Statistical Quality Control

Semester IV **STAT CC410**

Unit 2

- Comparison between Control Charts for Variables and Control Charts for Attributes
- Attributes Control Chart
- Variables Control Charts
- Choosing the Proper Type of Control Chart

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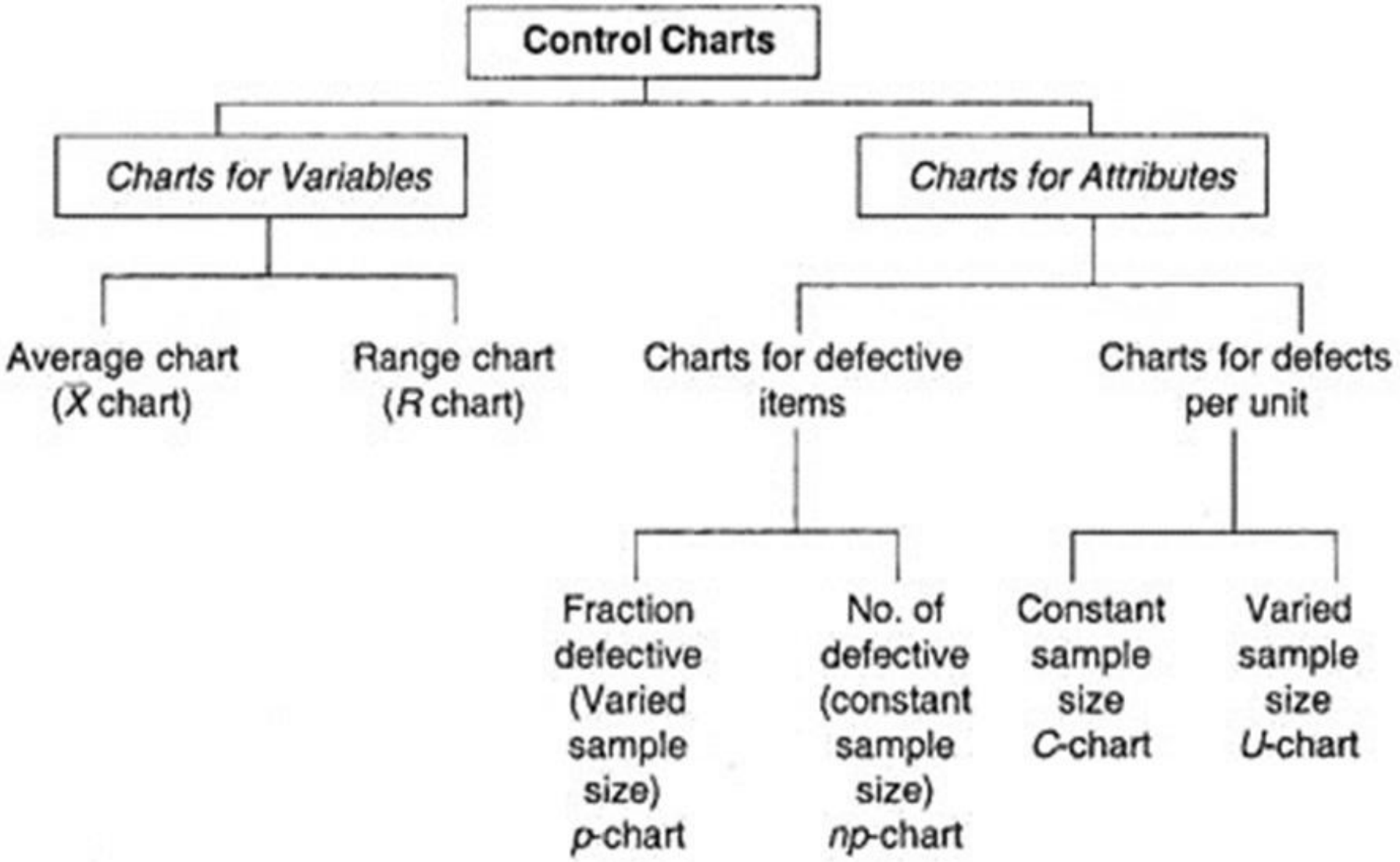
Comparison between Control Charts for Variables and Control Charts for Attributes

- In many applications, the analyst will have to choose between using a variable control chart, such as $\bar{x}$ and R charts, and an attributes control chart, such as the p chart.
- In some cases, the choice will be clear-cut. For example, if the quality characteristic is the colour of the item, such as might be the case in carpet or cloth production, then attributes inspection would often be preferred over an attempt to quantify the quality characteristics 'colour'.
- In other cases, the choice will not be obvious, and the analyst must take several factors into account in choosing between attributes and variable control charts.

