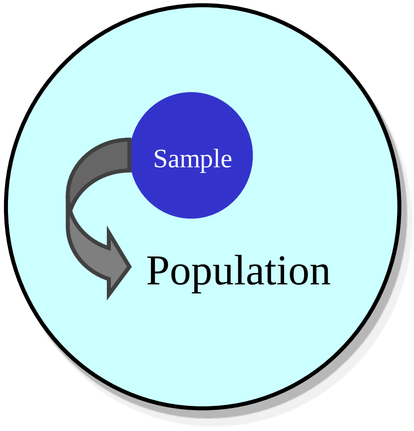
Continuous Improvement Toolkit

Sampling




Managing Risk
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Process Mapping
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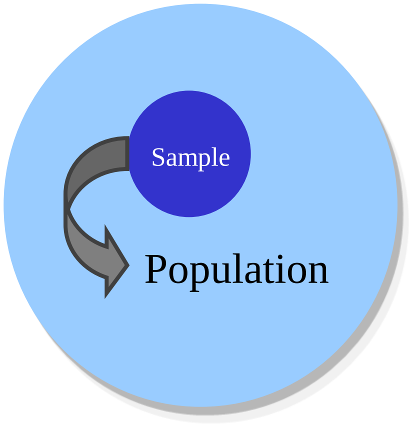
- Sampling

- Sampling is the process of selecting units from a **population** or from a **process** of interest to acquire some knowledge.
- Too many organizations measure 100% of their outputs.
- This approach is driven by a lack of confidence in statistics.
- In reality, most of the value of collected data is gained from the first few measurements.
- Don't assume that the existing data will be suitable for the project.



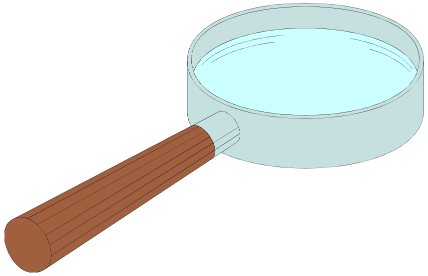
- Sampling

- **Sampling Benefits:**
  - Quicker.
  - Cheaper.
  - More efficient.
  - Sometimes there is no alternatives (e.g. destructive tests).

- **Sampling Risks:**
  - Population may not be uniform.
  - A sample may not reflect the whole population.
  - Process may vary with time.

- Sampling

- **Data need to be:**
  - Random.
  - Sufficient.
  - Representative to the population.
  - Reliable (accurate, precise, consistent, etc.).



A Sample Method: The way for selecting sample elements.

A Sample Size: How much data will be collected.

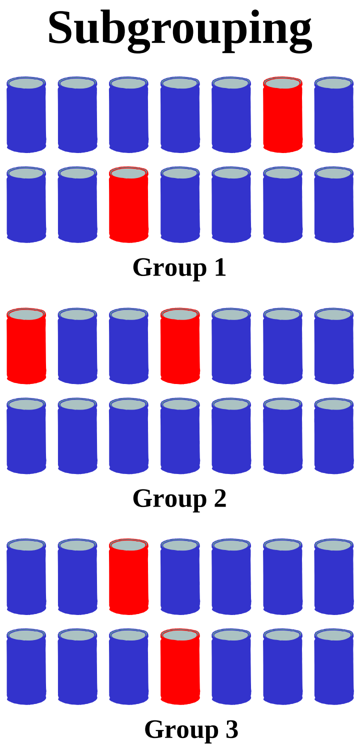
A Sample Frequency: How often data will be collected.

- Sampling

Sampling Methods:

- **Random Sampling:**
  - Every member of the population has an equal chance of being included in the sample.

- **Subgroup Sampling:**
  - Involve taking a number of random samples every predefined period of time.
  - Commonly used in SPC.
  - Limits the variability of common cause variation in the process.



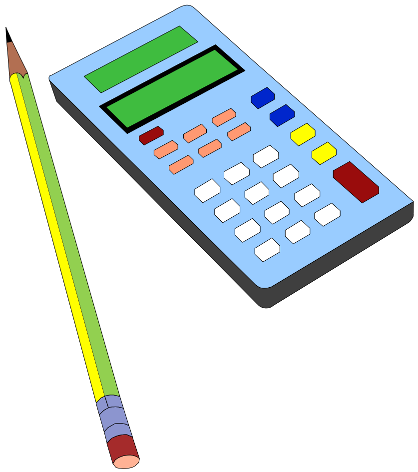
- Sampling

Sampling Methods:

- **Stratified sampling:**
  - Involves randomly selecting data from specific category within a **population**.
  - A completely random approach will not ensure that specific categories are represented in a sample.
  - Used when the population includes several different groups (e.g. different suppliers).
- **Systematic Sampling:**
  - Data collection is integrated into the process and therefore recorded automatically.

