PROCESS CAPABILITY ANALYSIS USING HISTOGRAM AND PROBABILITY PLOTTING

Semester IV **STAT CC410**

Unit 2

- Process Capability Analysis Using Histogram
- Process Capability Analysis Using Probability Plotting

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PROCESS CAPABILITY ANALYSIS USING HISTOGRAM

- The histogram can be helpful in estimating process capability.
- Alternatively, a stem-and-leaf plot may be substituted for the histogram.
- At least 100 or more observations should be available for the histogram (or the stem-and-leaf plot) to be moderately stable so that a reasonably reliable estimate of the process capability may be obtained.
- If the quality engineer has access to the process and can control the data collection effort, the following steps should be followed:

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1) Choose a machine or machines to be used. If the results based on one (or a few) machines are to be extended to a larger population of machines, the machine selected should be representative of those in the population.

   Furthermore, if the machine has multiple workstations or heads, it may be important to collect the data so that head-to-head variability can be isolated. This may imply that designed experiments should be used.

2) Select the process operating conditions. Carefully define conditions, such as cutting speeds, feed rates, and temperatures, for future reference. It may be important to study the effects of varying these factors on process capability.

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3) Select a representative operator. In some studies, it may be important to estimate operator variability. In these cases, the operators should be selected at random from the population of operators.

4) Carefully monitor the data collection process, and record the time order in which each unit is produced.

Thus, the histogram, along with the sample average $\bar{x}$ and sample standard deviation *s*, provides information about process capability.

- An advantage of using histogram to estimate process capability is that it gives an immediate, visual impression of process performance.
- It may also immediately show the reason for poor process performance.

Process Capability Analysis Using Probability Plotting

- Probability plotting is an alternative to the histogram that can be used to determine the shape, centre, and spread of the distribution.
- It has the advantage that it is unnecessary to divide the range of the variable into class intervals, and it often produce reasonable results for moderately small samples which the histogram will not perform.
- Generally, probability plot is a graph of the ranked data versus observed sample cumulative frequency [(j–0.5)/n or 100(j–0.5)/n] on a special graph paper, known as **probability paper**, where j is the rank of the sample data.
- A vertical scale chosen so that the cumulative distribution of the assumed type is a straight line.
- The probability plot so obtained is very useful in a process capability studies.

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- In the probability plot if the data lie nearly along the straight line then we say that the distribution is normal.
- For the normal distribution, we find the mean as the fiftieth percentile and the standard deviation of the distribution is the slop of the of the straight line.
- It is convenient to estimate the standard deviation as the difference between the eighty-fourth and fiftieth percentiles.
- The normal probability plot can also be used to estimate process yields and fallouts.

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- Care should be taken in using probability plots. If the data do not come from the assumed distribution, inferences about process capability drawn from the plot may give an error.
- An obvious disadvantage of probability plotting is that it is not an objective procedure.
- It is possible for two analysts to arrive at different conclusions using the same data.
- For this reason, it is often desirable to supplement probability plots with more formal statistically based goodness of fit tests.

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- For a normal probability plot with Shapiro-Wilk test for normality can make the procedure much more powerful and objective.
- Choosing the distribution to fit the data is also an important step in probability plotting.
- Sometimes we can use our knowledge of the physical phenomena or past experience to suggest the choice of distribution.
- Alternatively, calculate β_1 and β_2, the measure of skewness and kurtosis from the sample data and find the normality of the distribution.
- One caution should be taken here that the skewness and kurtosis statistics are not reliable unless they are computed form very large samples.