Tools for Quality Improvement

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TQM requires that the company maintain this quality standard in all aspects of its business. This requires ensuring that things are done right the first time and that defects and waste are eliminated from operations. For these the workforce should know about the different quality tools to be used for quality improvement.
Seven tools for Quality improvement

First introduced by Kaoru Ishikawa who in turn was influenced by a series of lectures W. Edwards Deming had given to Japanese engineers and scientists after 1950.

1. Flow Chart
2. Cause Effect Diagram
3. Check Sheet
4. Histogram
5. Control Charts
6. Scatter Diagram
7. Pareto Chart
Quality Tool

Flow Charts
Flow Charts

**Purpose:**

Visual illustration of the sequence of operations required to complete a task

- Schematic drawing of the process to measure or improve.
- Starting point for process improvement
- Potential weakness in the process are made visual.
- Picture of process as it *should* be.

**Benefits:**

- Identify process improvements
- Understand the process
- Shows duplicated effort and other non-value-added steps
- Clarify working relationships between people and organizations
- Target specific steps in the process for improvement.
**Benefits**
- Simple to use
- Used for planning new processes or examining existing one
- Keep people focused on the whole process

**How is it done?**
- List major steps
- Write them across top of the chart
- List sub-steps under each in order they occur

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**Flow Charts**

**Top Down**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Analyze</th>
<th>Improve</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem report</td>
<td>Customer input</td>
<td>Hardware procurement</td>
<td>Fleet leader reports</td>
</tr>
<tr>
<td>Hardware return</td>
<td>Stress analysis</td>
<td>Customer coordination</td>
<td>Service reports</td>
</tr>
<tr>
<td>Failure analysis</td>
<td>Heat transfer analysis</td>
<td>Compliance verification</td>
<td>Operational statistics</td>
</tr>
<tr>
<td></td>
<td>Life analysis</td>
<td>Documentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Substantiation</td>
<td>FAA approval</td>
<td></td>
</tr>
</tbody>
</table>
Benefits

- Show what actually happens at each step in the process
- Show what happens when non-standard events occur
- Graphically display processes to identify redundancies and other wasted effort

How is it done?

- Write the process step inside each symbol
- Connect the Symbols with arrows showing the direction of flow
Quality Tool
Sample Linear Flow

1 - Fleet Analysis utilizes data warehouse reports to create and distribute a selection matrix.

2 - Other Groups compile data as determined by FRB.

3 - FRB meets to analyze data.

4 - FRB selects candidate problems for additional investigation.

5 - Action Assignee performs detail analysis of failure. Requests failure analysis as needed.

6 - Action Assignee documents investigation findings.

7 - Action Assignee reports investigation results to FRB.

8 - Fleet Analysis monitors failed item to ensure failure has been corrected.

9 - FRB Categorize Failure: Workmanship, component, material, maintenance, or design. Also fleet wide or RSU.

10 - FRB determines required corrective action - i.e. QAM or supplier corrective action.

11 - Fleet Analysis monitors failure to ensure corrective action is effective.

Still failing?

No

Yes

Yes

END

No

Yes

Start
Flow Chart

1. Lamp doesn’t work
   - Lamp plugged in?
     - Yes: Bulb burned out?
       - Yes: Replace bulb
       - No: Buy new lamp
     - No: Plug in lamp

Quality Tool

Cause and Effect Diagrams
**Fishbone Diagram**

**Purpose:** Graphical representation of the trail leading to the root cause of a problem

**How is it done?**

- Decide which quality characteristic, outcome or effect you want to examine (may use Pareto chart)
- Backbone – draw straight line
- Ribs – categories
- Medium size bones – secondary causes
- Small bones – root causes
Cause & Effect Diagrams

Benefits:
- Breaks problems down into bite-size pieces to find root cause
- Fosters team work
- Common understanding of factors causing the problem
- Road map to verify picture of the process
- Follows brainstorming relationship
Quality Tool

Checksheets
Checksheets

Purpose:
– Tool for collecting and organizing measured or counted data
– Data collected can be used as input data for other quality tools

Benefits:
– Collect data in a systematic and organized manner
– To determine source of problem
– To facilitate classification of data (stratification)

<table>
<thead>
<tr>
<th>Operator</th>
<th>Morning</th>
<th>Afternoon</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator A</td>
<td>Morning</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Afternoon</td>
<td>XX</td>
<td>XXXXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator B</td>
<td>Morning</td>
<td>X</td>
<td>XX</td>
<td></td>
</tr>
<tr>
<td>Afternoon</td>
<td>XX</td>
<td>XXXXXXXXX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

X = Number of times the supervisor is called per day.
Quality Control Tool

Histograms
Histograms

Purpose:
To determine the spread or variation of a set of data points in a graphical form

How is it done?:
- Collect data, 50-100 data point
- Determine the range of the data
- Calculate the size of the class interval
- Divide data points into classes
  - Determine the class boundary
- Count # of data points in each class
- Draw the histogram

Stable process, exhibiting bell shape
**Histograms**

**Benefits:**

- Allows you to understand at a glance the variation that exists in a process
- The shape of the histogram will show process behavior
- Often, it will tell you to dig deeper for otherwise unseen causes of variation.
- The shape and size of the dispersion will help identify otherwise hidden sources of variation
- Used to determine the capability of a process
- Starting point for the improvement process
Quality Control Tool

Control Charts
Control Charts

**Purpose:**

The primary purpose of a control chart is to predict expected product outcome.

