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Operations Management

Managing Quality

Chapter 6
Outline

- GLOBAL COMPANY PROFILE: MOTOROLA
- QUALITY AND STRATEGY
- DEFINING QUALITY
  - Implications of Quality
  - Malcolm Baldrige National Quality Award
  - Cost of Quality (COQ)
- INTERNATIONAL QUALITY STANDARDS
  - ISO 9000
  - ISO 14000
Outline - Continued

- TOTAL QUALITY MANAGEMENT
  - Continuous Improvement
  - Employee Empowerment
  - Benchmarking
  - Just-in-Time (JIT)
  - Taguchi Concepts
  - Knowledge of TQM Tools
TOOLS OF TQM

- Check sheets
- Scatter Diagrams
- Cause-and-Effect Diagram
- Pareto Charts
- Flow Charts
- Histograms
- Statistical Process Control (SPC)
Outline - Continued

◆ THE ROLE OF INSPECTION
  ◆ When and Where to Inspect
  ◆ Source Inspection
  ◆ Service Industry Inspection
  ◆ Inspection of Attributes vs Variables

◆ TQM IN SERVICES
Learning Objectives

When you complete this chapter, you should be able to:

Identify or Define:

- Quality
- Malcolm Baldrige National Quality Award
- ISO International Quality Standards
- Demings, Juran, and Crosby
- Taguchi Concepts
Learning Objectives - continued

When you complete this chapter, you should be able to:

Explain:

- Why quality is important
- Total Quality Management (TQM)
- Pareto charts
- Process charts
- Quality robust products
- Inspection
To Make the Quality Focus Work

Motorola:

- Aggressively began a worldwide education program to be sure that employees understood quality and statistical process control
- Established goals
- Established extensive employee participation and employee teams
Ways in Which Quality Can Improve Productivity

Sales Gains
- Improved response
- Higher Prices
- Improved reputation

Reduced Costs
- Increased productivity
- Lower rework and scrap costs
- Lower warranty costs

Improved Quality

Increased Profits
Flow of Activities Necessary to Achieve Total Quality Management

- Organizational Practices
- Quality Principles
- Employee Fulfillment
- Customer Satisfaction
Organizational Practices

- Leadership
- Mission statement
- Effective operating procedure
- Staff support
- Training

Yields: What is important and what is to be accomplished
Quality Principles

- Customer focus
- Continuous improvement
- Employee empowerment
- Benchmarking
- Just-in-time
- Tools of TQM

*Yields: How to do what is important and to be accomplished*
Employment Fulfillment

- Empowerment
- Organizational commitment

Yields: Employees’ attitudes that they can accomplish what is important and to be accomplished
Customer Satisfaction

- Winning orders
- Repeat customers

Yields: An effective organization with a competitive advantage
Definitions of Quality

- **ASC**: Product characteristics & features that affect customer satisfaction
- **User-Based**: What consumer says it is
- **Manufacturing-Based**: Degree to which a product conforms to *design* specification
- **Product-Based**: Level of measurable product characteristic
Dimensions of Quality for Goods

- Operation
- Reliability & durability
- Conformance
- Serviceability
- Appearance
- Perceived quality
Service Quality Attributes

- Reliability
- Responsiveness
- Competence
- Access
- Courtesy
- Communication
- Tangibles
- Understanding
- Security
- Credibility
- Communication
- Understanding
- Security
- Credibility
Importance of Quality

- Costs & market share
- Company’s reputation
- Product liability
- International implications

Market Gains
  - Reputation
  - Volume
  - Price

Improved Quality

Lower Costs
  - Productivity
  - Rework/Scrap
  - Warranty

Increased Profits

Improved Quality

Lower Costs
  - Productivity
  - Rework/Scrap
  - Warranty
Malcom Baldrige National Quality Award

- Established in 1988 by the U.S. government
- Designed to promote TQM practices
- Some criteria
  - Senior executive leadership; strategic planning; management. of process quality
  - Quality results; customer satisfaction
- Recent winners
  - Corning Inc.; GTE; AT&T; Eastman Chemical.
Costs of Quality

- **Prevention costs** - reducing the potential for defects
- **Appraisal costs** - evaluating products
- **Internal failure** - of producing defective parts or service
- **External costs** - occur after delivery
Costs of poor quality “are huge, but the amounts are not known with precision. In most companies, the accounting system provides only a minority of the information needed to quantify this cost of poor quality.”

