

Project Quality Management

Prepared by Dr. Ehab Mahmoud

PMG 354
Ishikawa Basic Tools

Lecture 03



Project Quality Management

Lecture 3

PMG354

Ishikawa Basic Tools

Prepared by
Dr. Ehab Mahmoud

Lecture

03

Objectives



At the end of this lecture, we expect to acquire a knowledge about Ishikawa basic seven tools that are used to monitor the quality level in achieving projects.



Lecture
03

Contents

- **Types of Data**
- **Basic Tools of Quality**
 - Cause and effect diagram
 - Check Sheets
 - Histogram
 - Pareto Diagram
 - Process Control Chart
 - Scatter Diagram
 - Flowchart

Types of Data

Attribute

Is a quality characteristic that is either present or absent, conforming or not conforming, within tolerance or out of tolerance, complete or incomplete
(invoices percent, number of lost complaints, mistakes per week)

Attributes data are collected by
counting

Variable

Is evaluated in terms of measurable values on a continuous scale
(time waiting for service, number of hours per week correcting documents, days from ordering to delivering)

Variables data are collected through
measurement

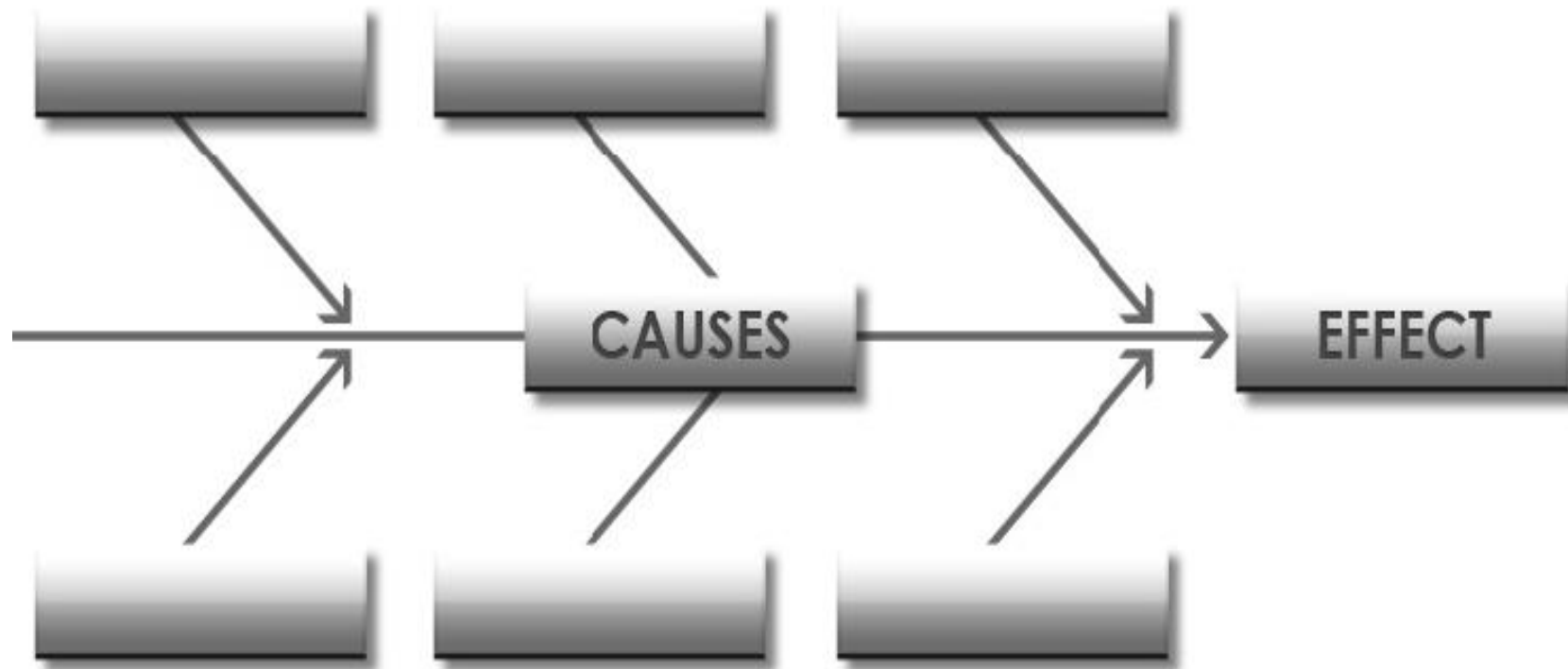
Basic Tools of Quality

Ishikawa adapted and invented seven basic chart/diagram tools of quality, so that the normal person could analyze and interpret data to identify a problem in the process

The Seven Tools

1. Cause and effect (Ishikawa / Fish Bone) diagram - **what causes the problems?**
2. Check sheets - **how often it occurs or is done?**
3. Histograms - **what do overall variations look like?**
4. Pareto diagram - **which are the big problems?**
5. Process control charts - **which variations to control and how?**
6. Scatter diagram - **what are the relationships between factors?**
7. Flow Charts - **identify problem areas and opportunities for process improvement.**