**Benefits:**

- Predict process out of control and out of specification limits
- Distinguish between specific, identifiable causes of variation
- Can be used for statistical process control
Control Charts

- **Strategy for eliminating assignable-cause variation:**
  - Get timely data so that you see the effect of the assignable cause soon after it occurs.
  - As soon as you see something that indicates that an assignable cause of variation has happened, search for the cause.
  - Change tools to compensate for the assignable cause.

- **Strategy for reducing common-cause variation:**
  - Do not attempt to explain the difference between any of the values or data points produced by a stable system in control.
  - Reducing common-cause variation usually requires making fundamental changes in your process
Control Charts

♦ Control Chart Decision Tree

– Determine Sample size (n)

– Variable or Attribute Data
  • Variable is measured on a continuous scale
  • Attribute is occurrences in n observations

– Determine if sample size is constant or changing
Control Charts

Control Chart Decision Tree

Start

Variable data

n = 2 to 10

n > 10

n = 1

X bar, R

IX, Moving Range

X bar, S

Attribute Data

Percent data

Constant n

Changing n

p (fraction defective) or np (number def. Per sample)

Count data

Constant n

Changing n

c (defects per sample or u defects per unit)

p

u

Constant n

Changing n

p

u
Control Charts

What does it look like?

- Adding the element of time will help clarify your understanding of the causes of variation in the processes.

- A run chart is a line graph of data points organized in time sequence and centered on the median data value.
Control Charts

Individual X charts

How is it done?

- The data must have a normal distribution (bell curve).
- Have 20 or more data points. Fifteen is the absolute minimum.
- List the data points in time order. Determine the range between each of the consecutive data points.
- Find the mean or average of the data point values.
- Calculate the control limits (three standard deviations)
- Set up the scales for your control chart.
- Draw a solid line representing the data mean.
- Draw the upper and lower control limits.
- Plot the data points in time sequence.
Control Charts

- Next, look at the upper and lower control limits. If your process is in control, 99.73% of all the data points will be inside those lines.

- The upper and lower control limits represent three standard deviations on either side of the mean.

- Divide the distance between the centerline and the upper control limit into three equal zones representing three standard deviations.
Quality Control Tool

Scatter Diagrams
Scatter Diagrams

Purpose:

To identify the correlations that might exist between a quality characteristic and a factor that might be driving it

- A scatter diagram shows the correlation between two variables in a process.
  - These variables could be a Critical To Quality (CTQ) characteristic and a factor affecting it, two factors affecting a CTQ or two related quality characteristics.

- Dots representing data points are scattered on the diagram.
  - The extent to which the dots cluster together in a line across the diagram shows the strength with which the two factors are related.
Scatter Diagrams

How is it done?:

- Decide which paired factors you want to examine. Both factors must be measurable on some incremental linear scale.
- Collect 30 to 100 paired data points.
- Find the highest and lowest value for both variables.
- Draw the vertical (y) and horizontal (x) axes of a graph.
- Plot the data
- Title the diagram

The shape that the cluster of dots takes will tell you something about the relationship between the two variables that you tested.
Scatter Diagrams

- If the variables are correlated, when one changes the other probably also changes.
- Dots that look like they are trying to form a line are strongly correlated.
- Sometimes the scatter plot may show little correlation when all the data are considered at once.
- Stratifying the data, that is, breaking it into two or more groups based on some difference such as the equipment used, the time of day, some variation in materials or differences in the people involved, may show surprising results.
Quality Control Tool

Pareto Charts
Parato Analysis

- 80 : 20 Rule
- Detection of Vital few
Pareto Charts

Purpose:
Prioritize problems.

How is it done?
- Create a preliminary list of problem classifications.
- Tally the occurrences in each problem classification.
- Arrange each classification in order from highest to lowest
- Construct the bar chart
Pareto Charts

**Benefits:**
- Pareto analysis helps graphically display results so the significant few problems emerge from the general background
- It tells you what to work on first

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Dent</th>
<th>Scratch</th>
<th>Hole</th>
<th>Others</th>
<th>Crack</th>
<th>Stain</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>104</td>
<td>42</td>
<td>20</td>
<td>14</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>
Pareto Charts

- Weighted Pareto charts use the quantity of defects multiplied by their cost to determine the order.

<table>
<thead>
<tr>
<th>Defect</th>
<th>Total</th>
<th>Cost</th>
<th>Weighted cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gap</td>
<td>4</td>
<td>200</td>
<td>800</td>
</tr>
<tr>
<td>Dent</td>
<td>104</td>
<td>2</td>
<td>208</td>
</tr>
<tr>
<td>Hole</td>
<td>20</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Crack</td>
<td>10</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>Scratch</td>
<td>42</td>
<td>1</td>
<td>42</td>
</tr>
<tr>
<td>Others</td>
<td>14</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Stain</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

Weighted Pareto Chart:

- X-axis: Defect (Gap, Dent, Hole, Crack, Scratch, Others, Stain)
- Y-axis: Weighted cost
- Data points: (Gap: 800, Dent: 208, Hole: 100, Crack: 80, Scratch: 42, Others: 14, Stain: 6)

The chart visually represents the weighted cost for each type of defect, with narrower bars for defects that do not significantly contribute to the total cost.
### Restaurant Complains

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourteous server</td>
<td>12</td>
</tr>
<tr>
<td>Slow service</td>
<td>42</td>
</tr>
<tr>
<td>Cold dinner</td>
<td>5</td>
</tr>
<tr>
<td>Cramped tables</td>
<td>20</td>
</tr>
<tr>
<td>Smoky air</td>
<td>10</td>
</tr>
</tbody>
</table>
Parato Chart

- Slow Service: 42
- Cramped Tables: 20
- Discourteous Server: 12
- Smoky Air: 10
- Cold Dinner: 5

Count vs. Complain vs. Percent