EC Environmental Standard
ISO 14000

Core Elements:

- Environmental management
- Auditing
- Performance evaluation
- Labeling
- Life-cycle assessment
International Quality Standards

- Industrial Standard Z8101-1981 (Japan)
  - Specification for TQM
- ISO 9000 series (Europe/EC)
  - Common quality standards for products sold in Europe (even if made in U.S.)
- ISO 14000 series (Europe/EC)
  - Standards for recycling, labeling etc.
- ASQC Q90 series; MILSTD (U.S.)
Traditional Quality Process (Manufacturing)

Customer ➔ Marketing ➔ Engineering ➔ Operations

- Customer: Specifies Need
- Marketing: Interprets Need
- Engineering: Designs Product, Defines Quality
- Operations: Produces Product, Plans Quality, Monitors Quality

Quality is customer driven!
TQM

Encompasses entire organization, from supplier to customer

Stresses a commitment by management to have a continuing, company-wide, drive toward excellence in all aspects of products and services that are important to the customer.
Achieving Total Quality Management

Organizational Practices

Quality Principles

Employee Fulfillment

Attitudes (e.g., Commitment)

How to Do

What to Do

Customer Satisfaction

Effective Business

Organizational Practices

PowerPoint presentation to accompany Heizer/Render – Principles of Operations Management, 5e, and Operations Management, 7e

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6-27
Deming’s Fourteen Points

- Create consistency of purpose
- Lead to promote change
- Build quality into the products
- Build long term relationships
- Continuously improve product, quality, and service
- Start training
- Emphasize leadership
Deming’s Points - continued

- Drive out fear
- Break down barriers between departments
- Stop haranguing workers
- Support, help, improve
- Remove barriers to pride in work
- Institute a vigorous program of education and self-improvement
- Put everybody in the company to work on the transformation
Concepts of TQM

- Continuous improvement
- Employee empowerment
- Benchmarking
- Just-in-time (JIT)
- Taguchi concepts
- Knowledge of TQM tools
Continuous Improvement

- Represents continual improvement of process & customer satisfaction
- Involves all operations & work units
- Other names
  - Kaizen (Japanese)
  - Zero-defects
  - Six sigma
Shewhart’s PDCA Model

1. **Plan**
   - Identify the improvement and make a plan

2. **Do**
   - Test the plan

3. **Check**
   - Is the plan working

4. **Act**
   - Implement the plan

Identify the improvement and make a plan.
Test the plan.
Is the plan working?
Implement the plan.
Employee Empowerment

- Getting employees involved in product & process improvements
  - 85% of quality problems are due to process & material

- Techniques
  - Support workers
  - Let workers make decisions
  - Build teams & quality circles
Quality Circles

- Group of 6-12 employees from same work area
- Meet regularly to solve work-related problems
  - 4 hours/month
- Facilitator trains & helps with meetings
Benchmarking

Selecting best practices to use as a standard for performance

- Determine what to benchmark
- Form a benchmark team
- Identify benchmarking partners
- Collect and analyze benchmarking information
- Take action to match or exceed the benchmark
Resolving Customer Complaints

Best Practices

- Make it easy for clients to complain
- Respond quickly to complaints
- Resolve complaints on the first contact
- Use computers to manage complaints
- Recruit the best for customer service jobs
Just-in-Time (JIT)

Relationship to quality:

- JIT cuts cost of quality
- JIT improves quality
- Better quality means less inventory and better, easier-to-employ JIT system
Just-in-Time (JIT)

- ‘Pull’ system of production/purchasing
  - Customer starts production with an order
- Involves ‘vendor partnership programs’ to improve quality of purchased items
- Reduces all inventory levels
  - Inventory hides process & material problems
- Improves process & product quality
Just-In-Time (JIT) Example

Work in process inventory level (hides problems)

Unreliable Vendors

Scrap

Capacity Imbalances
Just-In-Time (JIT) Example

Reducing inventory reveals problems so they can be solved.
Tools for TQM

- Quality Function Deployment
  - House of Quality
- Taguchi technique
- Quality loss function
- Pareto charts
- Process charts
- Cause-and-effect diagrams
- Statistical process control
Quality Function Deployment (QFD)

- Determines what will satisfy the customer
- Translates those customer desires into the target design
Taguchi Techniques

- Experimental design methods to improve product & process design
  - Identify key component & process variables affecting product variation
- Taguchi Concepts
  - Quality robustness
  - Quality loss function
  - Target specifications
Quality Robustness

- Ability to produce products uniformly regardless of manufacturing conditions
- Put robustness in House of Quality matrices besides functionality
Quality Loss Function

- Shows social cost ($) of deviation from target value
- Assumptions
  - Most measurable quality characteristics (e.g., length, weight) have a target value
  - Deviations from target value are undesirable
- Equation: \( L = D^2C \)
  - \( L = \) Loss ($); \( D = \) Deviation; \( C = \) Cost
Quality Loss Function

Target-oriented quality yields more product in the “best” category.

