Comparison of control charts of variables vs attributes

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Control charts for variables	Control charts for attributes
(i) A seperate chart is needed for each quality characteristic under consideration.	(i) A single chart is enough to decide for a no. of quality characteristics under consideration
(ii) Small samples serve the purpose very well.	(ii) Large samples are needed for correct conclusions.
(iii) The cost of inspection of units is large.	(iii) Cost of inspection of units is small as compared to measurement data.
(iv) It involves more computation labour.	(iv) The computations are simple.
(v) The control charts are sensitive to assignable causes.	(v) The control charts are less sensitive to assignable causes.
(vi) Control charts provide better quality control.	(vi) This charts are not very effective in keeping the quality control.

(vii) A control chart for variable can hardly be used for attributes.	(vii) Control charts for attributes can be used in lieu of charts for variables.
(viii) Samples from sub-groups should preferebly be of equal size	(viii) The need for equal size of samples is not as much as in the case of control charts for variables.

p-chart- (Population fraction defective chart)

While dealing with attributes a process will be adjudged in statistical control if all the samples or sub-groups are ascertained to have the same population proportion P.

Suppose P is the population fraction defective in a process during a fixed period, i.e., in the lot of items produced during that fixed period, the judgement about the process is based on the fraction defective p in a sample of size n. Let the sample contains d defectives. Hence $p = \frac{d}{n}$. Also,

$$E(p) = E\left(\frac{d}{n}\right)$$

$$= P$$

and $$S.D(p) = \sqrt{var(p)} = \sqrt{var\left(\frac{d}{n}\right)}$$

$$= \sqrt{\frac{1}{n^2} var(d)}$$

$$= \sqrt{\frac{nP(1-P)}{n^2}}$$

$$= \sqrt{\frac{P(1-P)}{n}}$$

To test whether the process is under control or not, we construct a p-chart. For this, the sample of items are taken and inspected. The proportion of defectives in each sample is calculated. In this chart p values are taken on the y-axis and the sample no. on the x-axis. Since, an unit can either be defective or non-defective, the variables ~~dipo~~ dichotomous and will follow binomial distribution. Let p' be the specified value of P then.

$$S.D(p') = \sqrt{\frac{p'(1-p')}{n}}$$

The control chart will be constructed on the basis of the following limits.

$$UCL = p' + 3\sqrt{\frac{p'(1-p')}{n}}$$

$$CL = p'$$

$$LCL = p' - 3\sqrt{\frac{p'(1-p')}{n}}$$

If the value of p is not known then p is to be estimated. Let d_i be the no. of defectives for the i^{th} sample of size n_i. Then p_i the fraction defective for the i^{th} sample of size n_i is given by:-

$$\cancel{\bar{p} = \frac{\sum d_i}{\sum n_i} = \frac{\sum n_i p_i}{}}$$

$$p_i = \frac{d_i}{n_i}. \text{ Then the population}$$

proportion p ~~estimated by~~ the statistic $\bar{p}$ given by:-

$$\bar{p} = \frac{\sum d_i}{\sum n_i} = \frac{\sum n_i p_i}{\sum n_i}, \quad i = 1, 2, \ldots k$$

~~of may~~ be remark that $\bar{p}$ is an unbiased estimator of p. In this case

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$CL = \bar{p}$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

In general it is preferred that the samples of equal size be selected, i.e., $n_1 = n_2 = \cdots = n_k = n$. then we have,

$$\bar{p} = \frac{\sum d_i}{nk} = \frac{1}{k} \sum p_i$$

Sample p values are plotted on the graph against sample no. If any points lies outside the control limits, it is concluded that the process is out of control, otherwise not. The points which lie outside the upper control line are called high spots. This points indicate a deterioration in the production process. Such a situation should immediately be reported to production incharge. Again the points fall below the lower control line, they are called low spots. This points show an improvement in the production process or give greater assurance of the good quality of the product. But it should be confirm that there is no slackness on the part of the checker.