1. Cause and Effect Diagram



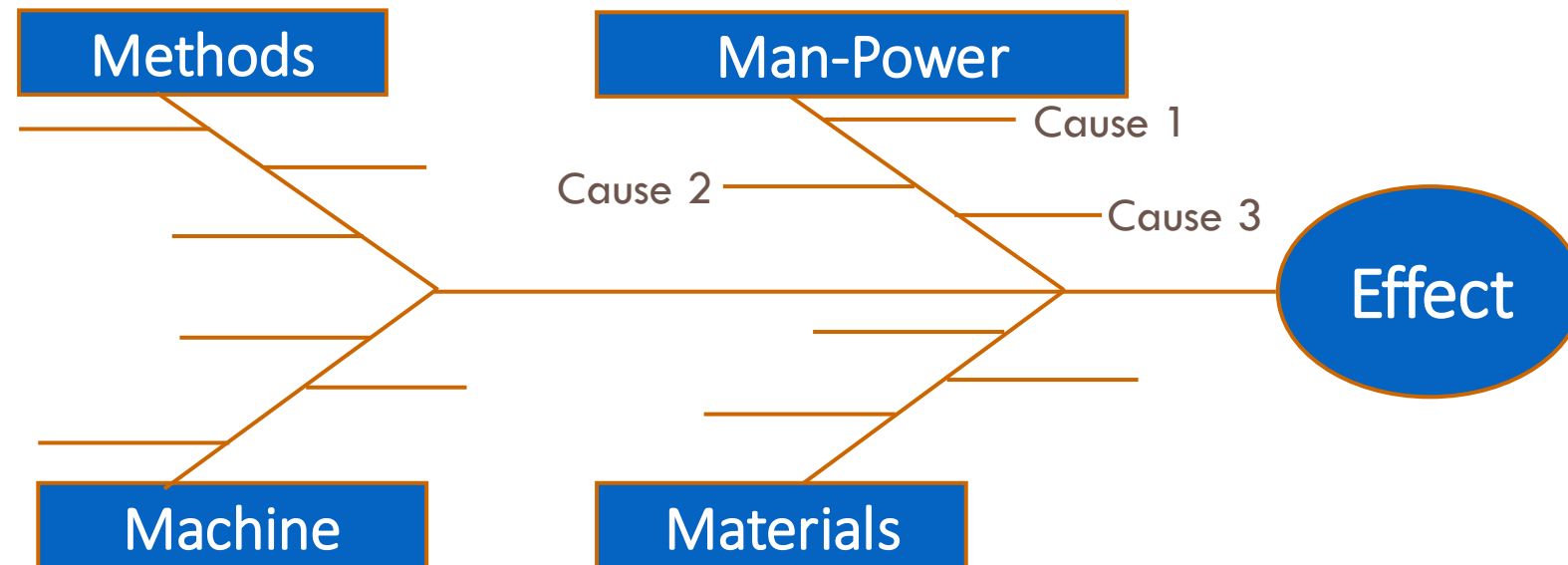
1. Cause and Effect Diagram

- Also called: Ishikawa diagram, Fishbone diagram.
- It is an excellent tool for organizing and documenting potential causes of problems in all areas and at all levels in the organization.
- It identifies many possible causes for an effect or problem so that further data collection and analysis can be carried out.
- No statistics involved.

Chapter
03

1. Cause and Effect Diagram

- It looks like a “Fish Skeleton”.
- It can be used through a brainstorming session.
- It easily **sorts** ideas into useful/helpful categories which makes improvement easier.



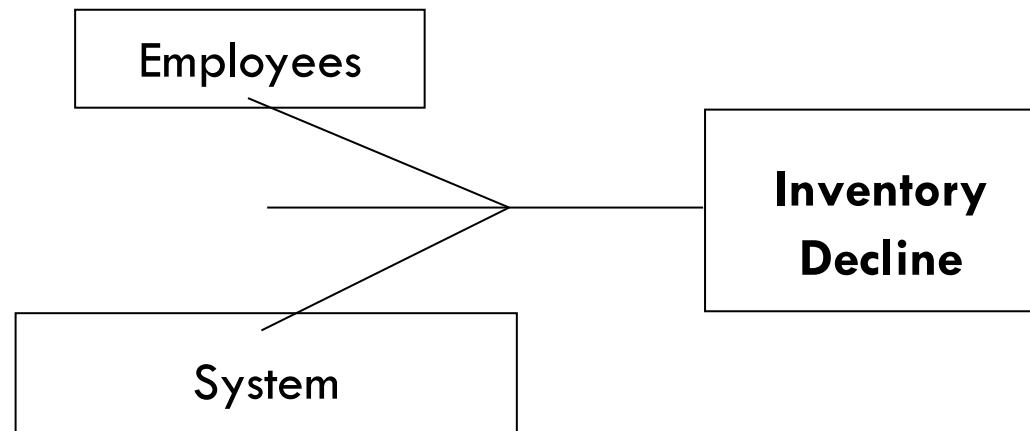
1. Cause and Effect Diagram

The 8 Ms (used in manufacturing)	The 8 Ps (used in service industry)	The 4 Ss (used in service industry)
• Machine • Method • Material • Man-Power • Measurement • Mother Nature • Management • Maintenance	• Product = Service • Price • Place • Promotion • People • Process • Physical Evidence • Productivity & Quality	• Surroundings • Suppliers • Systems • Skills

1. Cause and Effect Diagram

Constructing Cause and Effect Diagram

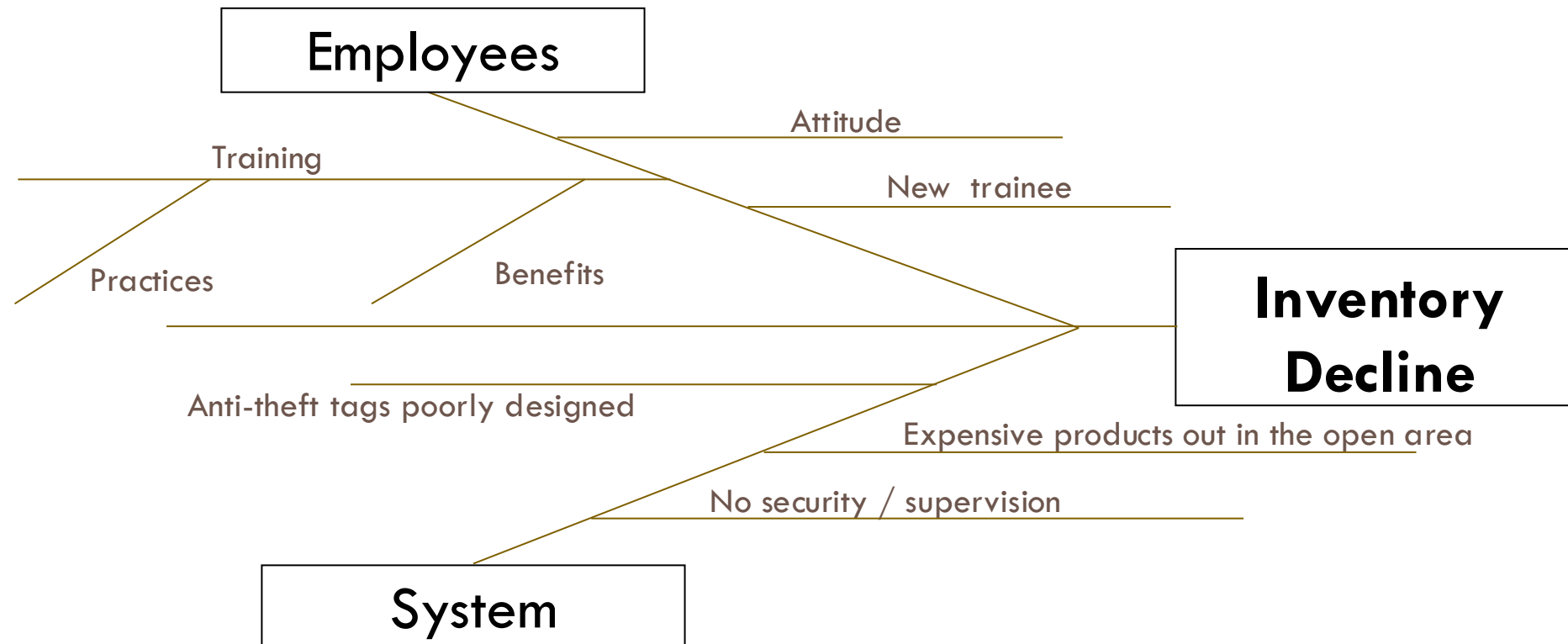
- Step 1 - Identify the Problem
- Step 2 - Draw “spine” and “bones”
- Step 3 – Identify different areas where problems may arise from (may be there are sub-problems).