Conformance-oriented quality keeps products within 3 standard deviations.

Distribution of Specifications for Products Produced
The specifications for the diameter of a gear are $25.00 \pm 0.25 \text{ mm}$.
If the diameter is out of specification, the gear must be scrapped at a cost of $4.00$. What is the loss function?
Quality Loss Function Solution

- \( L = D^2C = (X - \text{Target})^2C \)
  - \( L \) = Loss ($); \( D \) = Deviation; \( C \) = Cost
- \( 4.00 = (25.25 - 25.00)^2C \)
  - Item scrapped if greater than 25.25 (USL = 25.00 + 0.25) with a cost of $4.00
- \( C = \frac{4.00}{(25.25 - 25.00)^2} = 64 \)
- \( L = D^2 \cdot 64 = (X - 25.00)^264 \)
  - Enter various \( X \) values to obtain \( L \) & plot
A study found U.S. consumers preferred Sony TV’s made in Japan to those made in the U.S. Both factories used the same designs & specifications. The difference in quality goals made the difference in consumer preferences.
Quality Loss Function; Distribution of Products Produced

Loss (to producing organization, customer, and society)

High loss

Low loss

Frequency

Unacceptable
Poor
Fair
Good
Best

Target-oriented quality yields more product in the “best” category

Target-oriented quality brings products toward the target value

Conformance-oriented quality keeps product within three standard deviations

Distribution of specifications for product produced (b)
PDCA Cycle

1. **Plan:** Identify the improvement and make a plan
2. **Do:** Test the plan
3. **Check:** Is the plan working
4. **Act:** Implement the plan

1. **Plan:** Identify the improvement and make a plan
2. **Do:** Test the plan
3. **Check:** Is the plan working
4. **Act:** Implement the plan
Tools of TQM

- Tools for generating ideas
  - Check sheet
  - Scatter diagram
  - Cause and effect diagram

- Tools to organize data
  - Pareto charts
  - Process charts (Flow diagrams)

- Tools for identifying problems
  - Histograms
  - Statistical process control chart
Seven Tools for TQM

Tools for Generating Ideas
(a) Check Sheet: An organized method of recording data.

(b) Scatter Diagram: A graph of the value of one variable vs. another variable.

(c) Cause and Effect Diagram: A tool that identifies process elements (causes) that might affect an outcome.

Tools to Organize the Data
(d) Pareto Charts: A graph to identify and plot problems or defects in descending order of frequency.

(e) Flow Charts (Process Diagrams): A chart that describes the steps in a process.

Tools for Identifying Problems
(f) Histogram: A distribution showing the frequency of occurrences of a variable.

(g) Statistical Process Control Chart: A chart with time on the horizontal axis to plot values of a statistic.
Pareto Analysis of Wine Glass Defects (Total Defects = 75)

Causes, by percent total defects:
- Scratches: 72% (54 defects)
- Porosity: 15% (12 defects)
- Nicks: 5% (5 defects)
- Contamination: 4% (4 defects)
- Misc.: 3% (2 defects)

Cumulative Percent:
- 0% 100%
- 20% 80%
- 40% 60%
- 60% 40%
- 80% 20%
- 100% 0%
Process Chart

- Shows sequence of events in process
- Depicts activity relationships
- Has many uses
  - Identify data collection points
  - Find problem sources
  - Identify places for improvement
  - Identify where travel distances can be reduced
### Process Chart Example

**SUBJECT: Request tool purchase**

<table>
<thead>
<tr>
<th>Dist (ft)</th>
<th>Time (min)</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td></td>
<td>![Symbol Image]</td>
<td>Write order</td>
</tr>
<tr>
<td></td>
<td></td>
<td>![Symbol Image]</td>
<td>On desk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>![Symbol Image]</td>
<td>To buyer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>![Symbol Image]</td>
<td>Examine</td>
</tr>
</tbody>
</table>

○ = Operation; ⇔ = Transport; □ = Inspect; △ = Delay; ▽ = Storage
**Cause and Effect Diagram**

