np Charts: Control Charts for Proportions / Percentages

Data Science for Quality Management: Control Charts for Discrete Data

with **Wendy Martin**

Learning objectives:

Differentiate between the p chart and np chart

Calculate np for a sample

Create centerlines for the np chart

np Charts Introduction

- Like the p chart, the np chart is an attributes control chart used to monitor a process for the number of nonconforming or defective units per inspection unit and is based on the binomial distribution

np Charts Introduction

- The np chart shows counts instead of proportions, and so must have equal sample sizes

The Case of the Chain Saw Bars

- You have been given responsibility for improving the quality of chain saw bars.
- These bars are used by loggers on their chain saws. The chain saw bar is the component of the chain saw around which the cutting chain travels. These bars are made in a high-volume operation.

The Case of the Chain Saw Bars

- Market research has identified three characteristics that concern your customers.
- The first is scratches. While scratches do not affect function, they reduce the salability of the bars. Scratches must be minimized.
- The other two characteristics, flatness and warp, affect the function of the bars.

The Case of the Chain Saw Bars

- Flatness is concerned with how flat the bar is. For example, the bar could be slightly bowed.
- End-to-end warp exists when the bar is twisted.
- Each of these characteristics is examined by loggers when examining a bar before purchase. Problems of this type must be minimized to improve market share.

Step 1: Select a Characteristic

- You decide to monitor each of the three characteristics.
- Studies have shown an acceptable ability to evaluate what is defective versus non-defective, and conforming versus nonconforming, for each of the three characteristics.

Step 2: Select the Sampling Plan

- The end-of-line inspectors have been sampling 5,000 pieces per day from the production line. The bars have been classified as nonconforming / defective if any of the following three conditions were present:

Step 2: Select the Sampling Plan

- Severe or numerous **scratches** (render the unit defective)
- Lack of **flatness** (render the unit nonconforming)
- End-to-end **warp** (render the unit nonconforming)

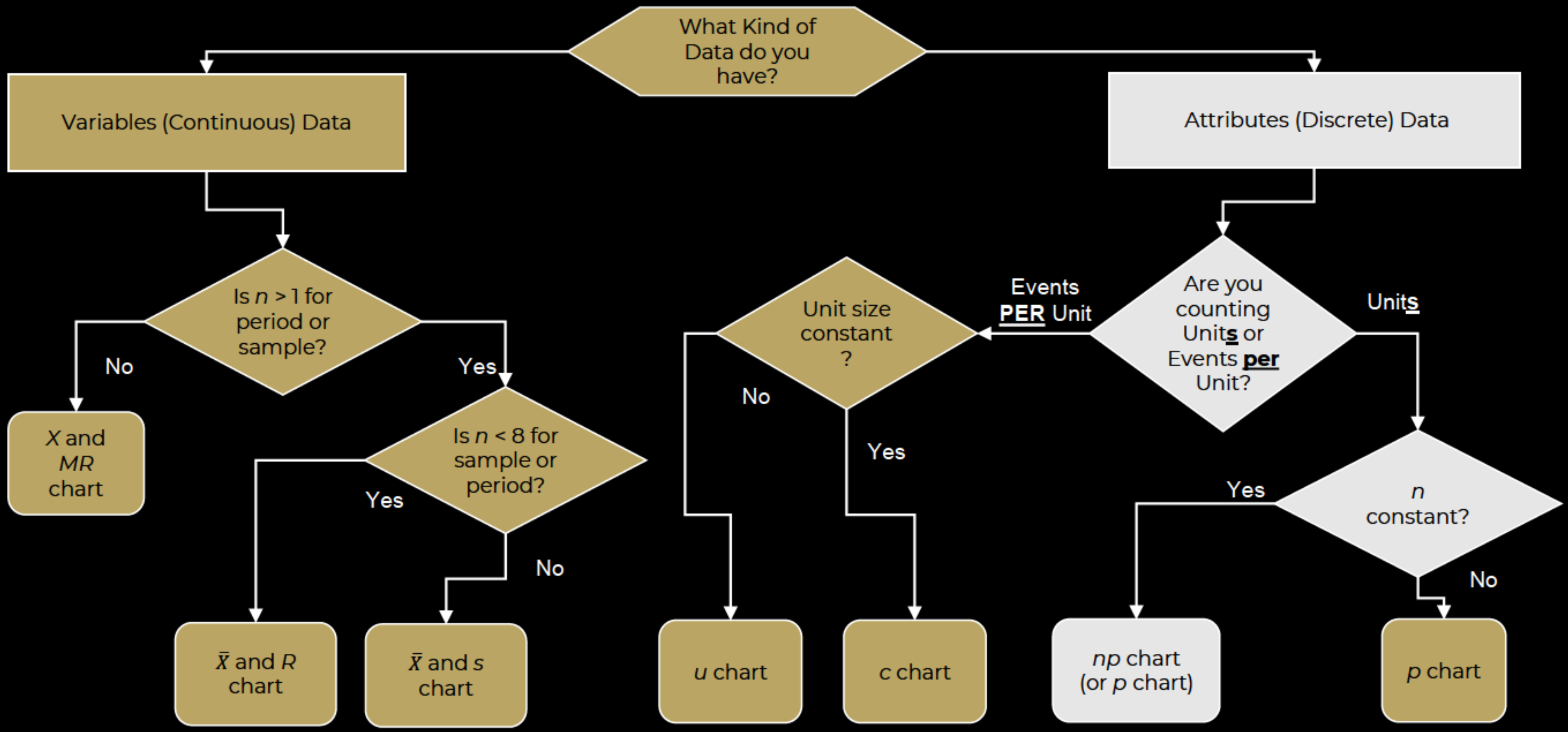
Step 3: Select the Chart Type

- The bars are being classified as either conforming or nonconforming
- The sample size is constant (5,000 pieces per sample)
- You prefer to leave the nonconforming / defective amount as counts

Step 3: Select the Chart Type

- You decide to use an np chart for each characteristic, and a fourth chart for the total nonconforming / defective count (why? Why not just one chart for the total?)

Step 3: Select the Chart



Step 4: Collect Data

- In this case, the data have already been collected. You have 25 days worth to analyze.
- In the file are the number of nonconforming / defective units found during the end-of-line inspection of the chain saw bars.

Step 5: Generate Chart

In Rstudio

```
spc.chart.attributes.proportion.np
.binomialdistribution.simple( )
```

Sample Statistics

- For each sample, np is just the number of nonconforming units
- For example, looking at the first sample:
  - np for scratches = 8
  - np for flatness = 3
  - np for warp = 1
  - np for total = 12

Scratches	Flatness	Warp	Total
8	3	1	12
9	2	3	14
7	4	0	11
12	3	1	16
11	1	0	12
13	1	1	15
10	2	1	13
10	1	2	13

Centerline(s)

- The centerline for the np chart is the average number of units in the classification and is calculated as follows (for the Total Number of Defective / Nonconforming Units per Sample of 5000):

$$\text{CL} = \overline{np} = \frac{\sum np}{k} = 8.8$$

Sources

The material used in the PowerPoint presentations associated with this course was drawn from a number of sources. Specifically, much of the content included was adopted or adapted from the following previously-published material:

- Luftig, J. An Introduction to Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1982
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