Chapter
03

1. Cause and Effect Diagram

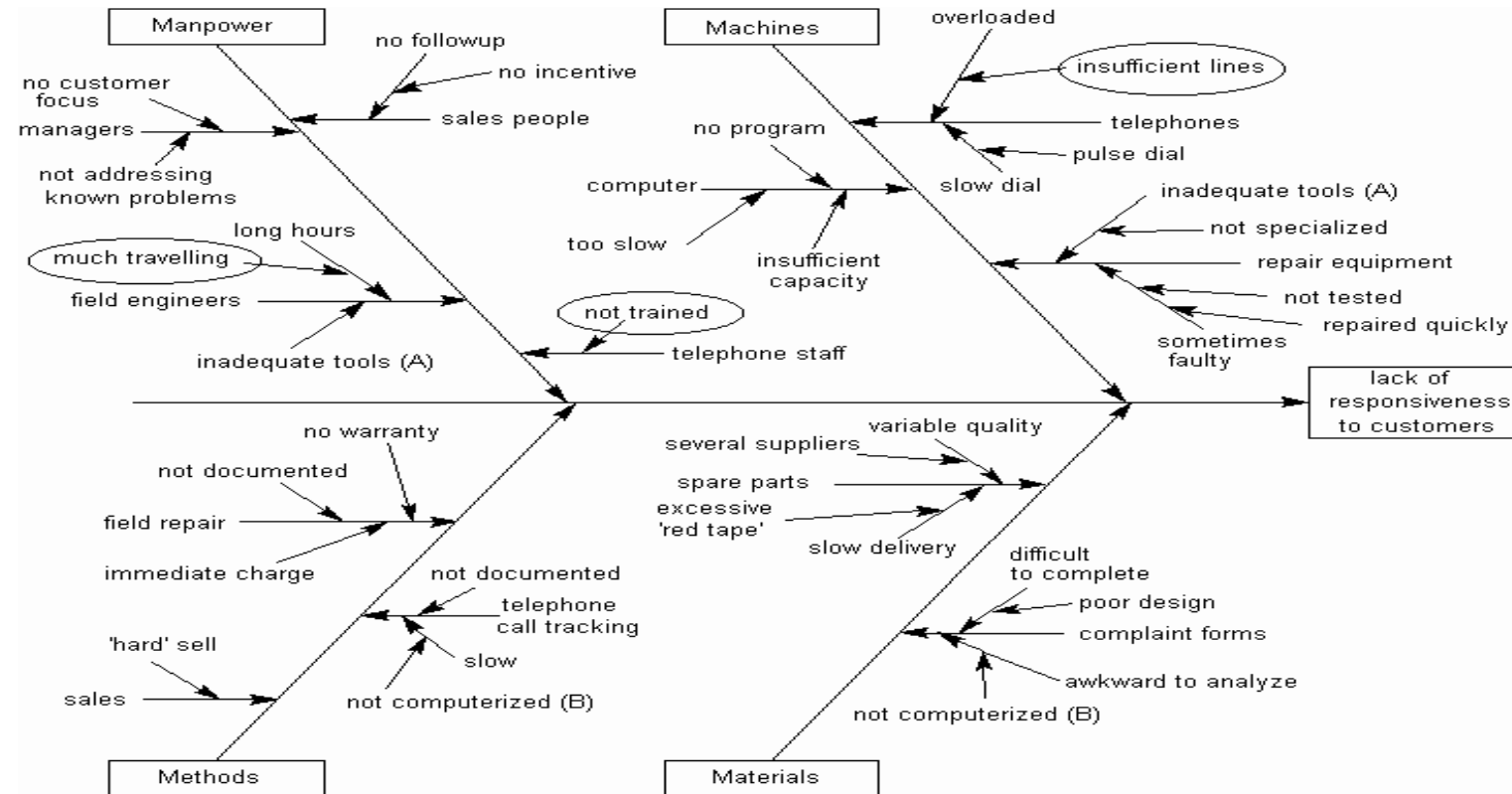
- Step 4 – Identify what these specific causes could be.



