Lecture Outline

- Meaning of Quality
- Total Quality Management and QMS
- Quality Improvement and Role of Employees
- Role of Employees in Quality Improvement
- Six Sigma
- Quality in Services
- Cost of Quality
- Quality Management and Productivity
- Quality Awards
- ISO 9000

What Is Quality?

- A degree or level of excellence
  (Oxford American Dictionary)
- The totality of features and characteristics that satisfies given needs
  (ASQ definition)
- Consumer’s and Producer’s Perspective
Meaning of Quality: Consumer’s Perspective

- Fitness for use
  - how well product or service does what it is supposed to
- Quality of design
  - Degree of quality characteristics designed into a product/service
  - A Mercedes and a Ford are equally “fit for use,” but with different design dimensions

Dimensions of Quality: Manufactured Products

- Performance (basic operating characteristics)
- Features (extra items added)
- Reliability (likelihood that product will perform normally over time)
- Conformance (meeting pre-specified standards)
- Durability (useful life span)
- Serviceability (ease of repair)
- Aesthetics (sensory characteristics)
- Safety (free from injury or harm)
- Perception (perceived quality)

Dimensions of Quality: Service

- Time & Timeliness (waiting time, on time service)
- Completeness (customer gets all they asked for)
- Courtesy (treatment by employees)
- Consistency (same level of service for all)
- Accessibility & Convenience (ease of obtaining service)
- Accuracy (performed right every time)
- Responsiveness (reactions to unusual situations)
Meaning of Quality: Producer’s Perspective

- Quality of Conformance
  - Making sure a product or service is produced according to design
    - if new tires do not conform to specifications, they wobble
    - if a hotel room is not clean when a guest checks in, the hotel is not functioning according to specifications of its design

Meaning of Quality: A Final Perspective

Total Quality Management (TQM)

- Management of the entire organization so that it excels on all dimensions of products and services that are important to the customer
Total Quality Management

Principles

1. Customer-driven quality
2. Top management leadership
3. Quality as a strategic issue
4. All employees responsible for quality
5. Continuous improvement (CI)
6. Shared problem solving
7. Statistical quality control (SQC)
8. Training & education for all employees

Total Quality Management

Quality Gurus

- Walter Shewhart
  - In 1920s, developed control charts
  - Known as the father of statistical quality control
- W. Edwards Deming
  - After war, taught Japanese the statistical quality control techniques
  - Advocated continuous improvement via PDCA
  - Proposed famous 14 points for TQM
- Joseph M. Juran
  - Followed Deming to Japan in 1954
  - Focused on strategic quality planning
  - Published "Juran’s Quality Handbook"

Total Quality Management

Quality Gurus (cont.)

- Armand V. Feigenbaum
  - Published “Quality Control” and introduced concepts of total quality control and continuous quality improvement
- Philip Crosby
  - Published “Quality Is Free” and emphasized that costs of poor quality far outweigh the cost of prevention
  - Emphasized conformance to requirements, prevention, and “zero defects”
- Kaoru Ishikawa
  - Promoted use of quality circles
  - Developed “fishbone” diagram
  - Emphasized importance of internal customer
Total Quality Management

Deming Wheel: PDCA Cycle

1. Plan
   - Identify problem and develop a plan for improvement.

2. Do
   - Implement plan on a test basis.

3. Study/Check
   - Assess plan; is it working?

4. Act
   - Institutionalize improvement; continue cycle.

Deming’s 14 Points

1. Create constancy of purpose
2. Adopt philosophy of prevention
3. Cease mass inspection
4. Select a few suppliers based on quality
5. Constantly improve system and workers
6. Institute worker training
7. Instill leadership among supervisors
8. Eliminate fear among employees
9. Eliminate barriers between departments
10. Eliminate slogans
11. Remove numerical quotas
12. Enhance worker pride
13. Institute vigorous training and education programs
14. Develop a commitment from top management to implement above 13 points
Quality Improvement and Role of Employees

- Participative problem solving
  - every employee has undergone extensive training to provide quality service to Disney's guests
- Kaizen
  - involves everyone in process of continuous improvement

