STATISTICAL QUALITY CONTROL

ME 513

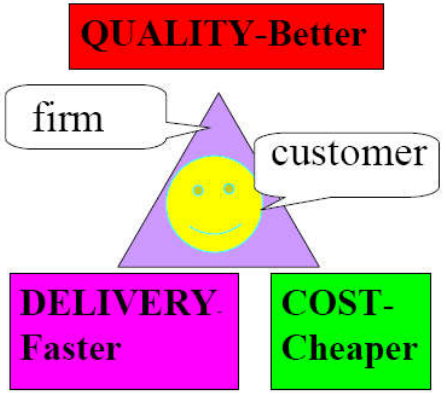
THE THREE GOALS OF OPERATIONS-QDC

- Customer expectation is three fold: QDC
  - QUALITY
  - DELIVERY
  - COST

✓ Customer is satisfied

- The Firm's response should be: BFC
  - BETTER
  - FASTER
  - CHEAPER

✓ Firm develops competitive advantage!



DIFINITION OF QUALITY

- The concept and vocabulary of quality are elusive. Different people interpret quality differently. Few can define quality in measurable terms that can be proved operationalized. When asked what differentiates their product or service;

The banker will answer" service"
The healthcare worker will answer "quality health care"
The hotel employee will answer "customer satisfaction"
The manufacturer will simply answer "quality product"

Five Approaches of Defining Quality

- Harvard professor David Garvin, in his book *Managing Quality* summarized five principal approaches to define quality.

- Transcendent
- Product based
- User based
- Manufacturing based
- Value based

Transcendental view

- Those who hold the transcendental view would say “I can’t define it, but I know it when I see it”
- Advertisers are fond of promoting products in these terms.

  “ Where shopping is a pleasure” (supermarket). “We love to fly and it shows" (airline).

  Television and print media are awash with such indefinable claims and therein lies the problem:
- Quality is difficult to define or to operationalize. It thus becomes elusive when using the approach as basis for competitive advantage. Moreover, the functions of design, production and service may find it difficult to use the definition as a basis for quality management.

PRODUCT BASED

- Quality is viewed as a quantifiable or measurable characteristic or attribute. For example durability or reliability can be measured and the engineer can design to that benchmark.
- Quality is determined objectively.
- Although this approach has many benefits, it has limitation as well. Where quality is based on individual taste or preference, the benchmark for measurement may be misleading.

USER BASED

It is based on idea that quality is an individual matter and products that best satisfy their preferences are those with the highest quality. This is rational approach but leads to two problems;

- Consumer preference vary widely and it is difficult to aggregate these preferences into products with wide appeal. This leads to the choice between a niche strategy or a market aggregation approach which tries to identify those product attributes that meet the needs of the largest number of consumers.
- Another problem concerns the answer to the question “Are quality and customer satisfaction the same?” the answer is probably not. One may admit that a Lincoln continental has many quality attribute, but satisfaction may be better achieved with an Escort.

MANUFACTURING BASED

- Manufacturing-based definitions are concerned primarily with engineering and manufacturing practices and use the universal definition of “conformance to requirements”. Requirements or specifications are established by design and any deviation implies a reduction in quality. The concept applies to services as well as product. Excellence in quality is not necessarily in the eye of the beholder but rather in the standards set by the organization.
- This approach has the serious weakness. The consumer’s perception of quality is equated with conformance and hence is internally focused.

Value Based

- It is defined in term of costs and prices as well as number of other attributes. Thus, the consumer's purchased decision is based on quality at an acceptable price. This approach is reflected in the popular *Consumer Reports* magazine which ranks products and services based on two criteria: Quality and Value.
- The highest quality is not usually the best value. That designation is assigned to the "best- buy" product or service.

The dimensions of quality

- Performance
- Features
- Conformance
- Reliability
- Durability
- Service
- Response
- Aesthetics
- Reputation

QUALITY CHARACTERISTICS

1. **Physical**
2. **Sensory**
3. **Time orientation**

Key Dimensions of Quality

- Performance
- Features
- Reliability
- Conformance
- Durability
- Serviceability
- Aesthetics
- Perceived quality
- Value

Defining Quality

The totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs

American Society for Quality

Quality – Fitness for use

Q = P/E

Q = QUALITY
P = PERFORMANCE
E = EXPECTATIONS

Quality of Design

Intentional levels or grades of quality.

