Defect Analysis of Product Using Statistical Process Control

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Abstract

Statistical process control (SPC) techniques are employed to monitor production process over time to detect changes in process performance. SPC helps ensure the process operates efficiently, producing more specification conforming products with less waste. SPC applied to any process where the 'conforming products' output can be measured. Key tools used in SPC includes run chart, control chart, a focus on continuous improvement. In industry, during machining of the component some defects are occurs due to blunt tool, so there is rejection of that component , hence to overcome this problem there is need to implement the SPC with its technique of control chart such as $\overline{X}$ and R chart . The sharda motors is the industry in which the parts of automobile suspension system are manufactured. In this industry, during boring operation of suspension system (upper control arm 105), some variations are occurred in the dimensions of components. Due to this there is rejection of that component. Hence there is need to implement such a quality method which gives early detection and prevention of problems rather than the correction of problem after they have occurred.

Keywords: *Control charts, Process capability, Process monitoring, Process variation, Statistical process control*

I. INTRODUCTION

Statistical process control (SPC) is a powerful collection of problem solving tools useful in achieving manufacturing process stability and improving capability through the reduction of variability. SPC refers to some statistical methods used extensively to monitor and improve the quality and productivity of manufacturing processes and service operations. It is a sub-area of SQC, consists of methods for understanding, monitoring, and improving process performance over time. It may be used when a large number of similar is being produced. . The main objective of SPC is to give a signal when the process changes, i.e. its mean moves away from the target value and its variability increases. In essence, SPC is used to support manufacturing operations. When a signal shows that the process is changing, it is the up to the machine operator to trigger a corrective action, traditionally, the most important SPC tool is control charts, which graphically represents process data and shows whether the process is under statistical control or not. It detects any change in a process that may affect the quality of the output.

Initially in the industry during machining of part of suspension system (upper control arm 105), on boring machine, there are some variations are observed in dimensions of inner diameter of components. Also inspection of components is carried out by GO NO-GO gauges. GO gauges should check all dimensions in one pass. If it is go into the component then dimensions Aare OK, if it is not go into the component then the component dimensions are NOT OK, similar for no go gauge. After inspection of component, which is coming out from boring operation, it is observed that there are variations in dimensions of so many components, due to that the rejection of that component, so there is need to check the average performance of the process to find out possible causes of variation in dimensions in component.

Fig No.1Upper control arm (105)

METHODOLOGY:

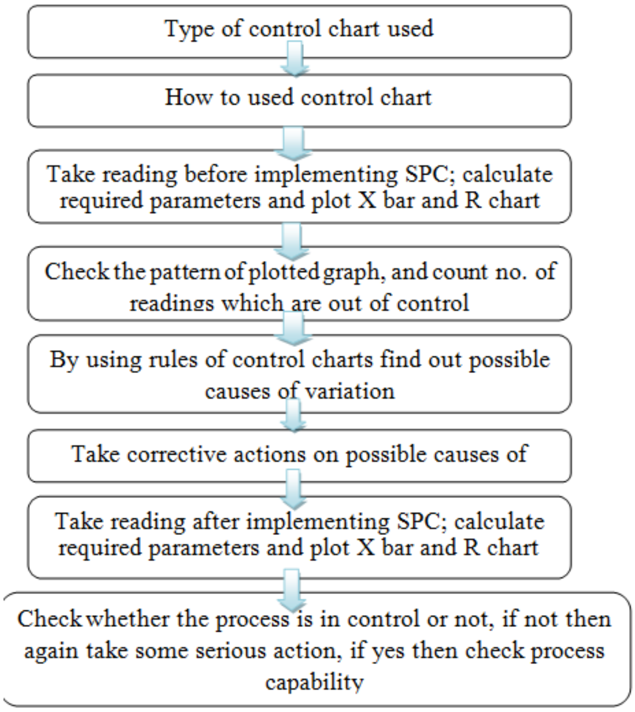


Fig No.2 Methodology of case study

BEFORE IMPLEMENTING SPC:

The condition of process before implementing SPC

Table No. 1 observations before implementing SPC

SR NO	1	2	3	4	5	6	7	8	9	10
X1	40.16	40.31	40.19	40.18	40.28	40.26	40.17	40.30	40.32	40.31
X2	40.20	40.28	40.25	40.25	40.32	40.31	40.18	40.25	40.27	40.30
X3	40.19	40.30	40.18	40.24	40.31	40.27	40.21	40.25	40.29	40.28
X4	40.20	40.29	40.18	40.25	40.26	40.27	40.17	40.27	40.28	40.28
X5	40.18	40.28	40.18	40.23	40.26	40.26	40.20	40.29	40.27	40.29
R	0.04	0.03	0.07	0.07	0.06	0.05	0.04	0.05	0.05	0.02