Chapter
03

1. Cause and Effect Diagram

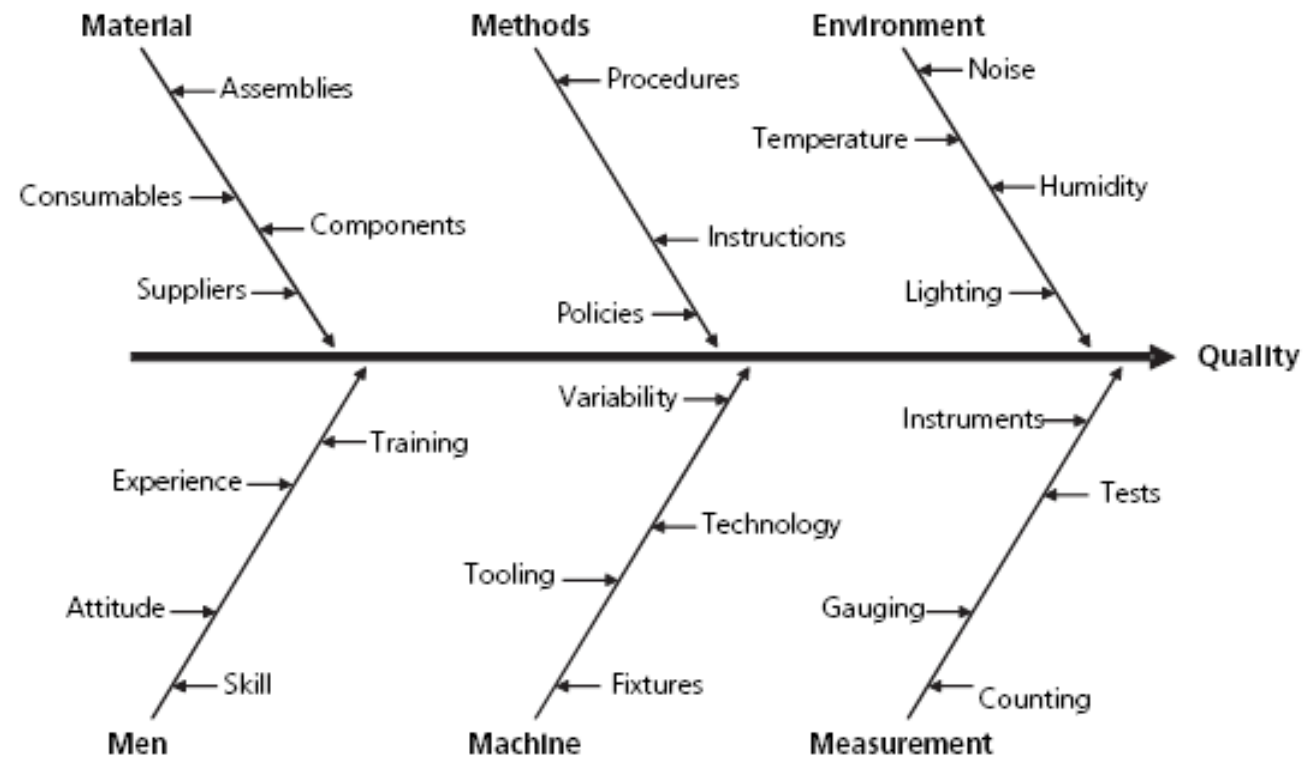
Cause and Effect Diagrams - Example



Chapter
03

1. Cause and Effect Diagram

Cause-and-Effect Diagram to identify the factors affecting quality.



2. Check Sheets

Defect	Tallies	Total
Defect 1		8
Defect 2		3
Defect 3		5
Defect 4		13

2. Check Sheets

- ☐ Also called: defect concentration diagram
- ☐ A check sheet is a structured, prepared form for *collecting and analyzing data*.
- ☐ Check sheet used when:
 - Data can be observed and collected time after time by the same person or at the same location,
 - Collecting data on the frequency or patterns of events, problems, defects, defect location, defect causes, etc.
 - Collecting data from a production process.

2. Check Sheets

Constructing Check Sheets

1. Decide what event or problem will be observed.
2. Decide when data will be collected and for how long.
3. Design the form. Set it up so that data can be recorded simply by making check marks or similar symbols and so that data do not have to be recopied for analysis.
4. Label all spaces on the form.
5. Test the check sheet for a short trial period to be sure it collects the appropriate data and is easy to use.
6. Each time the targeted event or problem occurs, record data on the check sheet.

2. Check Sheets

Check Sheets – Example: Copier Problem Check Sheet

Problem Type	Mon.	Tues.	Wednes.	Thurs.	Fri.	Total
Setup routines not standardized						
Missing equipment for setup						
Failure to separate internal and external tasks						
Extensive machine resetting and paper change						
Other						
Total						

