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# Defect Analysis through the Implementation Statistical Quality Control Tools on VMC Machined Aluminium Component

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**Abstract:** Produced components needs process capacity record (Cpk) to evaluate the nature of their things with a specific end goal to enhance quality and chop down the working costs which improve the profitability and help them to remain focused market. In this work process capability of machined components was evaluate by used statistical quality control tools due to this occurrence defects should be identified process itself. Understanding the procedure and its parameter's impact and impact the produced part is important to distinguish the deviations. Number of rejections during production is identified and decreasing the inspection time using the lean six-sigma rule. Lean six-sigma help to decrease the inspection time as well as reworking time and also diminish the cost acquired with above and dismissals. In this work a VMC machined component is considered for analysis. The some of the devastations were identified at hole diameter of component. The major objective of this work is to reduce the deviations and enhance the process capability & performance capability.

**Keywords:** Statistical Quality Control, X-bar Chart, R-bar Chart, Histogram, Process capability, Performance capability

## I. INTRODUCTION

Which means of Lean the term Lean was used unprecedented for 1988, in the midst of the International Motor Vehicle Program, which went for understanding the qualifications in productivity among Japanese and Western endeavors [1]? The term was then exceptional by Womack in their book "The Machine That Changed the World" [2]. The wellspring of Lean Manufacturing began from the Toyota Production System, it relies upon the rule of executing a wide range of wasted a motivating force inside the wander [3]. Organization gauges of LM For a few makers, LM is a whole deal corporate framework and a thinking of corporate organization [4]. Toyota winning with respect to consolidating LM in its affiliation and has continued doing accordingly for more than 40 years [5]. Liker proposed 14 organization measures that give a champion amongst the most recognized depictions of LM

- A. Choices established on a long haul rationality, even to the weakness of here and now money related destinations;
- B. The association of procedures into single piece streams to recognize issues;
- C. Utilization of pulled frameworks (stream activated just by customer orders) to stay away from overabundance generation;
- D. Generation smoothing;
- E. Make a culture of prompt quality critical thinking the first run through;
- F. Institutionalize assignments as the premise of consistent change and enable representatives;
- G. Utilize visual review with the goal that no blame stays concealed;
- H. Utilize dependable advances demonstrated over quite a while;
- I. Prepare administrators with idealize information of the work, experience the logic and show it to others;
- J. Prepare people and groups who apply the endeavor's logic;
- K. Regard the system of accomplices and providers by empowering them and helping them to advance;
- L. Collaborate with the field to plainly comprehend the circumstance;
- M. Take choices consensually, by taking the time important, looking at in detail every one of the alternatives and applying choices rapidly; and
- N. 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.

## II. METHODOLOGY

During manufacturing critical dimension in the component, its dimensions are measured using a 2D height gauge as shown in figure 1 for inspection. The hole diameters are observed and plotted in table 1



Figure 1: 2D Height Gauge

## III. DATA COLLECTION & ANALYSIS OF DATA

Table 1: Hole Diameter (mm)

S.NO	1	2	3	4	5	6	7	8	9	10
1	16.1213	16.1594	16.1315	16.1213	16.1340	16.1442	16.1340	16.1137	16.1290	16.1239
2	16.1620	16.1340	16.1290	16.1264	16.1112	16.1696	16.1290	16.1010	16.1188	16.1315
3	16.1239	16.1239	16.1061	16.1213	16.1340	16.1112	16.1874	16.1340	16.1340	16.1442
4	16.1366	16.1112	16.1290	16.1163	16.1290	16.1315	16.1366	16.1340	16.1315	16.1188
5	16.1061	16.1290	16.1213	16.1340	16.1340	16.1086	16.1239	16.1112	16.1340	16.1188

Table 2: Calculation for Histogram (mm)

S.NO	1	2	3	4	5	6	7	8	9	10
X-large (mm)	16.1620	16.1594	16.1315	16.1340	16.1340	16.1696	16.1874	16.1340	16.1340	16.1442
X-small (mm)	16.1061	16.1112	16.1061	16.1163	16.1112	16.1086	16.1239	16.1010	16.1188	16.1188
Range	0.0559	0.0482	0.0254	0.0177	0.0228	0.0610	0.0635	0.0330	0.00152	0.0254
Average	16.1300	16.1315	16.1234	16.1239	16.1284	16.1330	16.1422	16.1188	16.1295	16.1274