- Sampling

Sample Size:



- It must be large enough, but too large a sample is unnecessarily expensive.
- **30** samples is a good rule of thumb for use in basic tools such as histograms and capability studies.
- More advanced techniques as Hypothesis Testing and SPC Charts may require larger sample sizes.
- Attribute sample size is often larger than Continuous sample size.

- Sampling

Sample Size:

- **Sample size is based on the following considerations:**
  - The type of data involved (continuous, count or attribute).
  - The existing variation in the process.
  - The precision required of the results.
- Sometimes we need to calculate the **Minimum Sample Size** when designing data collection plans.
- Collect data until you reach to the minimum sample size before you make any calculations or decisions with the data.
- Sometimes, the time and resources available can prevent reaching the minimum sample size.

- Sampling

MSS for Continuous Data:

$$\textbf{MSS} = (2 * \textbf{Standard deviation} / \textbf{Precision})^2$$

- If the minimum sample size exceeds the parts available, measure them all (100%).
- If you haven't ever measured the standard deviation yet, estimate it.
- A very basic approach for estimating standard deviation is to look at the historical range of the process, then divide it by five.

- Sampling

Example:

- Calculate the minimum sample size for the data collected to assess the lead time of an invoice process, where the historically invoices have taken anywhere from 10 - 30 days, and the required precision is +/- 2 days.

- MSS = ((2 * 4/2)2 = 16
- So to estimate the mean invoice lead time to with +/- 2 days, you should collect at least 16 pieces of data.

MSS for Attribute Data:

$$MSS = (2 / Precision)^2 * p * (1-p)$$

- Where “p” is the expected proportion in the process represented as a percentage.
- Remember that the proportion is just an estimate.
- If you later find it to be inaccurate, you can always recalculate the MSS.
- If the minimum sample size exceeds the parts available, measure them all (100%).

- Sampling

Example:

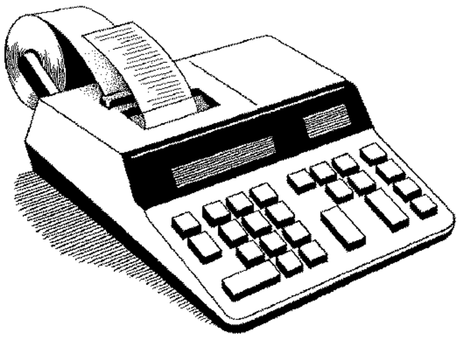
- Calculate the minimum sample size for the data collected to assess the proportion of furniture flat packs that sold with parts missing, where the historically estimation for the proportion is 10%, and the required precision is +/- 2.5%.

- MSS = (2 / 0.005)2 * 0.1 * (1 - 0.1) = 1600
- So to estimate the proportion of flat packs sold with parts missing to within +/- 1.5, you should collect at least 1600 pieces of data.

- Sampling

Sample Size:

- What if you can't get enough data to meet the minimum sample size?
  - Use what you have, but with the awareness that the confidence in any decisions will be lower than you would like it to be.
  - Use Confidence Intervals to assess the **precision** of a statistic.
- What if you have much more data than the minimum sample size?
  - Check if you are investing valuable resources in collecting unnecessarily large mount of data.



- Sampling

Sample Frequency:

- After selecting the sampling method and size, you will need to decide when to sample the process and how frequent.

- Sampling frequency could be based on the below factors:
  - The precision required of the recorded data.
  - The volume of products produced.
  - Any natural cycles that occur in the process (every process has some level of expected cycles in its output).

- Sampling

Sample Frequency:

- Examples for expected process cycles:
  - For a process operating across 3 shifts, the duration of the expected cycles could be around 8 hours.

Morning Shift	22.6g	31.7g	19.4g	28.4g	29.0g	21.6g	20.9g	30.6g	27.5g	27.7g
Evening Shift	22.6g	21.5g	26.8g	27.4g	30.0g	28.3g	20.4g	25.3g	25.2g	19.3g
Night Shift	27.2g	31.8g	28.8g	20.4g	27.4g	20.2g	27.6g	30.6g	21.5g	20.5g

- In this case, random samples could be taken from each shift

- Minimum frequency: 4 times every cycle

- Sampling

Sample Frequency:

- Examples for expected process cycles:
  - For a machining process, the tool wear might create an expected cycle duration.
  - For a transitional process, the expected cycle duration might be daily or weekly (to align with the known procedures and systems in place).

- Anytime the process becomes unstable (out of control), the sampling frequency should be increased to help identify the assignable cause of variation.
- When insufficient information is available for planning a sample frequency, sample as often as possible.