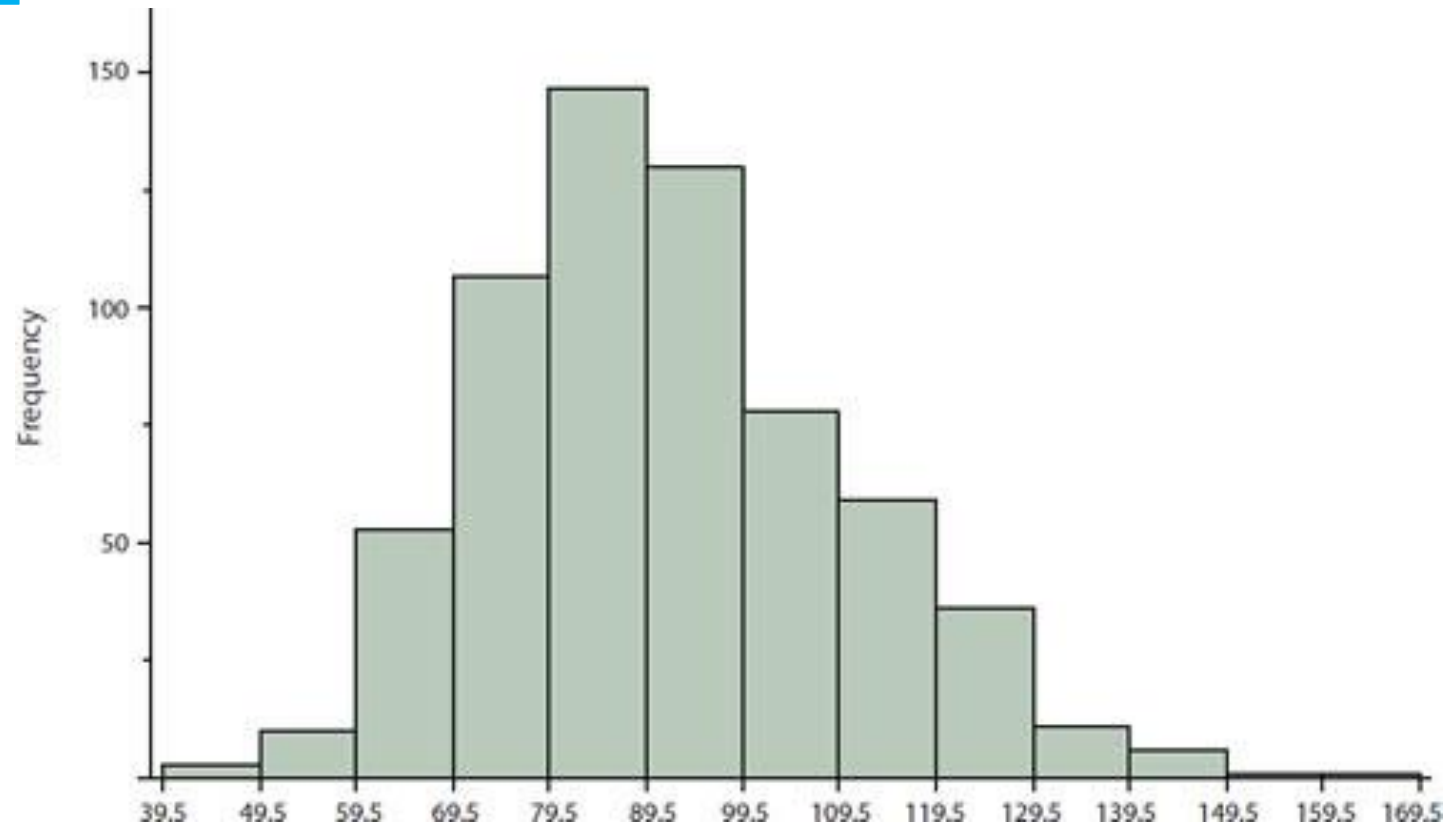
Chapter
03

2. Check Sheets

Check Sheets – Example: Telephone interruptions Check Sheet

Problem Type/Reason	Mon.	Tues.	Wednes.	Thurs.	Fri.	Total
Wrong number	 			 	 	20
Information request						10
Other	 		 			19
Total	12	6	10	8	13	49

3. Histogram



3. Histogram

- Also called: Bar chart
- Histogram is a graphical representation of the variation in a set of data to show **frequency distributions**.
- Patterns can be seen that would be difficult to see in an ordinary table of numbers.
- Histogram used when the data are **numerical**, and when you want to see the **shape of the data distribution**, especially when determining whether the output of a process is distributed approximately **normally**.

3. Histogram

Constructing a Histogram

1. Collect data (preferably 50 or more observations of an item).
2. Arrange all values in an ascending order.
3. Compute: Sum, Mean and Range of data
4. Use range to estimate beginning and end of the Histogram.

3. Histogram

Histograms - Example

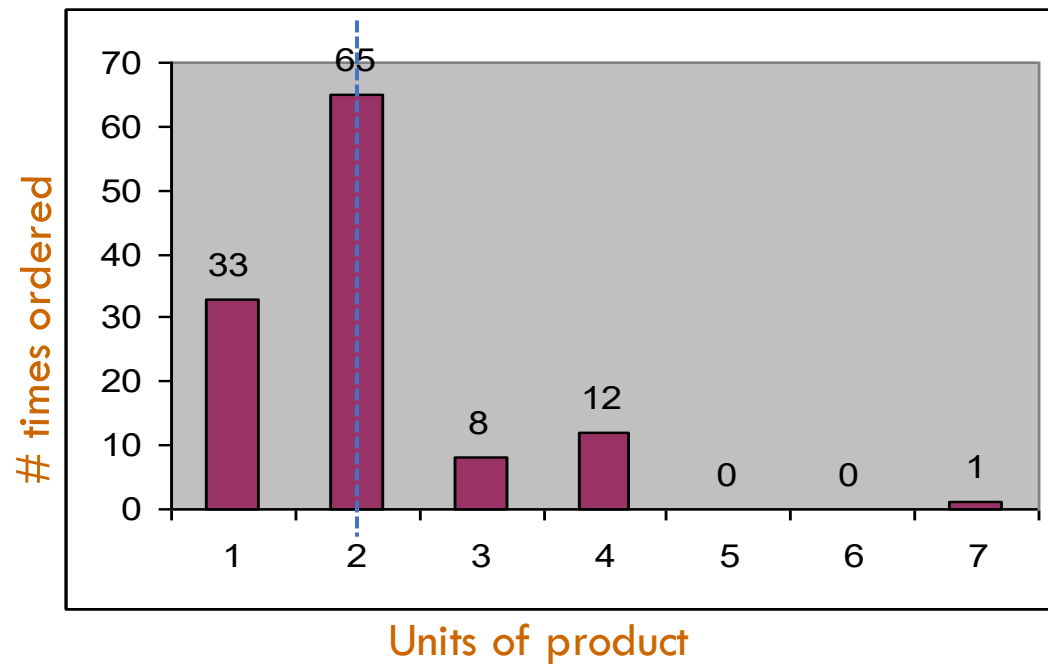
- Let's say the owner of *a factory* wants a distribution of Thursday Night Sales.
- These numbers represent the customers order at the order window at the store.
- Data Set from last Thursday

2 1 2 2 4 1 3 1 2 1 2 4 3 4 1 4 3 2 2 3 2 1 2 2 1 2 2 1 4 2 2 1 2 1 2 2 1 2 1 2 1 2 1 2 1 2 2 2 1 2 1 2 1 1 2 2 2 3 1 4 2 2 3 2 2 2 1 2 3 2 2 4 2
2 4 4 1 2 2 2 3 2 2 1 2 2 4 2 1 4 2 1 7 2 1 2 2 1 2 1 1 2 1 2 2 2 1 2 2 1 2 2 2 2 4 2 4