Quality of Conformance

How well the product conforms to specifications and tolerances required by design.

Quality Engineering

Operational, Managerial and Engineering activities that a company uses to ensure that the quality characteristics are at the nominal or required levels.

Variability

- No two products are identical
- If variation is large product may be unacceptable
- materials, operators, equipments may lead to variability

Quality Improvement

Reduction of variability in processes and products

Since variation can only be described in statistical terms, statistical methods are of considerable use in quality improvement efforts

Quality improvement as business strategy

- Strong consumer quality-performance orientation
- Product liability
- Increasing cost pressures on labour, energy and raw materials
- More intensive competition
- Dramatic improvements in productivity through quality engineering programmes

Two Ways Quality Improves Profitability

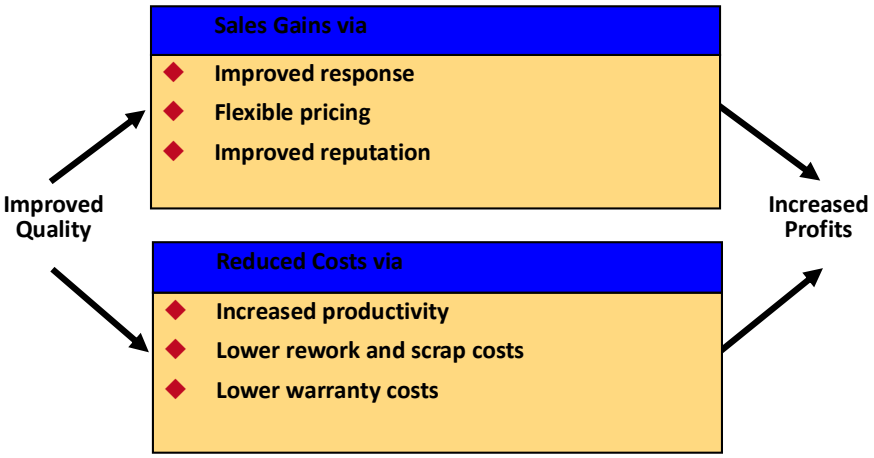


Figure 6.1

Costs of Quality

- **Prevention costs - reducing the potential for defects**
- **Appraisal costs - evaluating products, parts, and services**
- **Internal failure - producing defective parts or service before delivery**
- **External costs - defects discovered after delivery**

Prevention costs

- Quality planning and engineering
- New products reviews
- Product/ process design
- Process control
- Burn – in : Preshipment to prevent early failures
- Training
- Quality data acquisition and analysis

Appraisal costs

- Inspection and test of incoming material
- Product Inspection and test
- Materials and services consumed – consumed in reliability tests, devalued by reliability tests
- Maintaining accuracy of test equipment

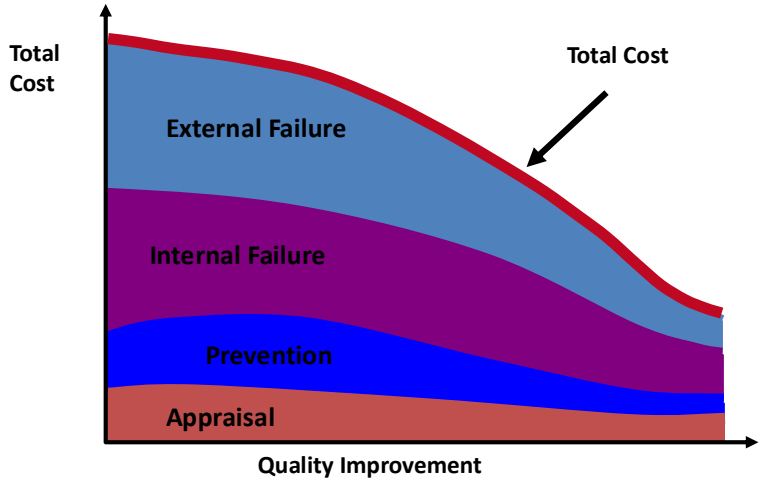
Internal failure costs

- Scrap
- Rework
- Retest
- Failure Analysis
- Downtime
- Yield losses
- Downgrading/ off - specing