Here, For,

$R= (X_{MAX}-X_{MIN})$

R bar = ∑R/ (no. of samples)

= (0.04+0.03+0.07+0.07+0.06+0.05+0.04+0.05+0.05+0.02)/10 = 0.048

For, $\bar{X}1$ =∑X/n

= (40.16+40.20+40.19+40.20+40.18)/5 = 40.18611

Similarly,

$\bar{X}1$	$\bar{X}2$	$\bar{X}3$	$\bar{X}4$	$\bar{X}5$	$\bar{X}6$	$\bar{X}7$	$\bar{X}8$	$\bar{X}9$	$\bar{X}10$
40.186	40.288	40.196	40.23	40.288	40.274	40.186	40.272	40.286	40.292

X double bar = $\sum\bar{X}$/ (no. of samples.)

=

(40.186+40.288+40.196+40.23+40.288+40.274+40.186+40.272+40.286+40.292)/10= 40.2498

For X bar chart

$UCLx = \bar{\bar{x}} + A2\ \bar{R}$= 40.2498 + (0.577*0.048) = 40.277

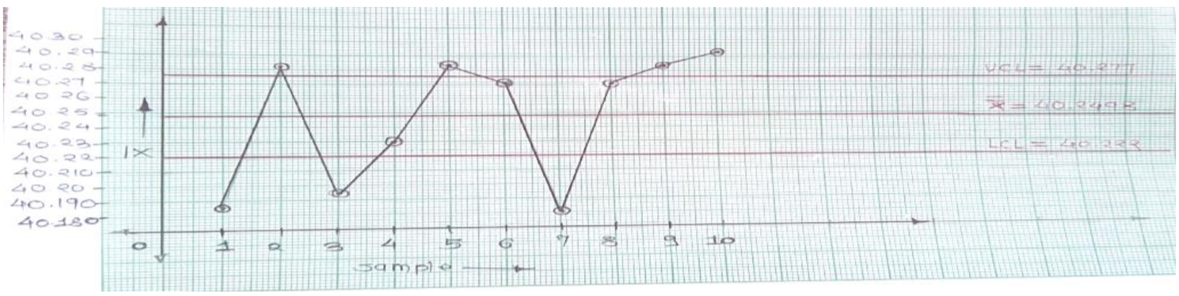
$LCLx = \bar{\bar{x}} - A2\ \bar{R}$= 40.2498 - (0.577*0.048) = 40.211

For $\bar{R}$ chart,

$UCL_R = D4\ \bar{R}$ = 2.114*0.048= 0.1014

$LCL_R = D3\ \bar{R}$= 0*0.048= 0

$\bar{X}$ CHART:



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R CHART:

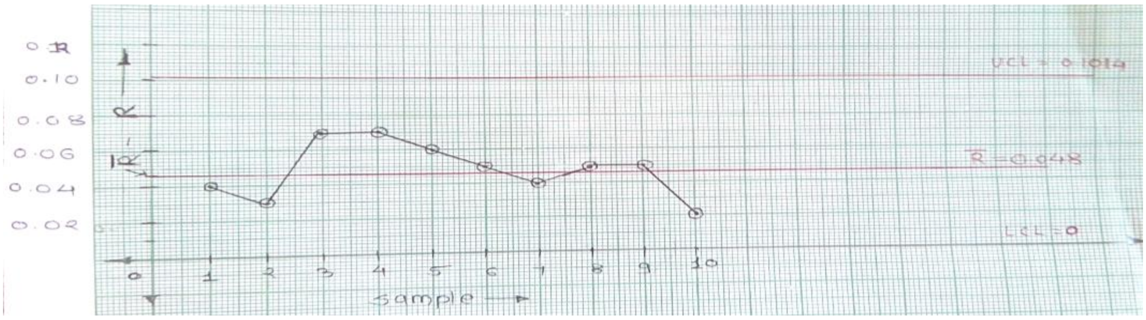


Fig No. 3 Control charts before implementing SPC

From above graph it is indicate that process is out of control and pattern of this process is trend type.