Control Charts



Attributes Control Charts

- Attributes control charts have the advantage that several quality characteristics can be considered jointly and the unit classified as nonconforming if it fails to meet the specification on any one characteristic.
- On the other hand, if the several quality characteristics are treated as variables, then each one must be measured, and either a separate $\bar{x}$ and *R* chart must be maintained on each or some multivariate control technique that consider all the characteristics must simultaneously be employed.
- There is an obvious simplicity associated with the attributes chart in this case.
- Furthermore, extensive and time consuming measurements may sometimes be avoided by attributes inspection.

Variables Control Charts

- Variable control charts, in contrast, provide much more useful information about process performance than does an attributes control chart.
- Specific information about the process mean and variability is obtained directly.
- In addition, when points plot out of control on variable control charts, usually much more information is provided relative to the potential *cause* of that out-of-control signal.
- For a process capability study, variables control charts are almost always preferable to attributes control charts.
- The exceptions to this are studies relative to nonconformities produced by machines or operators in which there are a very limited number of sources of nonconformities, or studies directly concerned with process yields and fallouts.

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- Perhaps the most important advantage of the $\bar{x}$ and *R* control charts is that they often provide an indication of impending trouble and allow operating personnel to take corrective action before any defectives are actually produced.
- Thus, $\bar{x}$ and *R* charts are *leading indicators* of trouble, whereas *p* charts (or *c* and *u* charts) will not react unless the process has already changed so that more nonconforming units are being produced.
- This increased efficiency of the $\bar{x}$ and *R* charts is much more pronounced when *p* is small, but less so when *p* is close to 0.5.

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- For illustration, consider the process mean is at μ_1, few nonconforming units are produced. Suppose the process mean begins to shift upward. By the time it has reached at μ_2, the $\bar{x}$ and *R* charts will have reacted to the change in the mean by generating a strong nonrandom pattern and possibly several out of control points.
- However, a *p* chart would not react until the mean had shifted all the way to μ_3, or until the actual number of nonconforming units produced had increased.
- Thus, the $\bar{x}$ and *R* charts are more powerful control tools than the *p* chart.

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- For a specified level of protection against process shifts, variables control charts usually require a much smaller sample size than does the corresponding attributes control chart.
- Thus, although variable type inspection is usually more expensive and time consuming on a per unit basis than attributes inspection, many fewer units must be examined.
- This is an important consideration, particularly in cases where inspection is destructive such as to test chemical properties of the product.
- In general, variables control charts are preferable to attributes.

Choosing the Proper Type of Control Chart

A. Variables Charts [$\bar{x}$ and *R* (or $\bar{x}$ and s) Charts]:

These are the situations where variables control charts can be used.

1) A new process is coming on stream, or a new product is being manufactured by an existing process.
2) The process has been in operation for some time, but it is chronically in trouble or unable to hold the specified tolerances.
3) The process is in trouble, and the control chart can be useful for diagnostic purposes (troubleshooting).
4) Destructive testing (or other expensive testing procedures) is required.
5) It is desirable to reduce acceptance sampling or other down stream testing to a minimum when the process can be operated in control.

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6) Attributes control charts have been used, but the process is either out of control or in control but the yield is unacceptable.
7) There are very tight specifications, overlapping assembly tolerances, or other difficult manufacturing problems.
8) The operator must decide whether or not to adjust the process, or when a set up must be evaluated.
9) A change in product specifications is desired.
10) Process stability and capability must be continually demonstrated, such as in regulated industries.

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B. Attributes Charts (*p* charts, *c* charts, and *u* *c*harts):

These are the situations where attributes control charts can be used.

1) Operators control the assignable causes, and it is necessary to reduce process fallout.
2) The process is a complex assembly operation and product quality is measured in terms of the occurrence of nonconformities, successful or unsuccessful product function, and so forth. (Examples include computers, office automation equipment, automobiles, and the major subsystems of these products.)
3) Process control is necessary, but measurement data can not be obtained.
4) A historical summary of performance is necessary. Attributes control charts, such as *p* charts, *c* charts, and *u* *c*harts, are very effective for summarizing information about the process for management review.
5) Remember that attributes charts are generally be inferior to charts for variable. Always use $\bar{X}$ and *R* or $\bar{X}$ and s charts whenever possible.