External Failure costs

- Component adjustment
- Returned product/ material
- Warranty charges
- Liability costs – including litigation
- Indirect costs – reputation, future business

Costs of Quality



Ethics and Quality Management

- **Operations managers must deliver healthy, safe, quality products and services**
- **Poor quality risks injuries, lawsuits, recalls, and regulation**
- **Organizations are judged by how they respond to problems**
- **All stakeholders must be considered**

Methods of Quality Improvement

- Acceptance sampling
- Statistical Process Control
- Design of Experiments
- Zero defects program
- Quality Circle programme

DEFINITION OF KAIZEN

改
善
改善

KAI = CHANGE

ZEN = GOOD
(FOR THE BETTER)
(Next Elevated State)

KAIZEN = CONTINUAL
IMPROVEMENT

WHY KAIZEN

1. Universally applicable to various industries and context
2. Directly impacting on all customer satisfaction parameters of business
3. Easy to implement at grass-root level compared to other tools
4. Accomplish self sustainable benefits through people involvement
5. Kaizen generates process-oriented thinking since processes must be improved before we get improved results
   - Support & Stimulate Efforts for Process improvement rather than Control and Command for Performance/Results improvement

KAIZEN – FOCUSED IMPROVEMENT

Improvement

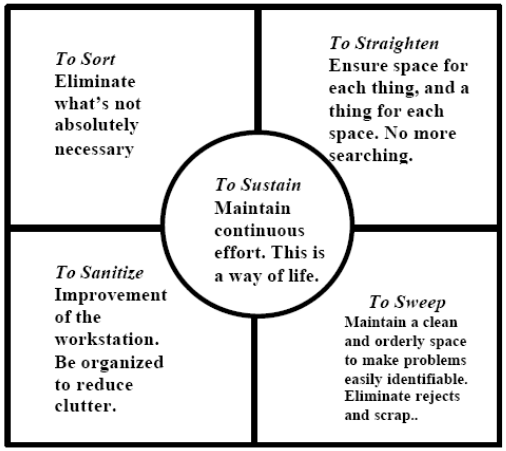
Focused Improvement

Improvement is like sunlight:
- Lot of energy, but dispersed (wasted)
- Small improvements
- Slow progress.

Focused improvement concentrates the energy:
- **Little energy, but concentrated and aligned**
- **Enables significant (large) improvements**
- **Small time required**
- **Rapid progress**

Innovation	KAIZEN
Creativity	Adaptability
Individualism	Teamwork (systems approach)
Specialist-oriented	Generalist-oriented
Attention to great leaps	Attention to details
Technology-oriented	people-oriented
Information: closed, proprietary	Information: open, sha red
Functional (specialist) orientation	Cross-functional orientation
Seek new technology	Build on existing technology
Line + staff	Cross-functional organization
Limited feedback	Comprehensive feedback

PDCA or Story Boards	Sequence of activities that show/discover what is going on.
5S	Set the scene for Continuous Improvements, de-clutter the work place & raise morale
7 Wastes	Distinct classifications of waste found on the shop floor or office.
7 Old & New Quality tools	Numerical and text based descriptions of quality control issues
5 Whys	Root cause problem solving
Value Stream Mapping	Determine value adding activities from non-value adding ones
Workstation improvement	Educate staff to allow them to improve their own areas
Success Stories	Celebrate the success of your teams



The 5 S

3 Mu Checklist of Kaizen activities

	MUDA(Waste)	*MURI(Strain)*	*MURA(Discrepancy)*
1	Manpower	Manpower	Manpower
2	Technique	Technique	Technique
3	Method	Method	Method
4	Time	Time	Time
5	Facilities	Facilities	Facilities
6	Jigs and Tools	Jigs and Tools	Jigs and Tools
7	Materials	Materials	Materials
8	Production time	Production time	Production time
9	Inventory	Inventory	Inventory
10	Place	Place	Place
11	Way of Thinking	Way of Thinking	Way of Thinking

The 4M Checklist

A. Man (Operator)

1. Does he follow standards?
2. Is his work efficiency acceptable?
3. Is he problem- conscious?
4. Is he responsible/accountable?
5. Is he qualified?
6. Is he experienced?
7. Is he assigned to the right job?
8. Is he willing to improve?
9. Does he maintain good human relations?
10. Is he fit and healthy?