Quality Circles

- Quality circle
  - A group of workers and supervisors from same area who address quality problems

TQM in Services

- Principles of TQM apply equally well to services and manufacturing
- Services and manufacturing companies have similar inputs but different processes and outputs
- Services tend to be labor intensive
- Service defects are not always easy to measure because service output is not usually a tangible item
Six Sigma

- A process for developing and delivering near perfect products and services
- Measure of how much a process deviates from perfection
- Six-Sigma = 3.4 defects per million opportunities (DPMO)

Six Sigma Methodology—DMAIC

People Involved in Six-Sigma Projects

Black Belts and Green Belts

- Champion
  - an executive responsible for project success
- Black Belt
  - project leader
- Master Black Belt
  - a teacher and mentor for Black Belts
- Green Belts
  - project team members
Cost of Quality

- Cost of achieving good quality
  - Prevention (quality planning and training, identify and removing poor quality source)
  - Appraisal (inspection, testing)
- Cost of poor quality
  - Internal failure costs (scrap, rework, repair)
  - External failure costs (returned products, warranty charges, complaints, liability)

Quality–Cost Relationship

- Quality is Free
  - Cost of doing things wrong (20 to 35% of revenues)
  - Cost of doing things right (3 to 4% of revenues)
  - Profitability
    - In the long run, quality is free
  - In general, when the cost of achieving good quality increases, the cost of poor quality declines.
  - Increased prevention costs lead to decreased failure costs.
  - Improved quality leads to increased sales and market share.
  - Higher quality products can command higher prices.

Quality Impact on Productivity

- Fewer defects increase output and quality improvement reduces inputs
- Yield: a measure of productivity
  \[
  \text{Yield} = \frac{\text{total input}}{\% \text{good units}} + \frac{\text{total input}(1-\% \text{good units})}{\% \text{reworked}}
  \]
  \[
  Y = (I)(\%G) + (I)(1-\%G)(\%R)
  \]
Product Yield Example

The Colonial House Furniture Company manufactures two-drawer oak file cabinets that are sold unassembled through catalogs. The company initiates production of 150 cabinet packages each week. The percentage of good-quality cabinets average 83 percent per week, and the percentage of poor-quality cabinets that can be reworked is 60%.

a. Determine the weekly product yield of file cabinets.
b. If the company desires a product yield of 145 units per week, what increase in the percentage of good-quality products must result?

Product Yield Example

a. Yield = (total input) (% good units) + (total input)(1 - % good units)(% reworked)
   = 150 x 83% + 150 x (1 – 83%) x 60%
   = 139.8 file cabinets

b. Yield = (total input) (% good units) + (total input)(1 - % good units)(% reworked)
   145 = 150 x G + 150 x (1 – G) x 60%
   Thus, G = 91.67%
Product Cost Per Unit

Product Cost = \frac{(K_d)(I) + (K_r)(R)}{Y}

where:

- \(K_d\) = direct manufacturing cost per unit
- \(I\) = input
- \(K_r\) = rework cost per unit
- \(R\) = reworked units
- \(Y\) = yield

Example of Product Cost

In the last example, if the direct manufacturing cost for cabinets is $27 and the rework cost is $8, compute the manufacturing cost per good product.

\[
\text{Product cost} = \frac{(27)(150) + (8)(15)}{139.8} = \frac{4050 + 120}{139.8} = \frac{4170}{139.8} = 29.8
\]

Product Yield and Product Cost

In-Class Exercise

A manufacturing company has a weekly production plan of 1700 units. The average percentage of good-quality products is 85%. Of the poor-quality products, 75% can be reworked and sold as good-quality products.

a. Determine the weekly product yield.

b. If the direct manufacturing cost for the products is $30 and the rework cost is $10, compute the manufacturing cost per-good product.
Computing Product Yield for Multistage Processes

\[ Y = (I)(\%g_1)(\%g_2) \ldots (\%g_n) \]

where:
\( I \) = input of items to the production process that will result in finished products
\( g_i \) = good-quality, work-in-process products at stage \( i \)