3. Histogram

Histograms - Example

Mean = 2.032258, Max = 7, Min = 1, Range = 6



Orders	Frequency
1	33
2	65
3	8
4	12
5	0
6	0
7	1

3. Histogram

Histograms - Example

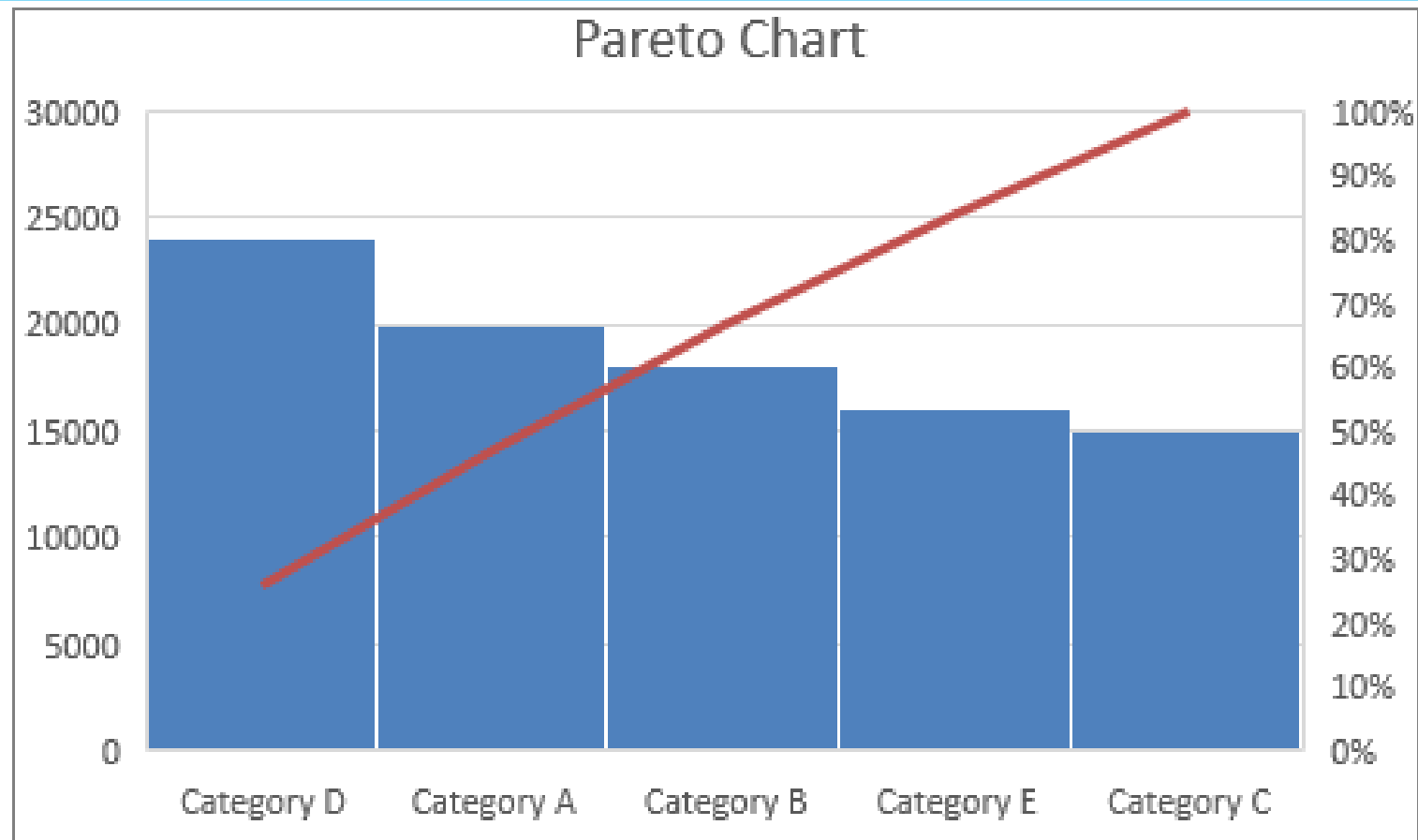
- This was helpful to *factory* in showing orders frequencies, variation, and forecasting next Thursday's demand.
- Knowing that the average customer will order *2 units of products* can be implemented into *factory's* strategic plan.
- By taking at least 2 units will be ready at peak hours, this can improve *factory's* customer service and speed. It makes the line move much faster making the perceived quality higher for the customer.

First value= $33 \times 1 + 65 \times 2 + 8 \times 3 + 12 \times 4 + 5 \times 0 + 6 \times 0 + 1 \times 7 = 242$

Second value= $33 + 65 + 8 + 12 + 0 + 0 + 1 = 119$

Mean= $242 / 119 = 2.032$

4. Pareto Diagram



4. Pareto Diagram

- Also called: Pareto chart, Pareto analysis.
- Pareto diagram is very similar to Histograms, but it shows percentages, and prepared to show **frequency of occurrences**.
- Pareto analysis separates the **vital few** from the **trivial many** and provides direction for selecting projects for improvement.
- A Pareto diagram is a bar graph.
 - The lengths of the bars represent frequency, cost, time, money; and are arranged with longest bars on the left and the shortest to the right.
 - In this way the chart shows which situations are more significant.

4. Pareto Diagram

- Pareto diagram used to analyze data about the **frequency of problems** or **causes in a process**, and when there are many problems or causes and you want to **focus** on the most significant.
- Sometimes it is used after doing a cause-and-effect analysis, to count the frequency of different causal factors, and to identify problems.
- So, it is used to **identify and prioritize problems** to be solved.

4. Pareto Diagram

Constructing Pareto Chart

1. Determine the categories of problems or causes to be compared.
2. Collect and Summarize the Data. Create a four-column table with the headings of “**problem category**”, “**frequency**”.
 - Problem category: list the categories of problems or causes.
 - Frequency: write the total for each of the categories over the selected period.

4. Pareto Diagram

3. Label the left-hand vertical axis.
 - Make sure the labels are spaced in equal intervals from 0 to a round number equal to or just larger than the total of all counts.
 - Provide a caption to describe the unit of measurement being used (frequency, quantity, cost and time).
4. Label the horizontal axis.
 - Label the categories from largest to smallest.
5. Plot a bar for each category.
 - The height of each bar should equal the count for that category.

4. Pareto Diagram

6. Add a cumulative line.
 - This is optional.
 - Label the right axis from 0 to 100%, and line up the 100% with the grand total on the left axis.
7. Continue the process for all the bars.
 - Connect the dots, starting at the top of the first bar.
 - The last dot should reach 100 percent on the right scale.
8. Add title, legend, and date.
9. Analyze the diagram.