B. Machine (Facilities)

1. Does it meet production requirements?
2. Does it meet process capabilities?
3. Is the lubrication adequate?
4. Is the inspection adequate?
5. Is operation interupted due to machine trouble?
6. Does it meet precision requirements?
7. Does it make any unusual noises?
8. Is the layout adequate?
9. Are there enough machines/facilities?
10. Is everything in good working order?

The 4M Checklist

C. Material

1. Are there any mistakes in volume?
2. Are there an mistakes in grade?
3. Are there any mistakes in the brand name?
4. Are there impurities mixed in?
5. Is the inventory level adequate?
6. Is there any waste in material?
7. Is the handling adequate?
8. Is the work-in-progress abandoned?
9. Is the storage layout adequate?
10. Is the quality standard adequate?

D. Method

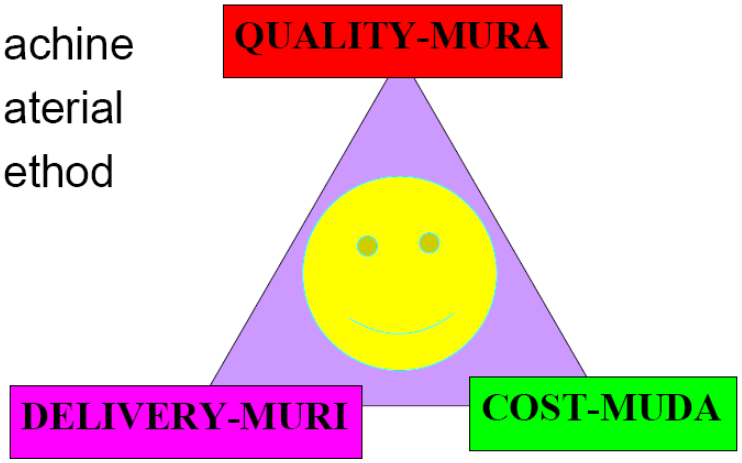
1. Are the work standards adequate?
2. Is the work standard upgraded?
3. Is it a safe method?
4. Is it a method that ensures a good product?
5. Is it an efficient method?
6. Is the sequence of work adequate?
7. Is the setup adequate?
8. Are the temperature and humidity adequate?
9. Are the lighting and ventilation adequate?
10. Is there adequate contact with the previous and next processes?

The 5 W and 1 H of Kaizen

Who?	What?	Where?
1. Who does it? 2. Who is doing it? 3. Who should be doing it? 4. Who else can do it? 5. Who else should do it? 6. Who is doing 3-Mus?	1. What to do? 2. What is being done? 3. What should be done? 4. What else can be done? 5. What else should be done? 6. What 3-Mus are being done?	1. Where to do it? 2. Where is it done? 3. Where should it be done? 4. Where else can it be done? 5. Where else should it be done? 6. Where are 3-Mus being done?
When?	**Why?**	**How?**
1. When to do it? 2. When is it done? 3. When should it be done? 4. What other time can it be done? 5. What other time should it be done? 6. Are there any time 3-Mus?	1. Why does he do it? 2. Why do it? 3. Why do it there? 4. Why do it then? 5. Why do it that way? 6. Are there 3-Mus in the way of thinking?	1. How to do it? 2. How is it done? 3. How should it be done? 4. Can this method be used in other areas? 5. Is there any other way to do it? 6. Are there any 3-Mus in the method?