Example of the Yield for a Process

The colonial House Furniture Company manufactures four-drawer oak filing cabinets in six stages. In the first stage, the boards forming the walls of the cabinet are cut; in the second stage the front drawer panels are wood-worked; in the third stage the boards are sanded and finished; in the fourth stage the boards are cleaned, stained, and painted with a clear finish; in the fifth stage the hardware for pulls, runners, and fittings is installed; and in the final stage the cabinets are assembled. Inspection occurs at each stage of the process, and the average percentages of good-quality units are given in the following table.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Average Percentage Good Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87%</td>
</tr>
<tr>
<td>2</td>
<td>91%</td>
</tr>
<tr>
<td>3</td>
<td>94%</td>
</tr>
<tr>
<td>4</td>
<td>93%</td>
</tr>
<tr>
<td>5</td>
<td>93%</td>
</tr>
<tr>
<td>6</td>
<td>96%</td>
</tr>
</tbody>
</table>

The cabinets are produced in weekly production runs with a product input for 300 units. Determine the weekly product yield of good-quality cabinets.

\[ Y = (I)(\%g_1)(\%g_2)\ldots(\%g_n) \]
\[ = 300 \times 87\% \times 91\% \times 94\% \times 93\% \times 93\% \times 96\% \]
\[ = 185 \text{ cabinets} \]
Quality–Productivity Ratio

QPR
- productivity index that includes productivity and quality costs

\[
QPR = \frac{\text{good quality units}}{(\text{input}) (\text{processing cost}) + (\text{defective units}) (\text{reworked cost})}
\]

Example of the Quality-Productivity Ratio

The total processing cost for producing the X-Pacer running shoe is $18. The Omega Shoe Company starts production of 650 pairs of the shoes weekly, and the average weekly yield is 90%, with 10% defective shoes. One quarter of the defective shoes can be reworked at a cost of $3.75. Compute the quality productivity ratio.

\[
QPR = \frac{\text{Good-quality units}}{(\text{input})(\text{processing cost}) + (\text{defective units})(\text{rework cost})} = \frac{650 \times 90\% + 650 \times 10\%/4}{650 \times 18 + 650 \times 10\%/4 \times 3.75} = 5.11
\]

Quality Tools

1. Pareto analysis
2. Process flowcharts
3. Check sheets
4. Histograms
5. Scatter diagrams
6. Control charts
7. Cause & effect diagrams
Seven Quality Control Tools:

1. Pareto Analysis

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>NUMBER OF DEFECTS</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor design</td>
<td>80</td>
<td>64</td>
</tr>
<tr>
<td>Wrong part dimensions</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>Defective parts</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Incorrect machine calibration</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Operator errors</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Defective material</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Surface abrasions</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>125</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Seven Quality Control Tools:

2. Flow Chart

Seven Quality Control Tools:

3. Check Sheet

COMPONENTS REPLACED BY LAB
TIME PERIOD: 22 Feb to 27 Feb 2005
REPAIR TECHNICIAN:  Bob

TV SET MODEL 1013
Integrated Circuits
Capacitors
Resistors
Transformers
Commands
CRT
Seven Quality Control Tools:

4. Histogram

5. Scatter Diagram

6. Control Chart
Seven Quality Control Tools:

7. Cause-and-Effect Diagram

- Measurement
  - Faulty testing equipment
  - Incorrect specifications
  - Inaccurate temperature control
- Human
  - Poor supervision
  - Lack of concentration
  - Not to specifications
- Machines
  - Out of adjustment
  - Tooling problems
  - Poor process design
- Environment
  - Dust and Dirt
  - Defective from vendor
  - Material-handling problems
- Materials
  - Inadequate training
  - Not to specifications
  - Deficiencies in product design
- Process
  - Old/worn
  - Ineffective quality management

Quality Awards

- The Malcolm Baldrige National Quality Award (USA, since 1987)
  - www.quality.nist.gov
- The Deming Prize (Japan, since 1951)
  - www.deming.org

ISO 9000

- A set of procedures and policies for international quality certification of suppliers
- Standards
  - ISO 9000:2000
  - ISO 9001:2000
  - ISO 9004:2000
- Implications
  - Requirement for overseas business
  - ISO 9000 accreditation
  - A total commitment to quality is required throughout an organization