle and techniques are being applied to the process to understand causes of the defects and to reducing the defect by following the optimized defect free process designed based on lean six sigma. This help to reduce the inspection time as well as reworking time and also reduce the cost incurred with above and rejections. In this work a machined (VMC) component is considered for analysis. During the observation of hole diameter of the components some of the deviation are identified. The main objective of this work is to minimize the deviations and improved the process capability & performance capability.

Keywords: Cause and Effect diagram, Histograms, Control charts, Pareto analysis, Process capability, Performance capability.

1. INTRODUCTION

Meaning of Lean The term Lean was utilized without precedent for 1988, amid the International Motor Vehicle Program, which went for understanding the distinctions in profitability amongst Japanese and Western ventures. The term was then advanced by Womack in their book "The Machine That Changed the World". The wellspring of Lean Manufacturing originated from the Toyota Production System, it depends on the guideline of killing all types of squandered an incentive inside the venture. Administration standards of LM For some creators, LM is a long haul corporate system and a reasoning of corporate administration. Toyota prevailing with regards to incorporating LM in its association and has kept on doing as such for over 40 years. Liker proposed 14 administration standards that give a standout amongst the most acknowledged portrayals of LM:

1. Choices established on a long haul rationality, even to the weakness of here and now money related destinations;
2. The association of procedures into single piece streams to recognize issues;
3. Utilization of pulled frameworks (stream activated just by customer orders) to stay away from overabundance generation;
4. Generation smoothing;
5. Make a culture of prompt quality critical thinking the first run through;
6. Institutionalize assignments as the premise of consistent change and enable representatives;
7. Utilize visual review with the goal that no blame stays concealed;
8. Utilize dependable advances demonstrated over quite a while;
9. Prepare administrators with idealize information of the work, experience the logic and show it to others;
10. Prepare people and groups who apply the endeavor's logic;
11. Regard the system of accomplices and providers by empowering them and helping them to advance;
12. Collaborate with the field to plainly comprehend the circumstance;
13. Take choices consensually, by taking the time important, looking at in detail every one of the alternatives and applying choices rapidly;
14. Reflect deliberately and enhance constantly.

In whatever is left of this article, we consider Liker's 14 administration standards to cross them with the attributes of SMEs.

Another procedure of lean six sigma joining was proposed and tried in a flying machine industry by siddharthanramamoorthy from madras. The examination includes the gathering of the upper primary section entryway of a business stream. The Lean Six Sigma is a mix of lean and Six Sigma that emphasis on nonstop process change. Lean Manufacturing is an idea of enhancing the speed and effectiveness of an association by dispensing with squander. Then again Six Sigma is a persistent change arrange for that is proposed to diminish fluctuation. Cause of lean administration in America The part of Connecticut organizations this paper is to give

a recorded record of the huge part that Connecticut organizations and business pioneers had in the disclosure and appropriation of Lean administration and consequent spread of Lean administration in the US. As connected to equipment generation, lean assembling centers around wiping out all wellsprings of waste by applying the accompanying methodologies one piece work process, Take time, Pull framework Lean recognizes the bottlenecks in plan and advancement forms that include pointless postponements and cost. At the point when connected fittingly in a procedure industry, can help in taking out waste, improve the nature of item, and accomplish better and smooth control on operations and in this manner decreasing the generation cost and creation time. An efficient way to deal with distinguishing and dispensing with squander through consistent change, streaming the item at the draw of the client in quest for flawlessness.

2. Methodology

The raw material should be carried out the following process flow chart to perform for the manufacturing.

Table: 2 Sequence of Process

Process Description	Machine, jigs, fixtures tools for manufacturing	Process	Evaluation Measurement Technique
Slug Cutting	Band saw Cutting Machine	Raw Material	Raw Material, Dig. Vernier Caliper, Visual
Turning	Lathe	Turning	Dig. Vernier Caliper, Visual
Turning	Jobber, turning fixture	Turning	Surface Roughness Tester, Dig. Height Gauge, Dig. Vernier Caliper, Plain plug gauge, Contracer, Kroplin, Profile Projector
Drilling & Tapping	VMC with fixture	Drilling	2D height master, Dig. vernier caliper, Plain plug gauge, Thread plug gauge, Visual
Drilling & Tapping	VMC with fixture	Drilling	2D height master, Dig. vernier caliper, Plain plug gauge, Thread plug gauge, Visual
Milling	VMC	Milling	Profile Projector, Dig. Height Gauge, Dig. Vernier Caliper, Surface Roughness Tester, Visual
Drilling	VMC	Drilling	Dig. vernier caliper, Hometric, Contracer, Profile Projector, Visual
Deburring	Manual	Manual	Visual



Figure: 10 machining process

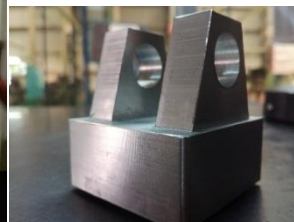


Figure: 11 work piece

Cause and Effect:

According to the manufacturing process of machined component, it involves in various process. During the various process causes deviations within the dimensions, it leads to defects. It can be reduces by using the cause and effect process in each and every process. It is easy to find the where the effects are raised due to some causes. Here some of the cause and effects diagrams according to process that are involved in the manufacturing process in machined component.