3 KAIZEN elements & QDC

- Man
- Machine
- Material
- Method



4Mx3mu=12 point improvement opportunity

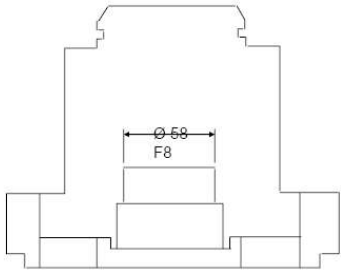
7 Old Quality Tools:

1. Measles Chart
2. Scatter (Correlation) Diagram
3. Check Sheet
4. Run Graphs
5. Control charts
6. Pareto 80:20
7. Fishbone Diagram

Actual Examples

Before Kaizen:

There was no method other than CMM to check the final size of Ø 58 F8.Separate inspection time was required and machine was kept idle to check this diameter in CMM.



After Kaizen:

Special Gauge is made to check the size,QC inspection is not required before I/D grinding.

CONTINUAL IMPROVEMENT

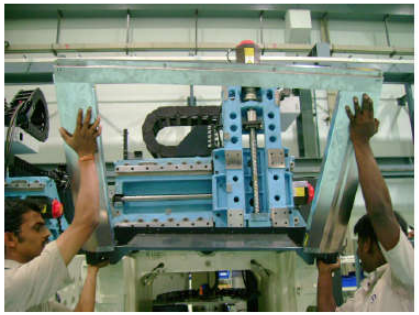
Theme: Improvement in bracket bellow support assembly for slim3 assembly

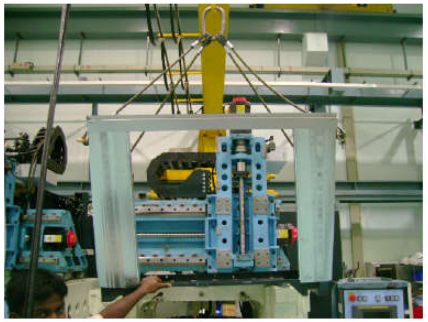
Before Kaizen:

There was a strain in mounting the Bracket bellow support on to slim3 machine. 2 persons required to assemble the cover

After Kaizen:

Fixture made by using simple frame from in-house parts. Single person can assemble the cover. Easy handling of part since crane will be used





QUALITY IMPROVEMENTS

Theme: Storage of spindle shafts for Slim3

Before Kaizen:
The storage of spindle shafts was being done with the help of a wooden V block fixture. This method was prone to damages

After Kaizen:
Special trolley introduced for storage of spindle shafts. Easy handling of spindle shafts. No damages will be caused during transport

Tools of TQM

- **Tools for Generating Ideas**
  - **Check sheets**
  - **Scatter diagrams**
  - **Cause-and-effect diagrams**
- **Tools to Organize the Data**
  - **Pareto charts**
  - **Flowcharts**

Tools of TQM

- **Tools for Identifying Problems**
  - **Histogram**
  - **Statistical process control chart**

Seven Tools of TQM

(a) Check Sheet: An organized method of recording data

	Hour							
Defect	1	2	3	4	5	6	7	8
A	///	/		/	/	/	///	/
B	//	/	/	/			//	///
C	/	//					//	////

Figure 6.6

Seven Tools of TQM

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

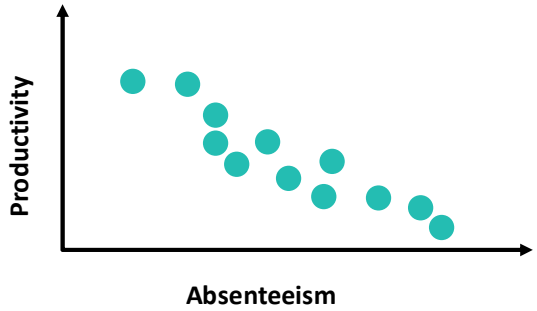


Figure 6.6

Seven Tools of TQM

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

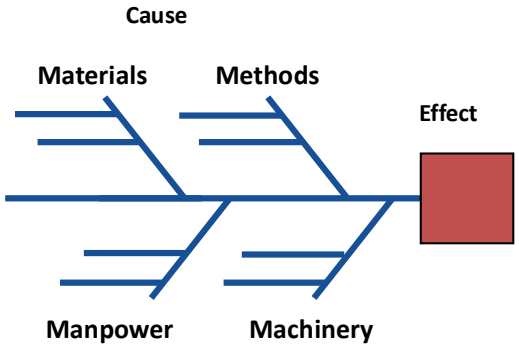


Figure 6.6

Seven Tools of TQM

(d) Pareto Chart: A graph to identify and plot problems or defects in descending order of frequency