POSSIBLE CAUSES OF PROCESS VARIATION

From above rules and pattern of control charts (table no. 1 and table no.2), it is easy to find out possible causes of variation. There are certain reasons which are responsible for variation in dimensions during boring operation. They are:

- Due to bunting of tool after performing operation on certain number of components
- Due to operator change or it's depended upon operator skill
- Due to change in coolant effectiveness after certain period.
- By avoiding above possible causes, it is observed that the variation in the dimension of component is less and process became is in control.

HOW TO AVOID POSSIBLE CAUSES OF VARIATION:

- Find out the tool life.
- Changing the tool after specific period of time, and before it gives adverse effect on component, which makes the component defective.
- Operator which works on machine should be highly skilled person.
- Check the coolant frequency on daily basis, and find out period after which coolant should change to obtain better performance of coolant.

STATISTICAL PROCESS CONTROL STUDY:

Part name: upper control arm (105)

Instrument to check inner diameter of component: bore dial gauge

Table No. 2 observations after implementing SPC

SR.NO	1	2	3	4	5	6	7	8	9	10
1	40.20	40.16	40.22	40.18	40.19	40.18	40.17	40.22	40.21	40.17
2	40.16	40.18	40.18	40.18	40.20	40.18	40.18	40.18	40.16	40.19
3	40.18	40.19	40.20	40.22	40.17	40.17	40.16	40.15	40.22	40.18
4	40.20	40.22	40.12	40.17	40.18	40.17	40.19	40.17	40.20	40.21
5	40.18	40.19	40.20	40.19	40.17	40.15	40.18	40.18	40.15	40.16
R	0.040	0.060	0.040	0.050	0.030	0.03	0.03	0.07	0.07	0.05

$R= (X_{MAX}-X_{MIN})$, R bar = $\sum R$/ (no. of samples)

= (0.040+0.060+0.040+0.050+0.030+0.030+0.030+0.070+0.070+0.050)/10 = 0.047

$\bar{X}1 = \sum X/n$= (40.20+40.16+40.18+40.20+40.18)/5= 40.184

Similarly,

$\bar{X}1$	$\bar{X}2$	$\bar{X}3$	$\bar{X}4$	$\bar{X}5$	$\bar{X}6$	$\bar{X}7$	$\bar{X}8$	$\bar{X}9$	$\bar{X}10$
40.184	40.188	40.184	40.192	40.178	40.170	40.176	40.180	40.188	40.182

X double bar = $\sum \bar{X}$/ (no. of samples.)

= (40.184+40.188+40.184+40.192+40.178+40.170+40.176+40.180+40.188+40.182)/10

= 40.1840

For X bar chart

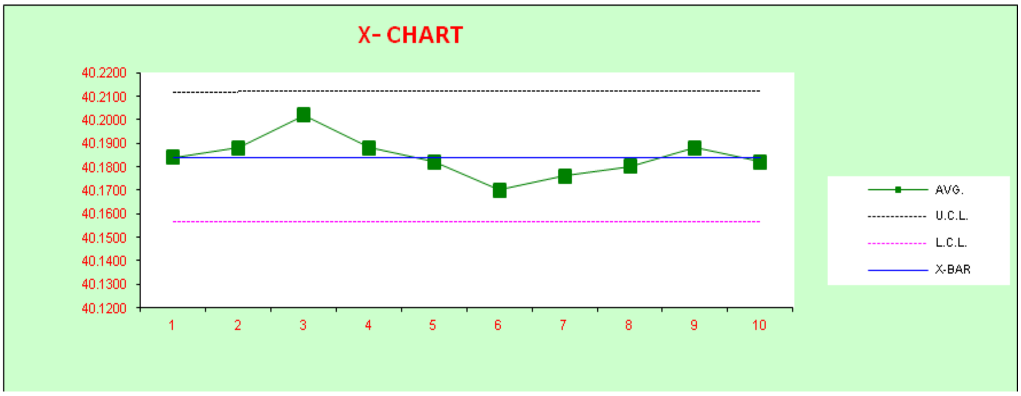
$UCL_x = \bar{\bar{x}} + A2\ R$ = 40.184 + (0.577*0.047)= 40.211

$LCL_x = \bar{\bar{x}} - A2\ \bar{R}$ = 40.184 - (0.577*0.047)= 40.15688

For $\bar{R}$ chart, $UCL_R = D4\ \bar{R}$ = 2.114*0.047= 0.099358

$LCL_R = D3\ \bar{R}$= 0*0.047= 0

X bar chart:



R bar chart:

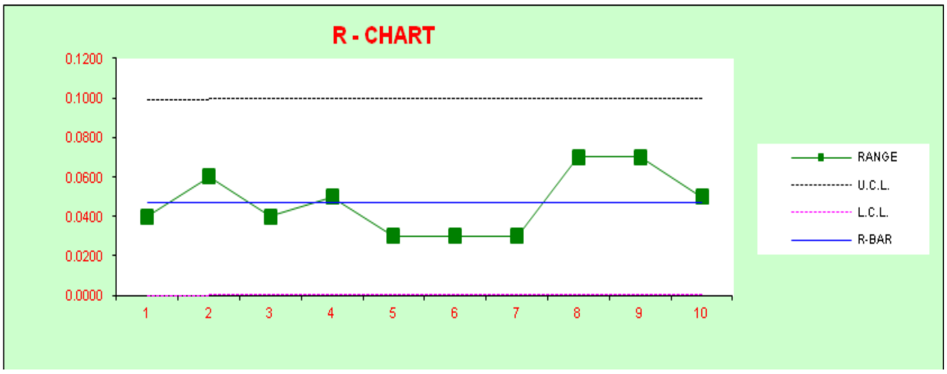


Fig No. 4 R control chart

From both the charts, it is conclude that the process is in control.

PROCESS CAPABILITY: The **process capability** is a measurable property of a process to the specification, expressed as a process capability index (e.g., C_{pk} or C_{pk}) or as a performance capability index. (e.g., P_{pk} or P_{pk}).

$\sigma = R/d2 = 0.047/2.326 = 0.020$

Cp = 2.02980 Cpk = 1.97810

Table no. 3 values of Cp and Cpk

Value of Cp	Value of Cpk	Remark
<1.33	<1.00	Unacceptable process
1.33 to 1.67	1.00 to 1.33	OK process
>1.67	>1.33	Good process

From table it is cleared that calculated Cp and Cpk gives good process indication.

CONCLUSION

Statistical process control (SPC) is a set of statistical method based on the theory of variation that can be used to make sense of any process or outcome measured over time, usually with the intension of detecting improvement or maintaining a high level of performance. From above calculated results it is conclude that SPC with control charts shows graphical representation of process, which easily indicate that whether the process is capable of producing parts with desired specifications or not.

FUTURE WORK

This work presents a methodology for applying SPC through control charts for achieving high level process maturity in defined level organizations considering the metrics effort deviation and schedule deviation. Due to the time constraints and the availability of the data it was not possible for this research to consider the following areas and it is the opportunity for the researchers to expand the research in the following areas.

- The research focuses only on one particular organization, which will provide a scope for future researchers to cover different software organizations.
- A major improvement would be the ability to change the control limits and study the applicability of the SPC and control charts in organizations.
- The research could be expanded to find the applicability of SPC in level 2 or level 1 company to achieve high level process maturity.

In these ways, future researcher could look into these aspects in order to further improve and refine the research findings.

REFERENCES:

I. Kamarul A. Ibrahim and Ming T. Tham, "Towards Active Statistical Process Control", IEEE, June 1995.

II. TimoLiukkonen, Aulis Tuominen "Case Study of SPC in Circuit Board Assembly: Statistical Mounting Process Control" 24th international conference on microelectronics, IEEE, 2004, volume 2

III. Hanida Ahmad Shari, Norazlin Khalid, NoraidahSahari, HairullizaMohamad Judi, “Statistical Process Control in Plastic Packaging Manufacturing: A Case Study”, IEEE, 2009.

IV. Gasper Skulj, RokVrabic, Peter Butala, AlojzijSluga “ Statistical Process Control As A Service: An Industrial Case Study”, ELSEVIER, 2013, pp. 401-406

V. L. Guerra, S. D. Souse, E. P. Nunes “Statistical Process Control Automation in The Final Inspection Process: An Industrial Case Study”, IEEE, 2013.

VI. PavolGejdos “Continuous Quality Improvement by Statistical Process Control”, ELSEVIER, 2015, pp. 565-572.

VII. Mohammed Alamine El Houssaini, AbdessadekAaroud, Ali El Hore, And JalelBenothman, “Detection of Jamming Attacks in Mobile Ad Hoc Networking Using Statistical Process Control”, ELSEVIER, 2016, pp. 26-33.

VIII. NurulAini, RatnoKusumaningrum, Mustafid, ErziHidayat “Statistical Process Control Systems in Apparel Production”, 2017 International Conference on Information Technology Systems and Innovation, IEEE, 2017.