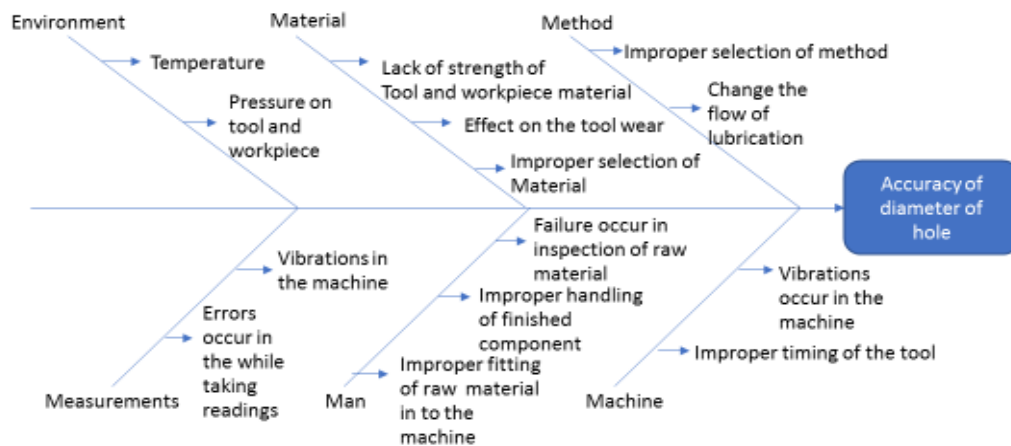


Figure: 15 Cause and Effect

Pareto Analysis:

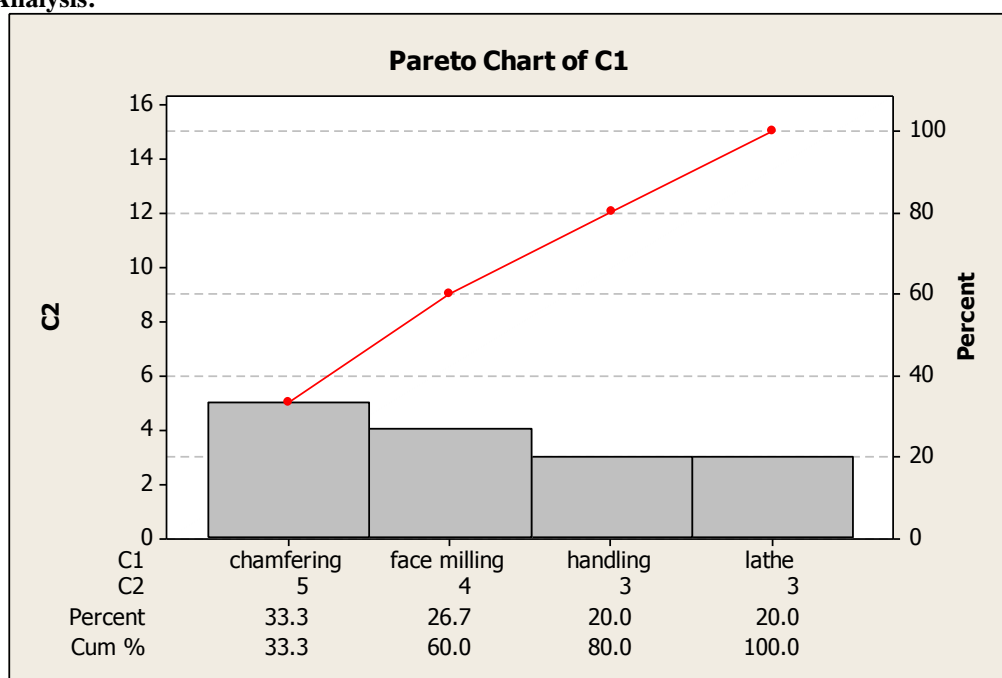


Figure: 16 Pareto Analysis

Pareto Analysis is a statistical technique in decision-making used for the selection of a limited number of tasks that produce significant overall effect