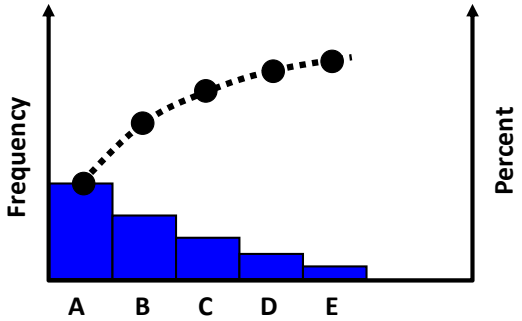


Figure 6.6

Seven Tools of TQM

(e) Flowchart (Process Diagram): A chart that describes the steps in a process

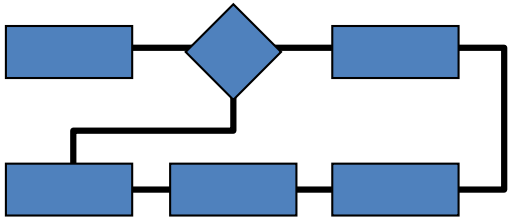


Figure 6.6

Seven Tools of TQM

(f) **Histogram: A distribution showing the frequency of occurrences of a variable**

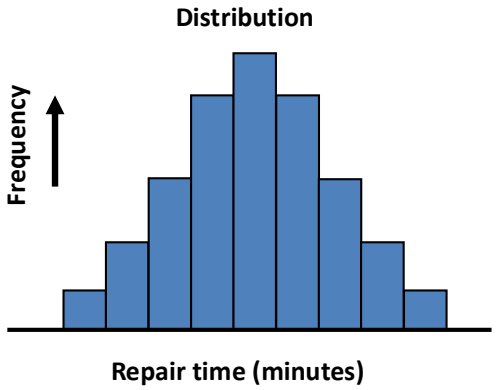


Figure 6.6

Seven Tools of TQM

(g) **Statistical Process Control Chart: A chart with time on the horizontal axis to plot values of a statistic**