A. X-Bar Chart

1) X-bar

$$\text{Upper control limit} = \bar{x} + A_2 * \bar{R}$$

$$\text{Lower control limit} = \bar{x} - A_2 * \bar{R}$$

2) R-bar

$$\text{Upper control limit} = D_4 * \bar{R}$$

$$\text{Lower control limit} = D_3 * \bar{R}$$

3) Other Formulas

$$\text{Standard deviation } (\sigma) = \frac{\bar{R}}{2}$$

$$\text{Process capability } C_p = \frac{T}{6\sigma}$$

$$\text{Starting point of interval} = X_{\min} - \frac{LC}{2}$$

$$\text{Interval} = \frac{\text{Process Width}}{\text{Tolerance}}$$

Collect as many subgroups as possible before calculating control limits. With smaller amounts of data, the X-bar and R chart may not represent variability of the entire system. The more subgroups you use in control limit calculations, the more reliable the analysis. Typically, twenty to twenty-five subgroups will be used in control limit calculations. X-bar and R charts have several applications. When you begin improving a system, use them to assess the system's stability. After the stability has been assessed, determine if you need to stratify the data. You may find entirely different results between shifts, among workers, among different machines, among lots of materials, etc. To see if variability on the X-bar and R chart is caused by these factors, collect and enter data in a way that lets you stratify by time, location, symptom, operator, and lots. You can also use X-bar and R charts to analyze the results of process improvements. Here you would consider how the process is running and compare it to how it ran in the past. Do process changes produce the desired improvement? Finally, use X-bar and R charts for standardization. This means you should continue collecting and analyzing data throughout the process operation. If you made changes to the system and stopped collecting data, you would have only perception and opinion to tell you whether the changes actually improved the system. Without a control chart, there is no way to know if the process has changed or to identify sources of process variability

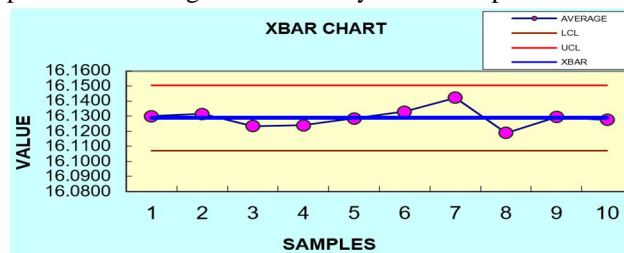


Figure 2: X-Bar Chart

An x-bar chart or average chart

- 1) We take 50 samples are taken and arrange them in 5-sub-group size and 10 as number of sub-groups.
- 2) On the vertical axis, we take average of 5-sub-group size each and on the horizontal axis, we take number of sub-group size as 10
- 3) Indicate the U.C.L & L.C.L values on the graph, by this it is easy to find out how many components are not within the limits
- 4) Formulas used to calculate the control limits  $U.C.L = \bar{X} + A_2 * \bar{R}$  and
- 5)  $L.C.L = \bar{X} - A_2 * \bar{R}$
- 6) Obtain values are  $U.C.L = 16.1505$  and  $L.C.L = 16.1070$
- 7) Plot the average value readings on graph with respective to the number of sub-group size
- 8) Make a line by adding all these values
- 9) Then it shows clearly that the components are in within the limits or not

**B. R-Bar Chart**

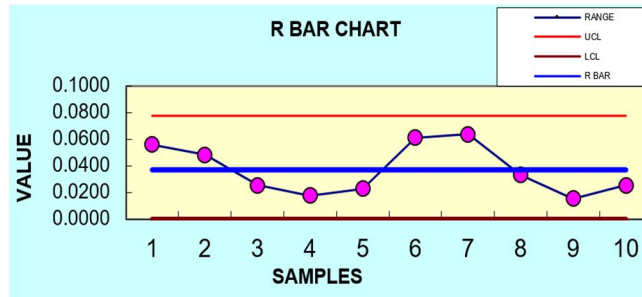


Figure: 3 R-Bar Chart

An R-chart (or range chart) is specifically designed for detecting changes in variability

- 1) On the vertical axis, we take range values of 5-sub-group size each and on the horizontal axis, we take number of sub-group size as 10
- 2) Range means difference of maximum values to minimum value
- 3) Indicate the U.C.L & L.C.L range values on the graph, by this it is easy to find out how many components are not within the limits
- 4) Formulas used to calculate the control limits  $U.C.L = D_4 * R\text{-bar}$  and
- 5)  $L.C.L = D_3 * R\text{-bar}$
- 6) Obtain values are  $U.C.L = 0.0776691$  and  $L.C.L = 0$
- 7) Plot the plot value readings on graph with respective to the number of sub-group size
- 8) Make a line by adding all these values
- 9) Then it is clearly shows that variability values of components are in within the limits or not