- Used to find problem sources/solutions
- Other names
  - Fish-bone diagram, Ishikawa diagram
- Steps
  - Identify problem to correct
  - Draw main causes for problem as ‘bones’
  - Ask ‘What could have caused problems in these areas?’
    Repeat for each sub-area.
Cause and Effect Diagram Example

Problem

Too many defects
Cause and Effect Diagram Example

- Method
  - Drill
  - Steel
  - Wood

- Manpower
  - Overtime
  - Lathe

- Material
  - Wood
  - Steel

- Machinery
  - Lathe

Too many defects

Sub-Cause
Fishbone Chart - Problems with Airline Customer Service

- Material
  - Inadequate supply of magazines
  - Insufficient clean pillows & blankets on-board
- Machinery
  - Mechanical delay on plane
  - Broken luggage carousel
  - Deicing equipment not available
- Manpower
  - Understaffed crew
  - Poorly trained attendants
- Methods
  - Misstaged luggage
  - Poor check-in policies
- Understaffed ticket counters
- Overbooking policies
- Bumping policies
- Dissatisfied Airline Customer

Problems with Airline Customer Service:

- Inadequate special meals on-board
- Mechanical delay on plane
- Broken luggage carousel
Statistical Process Control (SPC)

- Uses statistics & control charts to tell when to adjust process
- Developed by Shewhart in 1920’s
- Involves
  - Creating standards (upper & lower limits)
  - Measuring sample output (e.g. mean wgt.)
  - Taking corrective action (if necessary)
- Done while product is being produced
Statistical Process Control Steps

Start

- Produce Good
- Provide Service

No

- Take Sample

- Inspect Sample

Assign. Causes?

Yes

- Stop Process

- Find Out Why

Create Control Chart
Process Control Chart

Plot of Sample Data Over Time

- Sample Value
- UCL
- Average
- LCL

Sample Value vs. Time

Time:

0 20 40 60 80

Sample:

0 10 20 30 40 50

Plot:

Sample Value over time with control limits (UCL, Average, LCL) indicated.
Control Chart

Game Number

% of Free Throws Missed

0% 10% 20% 30%

Upper Control Limit
Coach's target value
Lower Control Limit

0 1 2 3 4 5 6 7 8 9 10
Patterns to Look for in Control Charts

- Normal behavior
- One plot out above (or below). Investigate for cause.
- Trends in either direction, 5 plots. Investigate for cause of progressive change.

- Two plots near lower (or upper) control. Investigate for cause.
- Run of 5 above (or below) central line. Investigate for cause.
- Erratic behavior. Investigate.
Inspection

- Involves examining items to see if an item is good or defective
- Detect a defective product
  - Does not correct deficiencies in process or product
- Issues
  - When to inspect
  - Where in process to inspect
When and Where to Inspect

- At the supplier’s plant while the supplier is producing
- At your facility upon receipt of goods from the supplier
- Before costly or irreversible processes
- During the step-by-step production processes
- When production or service is complete
- Before delivery from your facility
- At the point of customer contact
### Inspection Points in Services

<table>
<thead>
<tr>
<th>Organization</th>
<th>What is Inspected</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones Law Office</td>
<td>Receptionist</td>
<td>Is phone answered by the second ring</td>
</tr>
<tr>
<td></td>
<td>performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Billing</td>
<td>Accurate, timely, and correct format</td>
</tr>
<tr>
<td></td>
<td>Attorney</td>
<td>Promptness in returning calls</td>
</tr>
</tbody>
</table>
# Inspection Points in Services

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<thead>
<tr>
<th>Organization</th>
<th>What is Inspected</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Rock Hotel</td>
<td>Reception desk</td>
<td>Use customer’s name</td>
</tr>
<tr>
<td></td>
<td>Doorman</td>
<td>Greet guest in less than 30 seconds</td>
</tr>
<tr>
<td></td>
<td>Room</td>
<td>All lights working, spotless bathroom</td>
</tr>
<tr>
<td></td>
<td>Minibar</td>
<td>Restocked and charges accurately posted to bill</td>
</tr>
</tbody>
</table>
### Inspection Points in Services

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<tr>
<th>Organization</th>
<th>What is Inspected</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayfield Community Hospital</td>
<td>Billing</td>
<td>Accurate, timely, and correct format</td>
</tr>
<tr>
<td></td>
<td>Pharmacy</td>
<td>Prescription accuracy, inventory accuracy</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Audit for lab-test accuracy</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>Charts immediately updated</td>
</tr>
<tr>
<td></td>
<td>Admissions</td>
<td>Data entered correctly and completely</td>
</tr>
</tbody>
</table>
## Inspection Points in Services