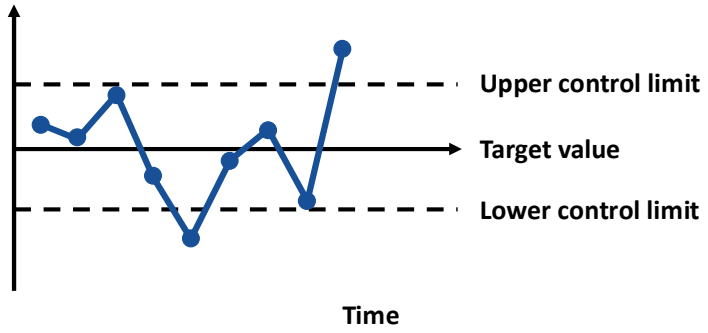


Figure 6.6

Cause-and-Effect Diagrams

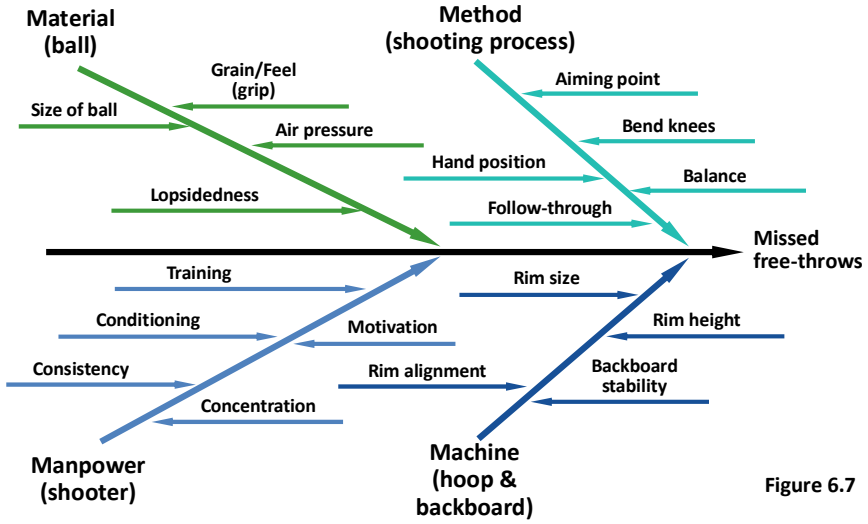
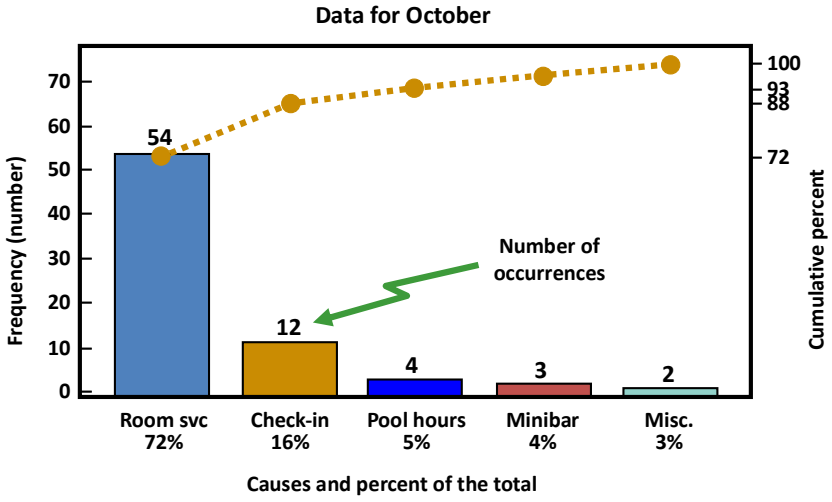


Figure 6.7

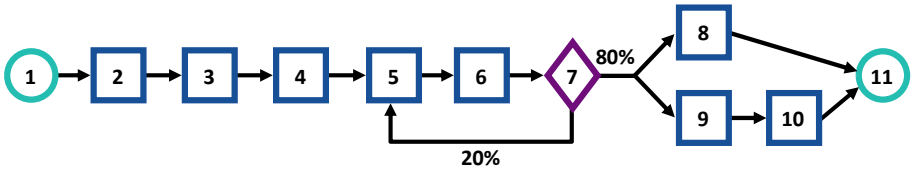
Pareto Charts



Flow Charts

MRI Flowchart

1. Physician schedules MRI
2. Patient taken to MRI
3. Patient signs in
4. Patient is prepped
5. Technician carries out MRI
6. Technician inspects film
7. If unsatisfactory, repeat
8. Patient taken back to room
9. MRI read by radiologist
10. MRI report transferred to physician
11. Patient and physician discuss



Statistical Process Control (SPC)

- Uses statistics and control charts to tell when to take corrective action
- Drives process improvement
- Four key steps
  - Measure the process
  - When a change is indicated, find the assignable cause
  - Eliminate or incorporate the cause
  - Restart the revised process

An SPC Chart

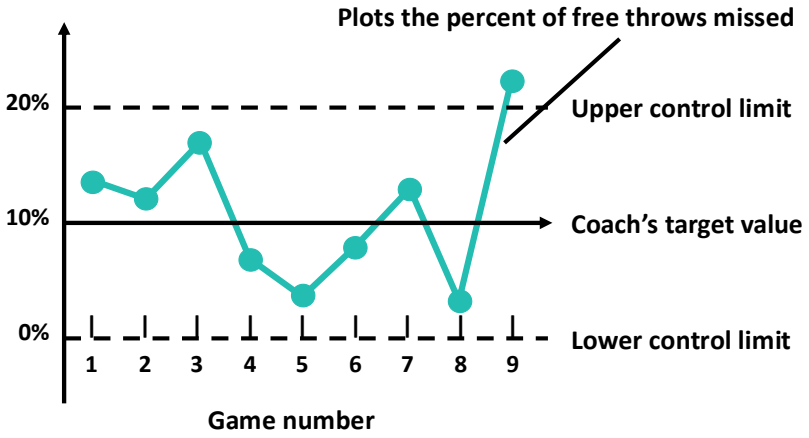


Figure 6.8