Chapter
03

4. Pareto Diagram

Pareto Chart – Hotel Example

Registered Complaints

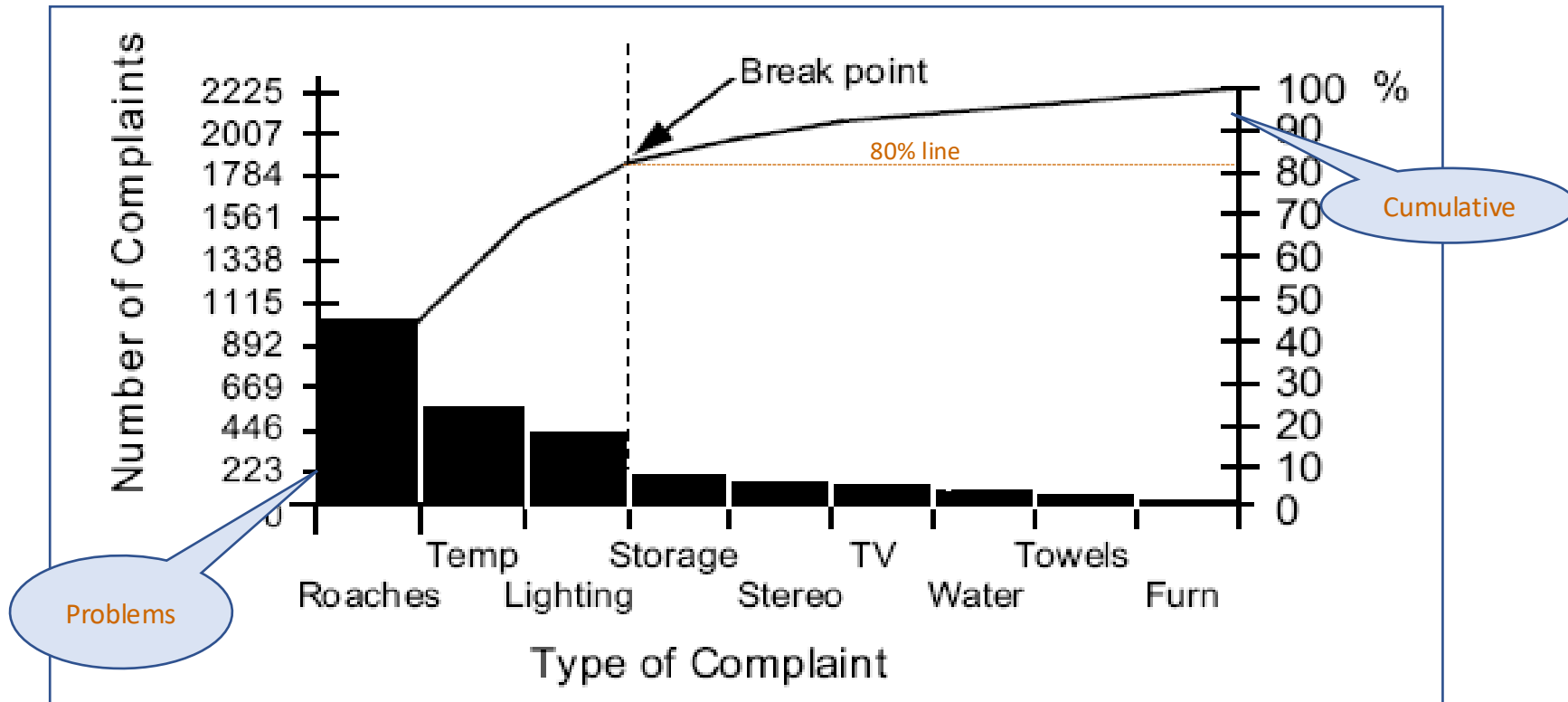
Causes/Category/Problems	Amount	Percent	Cum. % *
Cockroaches	962	43.2	43.2
Rooms too warm or cold	505	22.7	65.9
Inadequate lighting	350	15.7	81.6
Insufficient storage space	127	5.7	87.3
Loud stereo noise after 2300	97	4.4	91.7
Poor quality TV reception	83	3.7	95.4
Insufficient hot water	54	2.4	97.8
Towels too small and/or thin	32	1.4	99.2
Worn-out furniture	15	0.7	99.9
Total	2225		

* Cumulative percent column does not equal 100% because of rounding.

Chapter
03

4. Pareto Diagram

Pareto Chart – Hotel Example



Chapter
03

4. Pareto Diagram

Pareto Chart – Customer Complaint Example

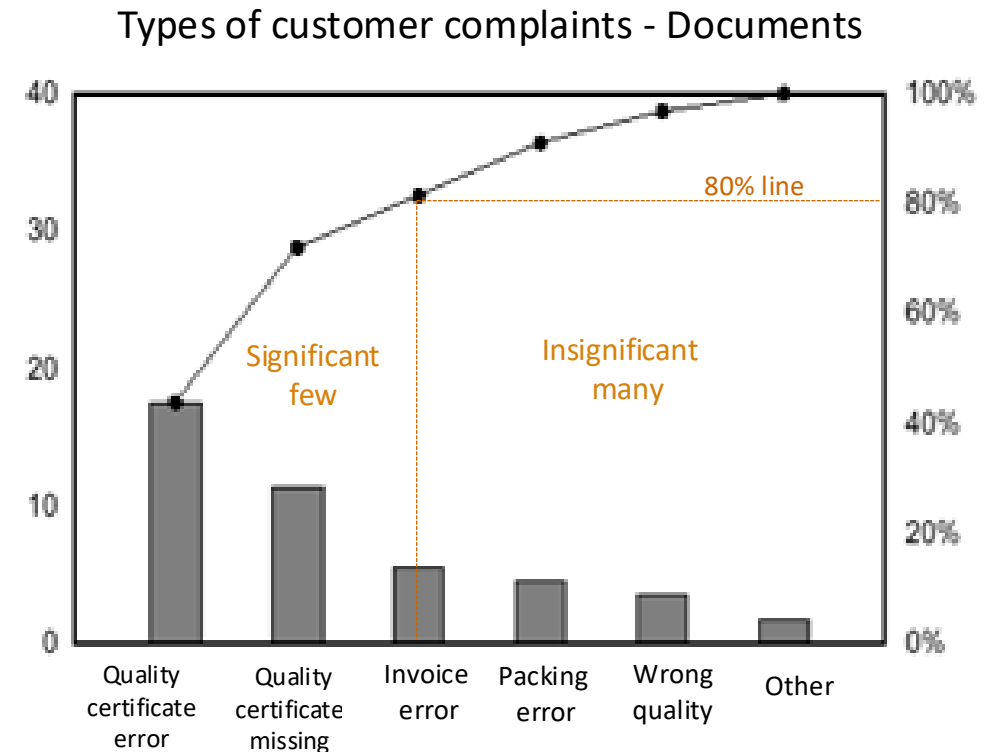


Chapter
03

4. Pareto Diagram

Taking the *largest category*, “documents,” from Example1, breaks it down into six categories of document related complaints, and shows *cumulative values*.