<table>
<thead>
<tr>
<th>Organization</th>
<th>What is Inspected</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Rock Cafe</td>
<td>Busboy</td>
<td>Serves water and bread within 1 minute</td>
</tr>
<tr>
<td></td>
<td>Busboy</td>
<td>Clears all entrée items and crumbs prior to desert</td>
</tr>
<tr>
<td></td>
<td>Waiter</td>
<td>Knows and suggest specials and desserts</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Organization</th>
<th>What is Inspected</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordstrom’s</td>
<td>Display areas</td>
<td>Attractive, well-organized, stocked, good lighting</td>
</tr>
<tr>
<td>Department Store</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stockrooms</td>
<td>Rotation of goods</td>
<td>Rotation of goods, organized, clean</td>
</tr>
<tr>
<td>Salesclerks</td>
<td>Neat, courteous,</td>
<td>Neat, courteous, very knowledgeable</td>
</tr>
<tr>
<td></td>
<td>very knowledgeable</td>
<td></td>
</tr>
</tbody>
</table>
### Inspection Points in Services

<table>
<thead>
<tr>
<th>Organization</th>
<th>Some Points of Inspection</th>
<th>Issues to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bank</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teller stations</td>
<td></td>
<td>Shortages, courtesy, speed, accuracy</td>
</tr>
<tr>
<td>Loan accounts</td>
<td></td>
<td>Collateral, proper credit checks, rates, terms of loans, default rates, loan rates</td>
</tr>
<tr>
<td>Checking accounts</td>
<td></td>
<td>Accuracy, speed of entry, rate of overdraws</td>
</tr>
</tbody>
</table>
# Inspection Points in Services

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<tr>
<th>Organization</th>
<th>Some Points of Inspection</th>
<th>Issues to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail store</td>
<td>Stockrooms: Clean, uncluttered, organized, level of stockouts, amply supply, rotation of goods</td>
<td>Neat, courteous knowledgeable personnel; waiting time; accuracy in credit checking and sales entry</td>
</tr>
<tr>
<td></td>
<td>Display areas: Attractive, well-organized, stocked, visible goods, good lighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sales counters:</td>
<td></td>
</tr>
</tbody>
</table>
# Inspection Points in Services

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<th>Some Points of Inspection</th>
<th>Issues to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restaurant</td>
<td>Clean, proper storage, unadulterated food, health regulations observed, well-organized</td>
<td>Speed, accuracy, appearance</td>
</tr>
<tr>
<td>Kitchen</td>
<td>Clean, comfortable, regular monitoring by personnel,</td>
<td></td>
</tr>
<tr>
<td>Cashier station</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dining areas</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TQM In Services

- Service quality is more difficult to measure than for goods
- Service quality perceptions depend on
  - Expectations versus reality
  - Process and outcome
- Types of service quality
  - Normal: Routine service delivery
  - Exceptional: How problems are handled
Goods versus Services

Good

◆ Can be resold
◆ Can be inventoried
◆ Some aspects of quality measurable
◆ Selling is distinct from production

Service

◆ Reselling unusual
◆ Difficult to inventory
◆ Quality difficult to measure
◆ Selling is part of service
Goods versus Services - continued

Good

- Product is transportable
- Site of facility important for cost
- Often easy to automate
- Revenue generated primarily from tangible product

Service

- Provider, not product is transportable
- Site of facility important for customer contact
- Often difficult to automate
- Revenue generated primarily from intangible service.
Service Quality Attributes

- Reliability
- Responsiveness
- Competence
- Access
- Courtesy
- Communication
- Tangibles
- Understanding
- Security
- Credibility
- Courtesy
- Communication
Determinants of Service Quality

- Reliability – consistency and dependability
- Responsiveness – willingness/readiness of employees to provide service; timeliness
- Competence – possession of skills and knowledge required to perform service
- Access – approachability and ease of contact
- Courtesy – politeness, respect, consideration, friendliness of contact personnel
Determinants of Service Quality - Continued

- Communication – keeping customers informed in languages they understand
- Credibility – trustworthiness, believability, honesty
- Security – freedom from danger, risk or doubt
- Understanding/knowing the customer – making the effort to understands the customer’s needs
- Tangibles – the physical evidence of the service