**C. Histogram**

A histogram is a bar graph which shows frequency distribution

- 1) On the vertical axis we are taking frequencies and on the horizontal axis is plotted as intervals of components diameters
- 2) Plot the frequencies values according to its intervals
- 3) The height of each bar should be equal to the frequency of its corresponding interval
- 4) The cumulative frequency values are taken by cumulating the number of components that are occur between the intervals according to the frequencies
- 5) Indicate the values of U.S.L & L.S.L to find the number of components are accepted final components and the defected components
- 6)  $U.S.L = 16.145$  and  $L.S.L = 16.095$

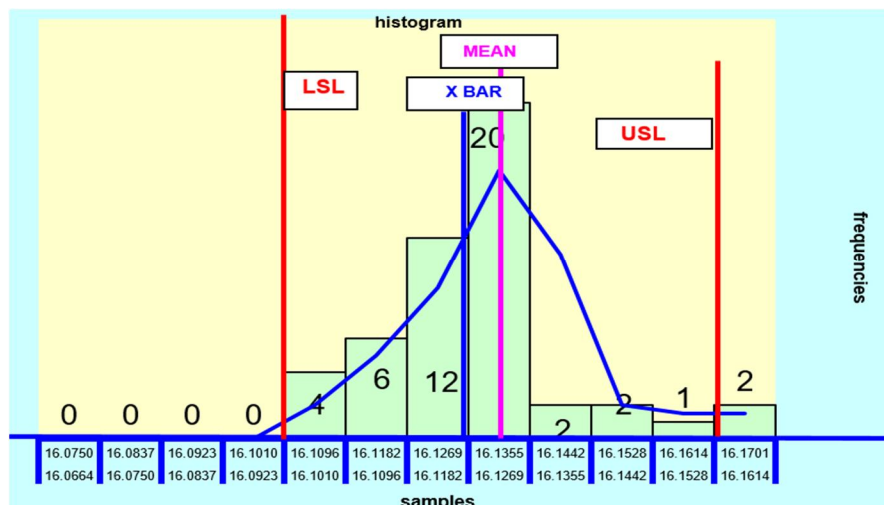


Figure: 4 Histogram

Table: 3 Final Calculation

Descriptions	Values
$U.C.L = \bar{X} + A_2 * \bar{R}$	16.1505219
$L.C.L = \bar{X} - A_2 * \bar{R}$	16.10709
$U.C.L = D_4 * \bar{R}$	0.0776691
$L.C.L = D_3 * \bar{R}$	0
$Std.Dev. = \sigma = \bar{R} / D_2$	0.01583
$C_p = (T / 6\sigma)$	0.52658
$C_{pK}$	0.34114

Table: 4 Frequency Distribution

Interval		Number of Frequency	Cumulative Frequency
16.0664	16.0750	0	0
16.0750	16.0837	0	0
16.0837	16.0923	0	0
16.0923	16.1010	0	0
16.1010	16.1096	4	4
16.1096	16.1182	6	10
16.1182	16.1269	12	22
16.1269	16.1355	20	42
16.1355	16.1442	2	44
16.1442	16.1528	2	46
16.1528	16.1614	1	47
16.1614	16.1701	2	49

The above table 4 showed that the number of components should be produced in the interval shows that the number of components categorized in accordance with the its range. This helps to address the causes for the higher number deviation in the manufactured components through analyzing the cause and effect diagram.

#### IV. DISCUSSION

X-Bar & Range Charts: Here average of all the components are varies within the control limits and also all are in acceptable. Variable-control chart in which range (R) of a subgroup to track , and all the values are in stable mode within a process. Histogram: Observed from the histogram the maximum number of components are produced in the range of 16.1269 to 16.1355. From Histogram, X-bar chart, R-bar chart are used to find the UCL – upper control limit, LCL- lower control limit are used to evaluate the process to be defect free before going to the customer, where customer specifies the requirements through USL & LSL – upper specified limit & lower specified limit.

#### V. CONCLUSIONS

The main aim of this work is identifying the various reasons for the defects that are occur in production. During mid-low manufacturing industries the cost of the product increase because of quality check for each and every component. From Histogram, X-bar chart, R-bar chart are used to find the UCL – upper control limit, LCL- lower control limit are used to evaluate the process to be defect free before going to the customer, where customer specifies the requirements through USL & LSL – upper specified limit & lower specified limit.

The above techniques are applied to understand the defect and then to eradicate the same during serial production.



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