- Create a vertical bar chart with causes on the x-axis and count (number of occurrences) on the y-axis
- Arrange the bar chart in descending order of cause importance that is, the cause with the highest count first
- Calculate the cumulative count for each cause in descending order
- Calculate the cumulative count percentage for each cause in descending order. Percentage calculation: $\{\text{Individual Cause Count}\} / \{\text{Total Causes Count}\} * 100$.
- Plot the cumulative count percentage of each cause on the x-axis.
- Join the points to form a curve

Scatter diagram:

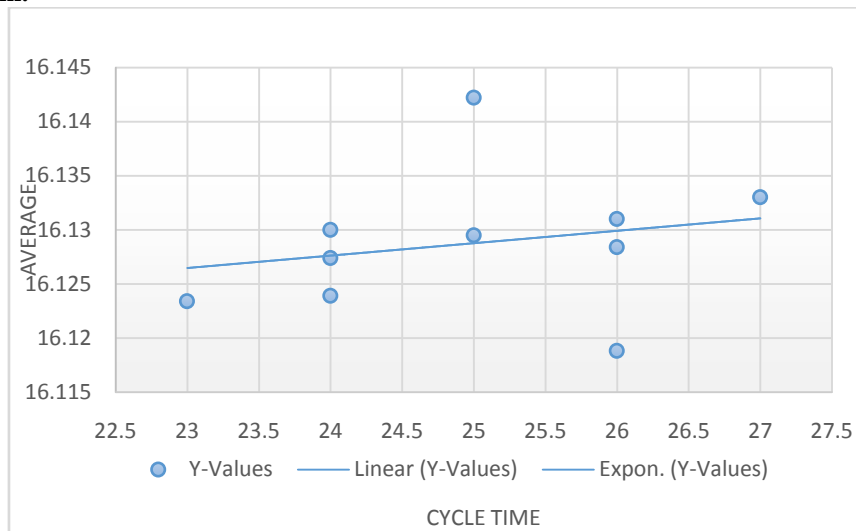


Figure: 17 Scatter Diagram

Scatter diagrams are a graphical tool that attempts to depict the influence in one variable as on the other one. A common diagram of this type usually displays point representing the observed values of one variable corresponding to another variable.

- On the vertical axis, we take cycle time of each sub-group size and on the horizontal axis, we take average of diametrical values
- Take the cycle time of 5-components in each sub-group size
- As the cycle time increases the number of deviations that are occur within the components
- Not only the cycle time, may also involve some other parameters to causes deviations within the hole
- It is easy way to estimate the components furtherly how many are going to defect with respective to required value

Results Observed

- Histogram:
Observed from the histogram the maximum number of components are produced in the range of 16.1269 to 16.1355
- Pareto chart:
Observed from the pareto chart the maximum number of rejections are occurred in the chamfering process
- Scatter diagram:
Observed from the scatter diagram the deviations are occurred in the cycle time. The cycle time of each group is different.
- Cause and effect diagram
It is a brainstorming process in this the observed that the causes are affected on the accuracy of hole diameter through tool wear, tool clamping, tool feed, tool speed, cutting fluids & operator efficiency.

Remedial Measures suggested

Process Parameters Optimization: During the VMC machining process multiple operations are performed, to optimize the parameters of the turning, milling, drilling, with various tools needed to be optimize the process with defect free. Speed rate of spindle, feed rate of tool bit are highly crucial for the improvement in the reduced cycle time and tool setting time. And also, it will aid to reduce the tool wear and improve the surface appearance will also aid the production process and reduce the defects. Leads to results in reduce the inspection time. Design expert statistical software like Minitab aid to optimize the process parameters. Optimization techniques are used to evaluate the optimized parameters for the machining and to reduce the tool wear, cycle time and tool setting time. Preventive maintenance and break down maintenance are also should to predicted to evaluate the Overall Equipment Efficiency.

3. Conclusions:

The objective of the work is to investigate the various reasons for the defects that occur in machined components. During mid-low volume production, quality check for each and every component is tedious work leading to increase in production cost. Hence causes for the defect should be addressed during the process itself. Reducing the inspection time and number of rejections during manufacturing is addressed using Lean-Six Sigma principles.

The techniques such as Histogram, Pareto Analysis, X bar chart, R bar chart, Cause & Effect diagram, Scatter diagram are plotted to understand the defects & its causes. Cause and Effect diagram are plotted to for the thorough understanding about the parameters which influence on the material requirements. Scatter plot and the Pareto analysis are used to find the defect occurring region and need to be consider through very special response for the eliminating the causes and optimize the parameter for the operation.

The above techniques are applied to understand the defect and then to eradicate the same during serial production. This helps to reduce the inspection as well as rework times leading to reduction in cost. Deviations in hole diameters during the manufacturing of VMC machined components were identified and improvements such change in lubricants & cutting fluids during high speed machining which increase the production rate and reduce the defects through the improvement as coolant during the process are key points suggested through lean six sigma principles.

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