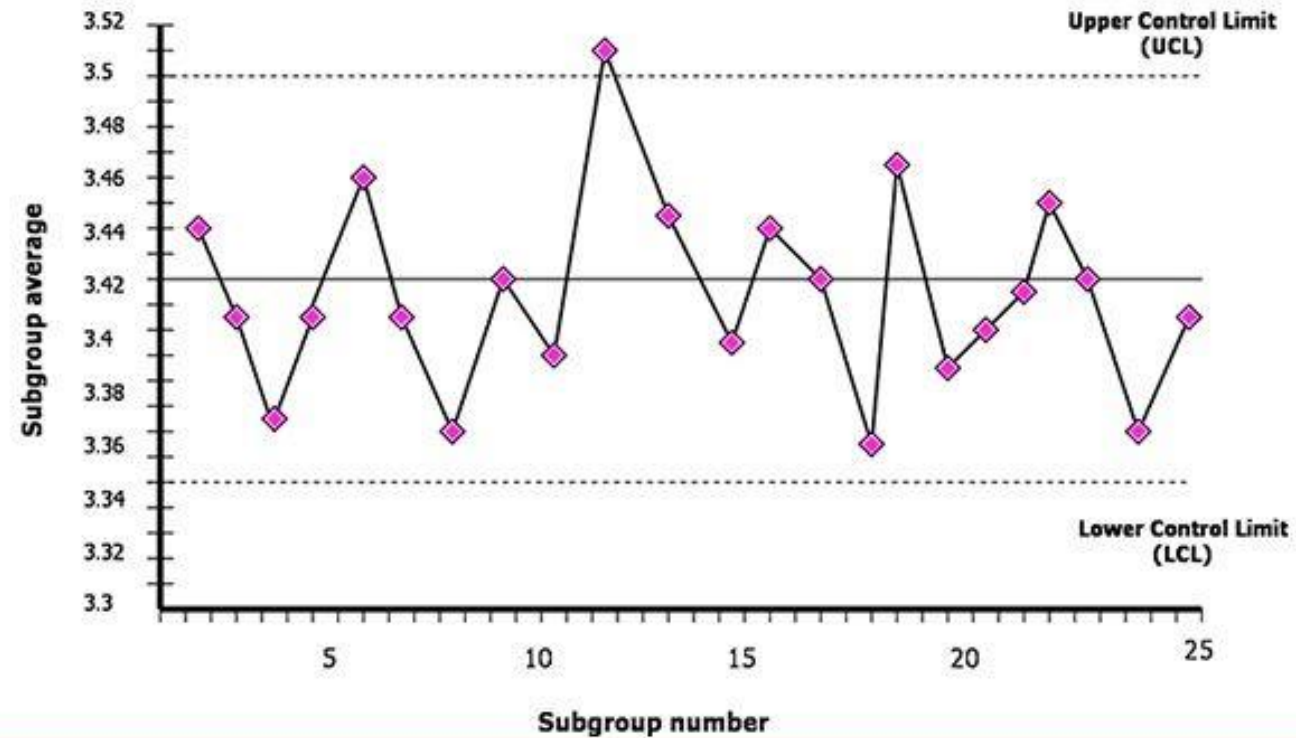
80% of
problems
caused by 20%
of complaints



Chapter
03

5. Process Control Chart

Control Charts



5. Process Control Chart

- ☐ Also called: statistical process control (SPC)
- ☐ The control chart is a graph used to study *how a process changes over time* and data are *plotted in time order*.
- ☐ It help understand the *nature of variation* in a process.
- ☐ It used to distinguish between *common causes and special causes* in process variation to identify the effects of special causes.
- ☐ A control chart always has a central line for the *average*, an upper line for the *upper control limit* and a lower line for the *lower control limit*. These lines are determined from historical data.

5. Process Control Chart

- ☐ By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).
- ☐ Control Chart used when:
 - ▣ Controlling ongoing processes by finding and correcting problems as they occur.
 - ▣ Want to make judgments of the process performance over a certain period of time.
 - ▣ Determining whether a process is stable (in statistical control).
 - ▣ Analyzing patterns of process variation from special causes (non-routine events) or common causes (built into the process).
 - ▣ Determining whether your quality improvement project should aim to prevent specific problems or to make fundamental changes to the process.

5. Process Control Chart

Process Control Charts – Factory Example

- A quality control department wants to get in on the control chart action for die as follows:
 - ▣ Upper Limit = 17 inches
 - ▣ Average Diameter = 16 inches
 - ▣ Lower Limit = 15 inches

Chapter
03

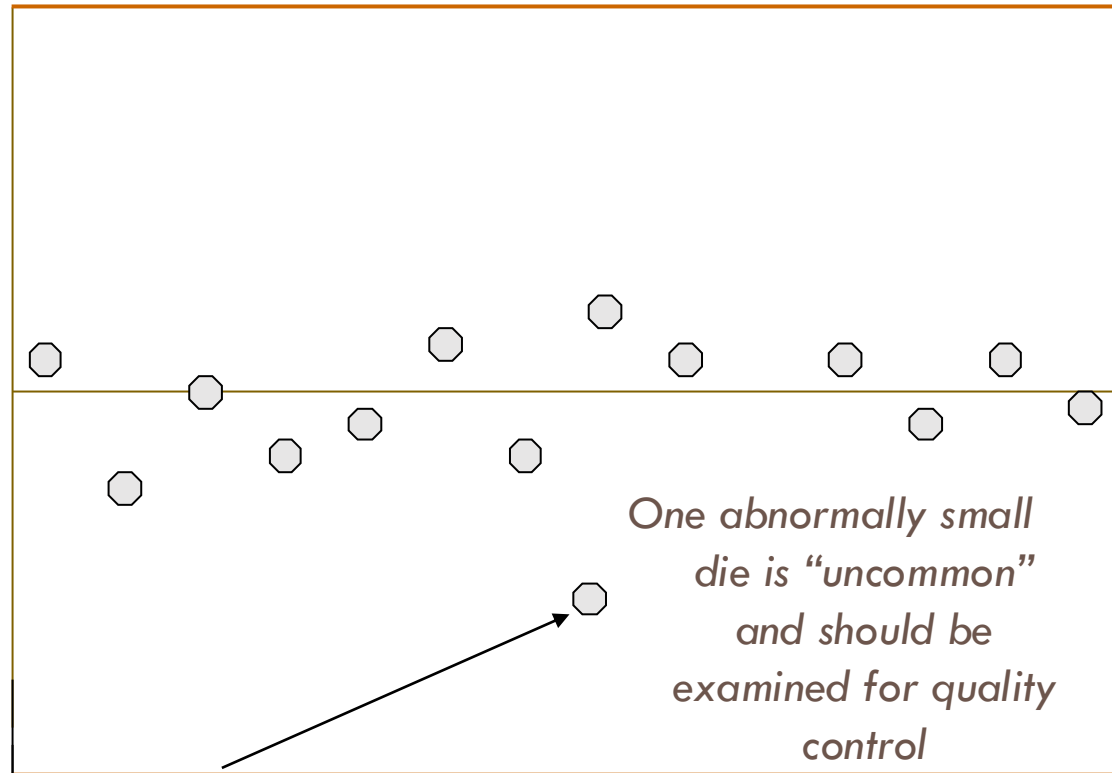
5. Process Control Chart

Process Control Charts – Factory Example

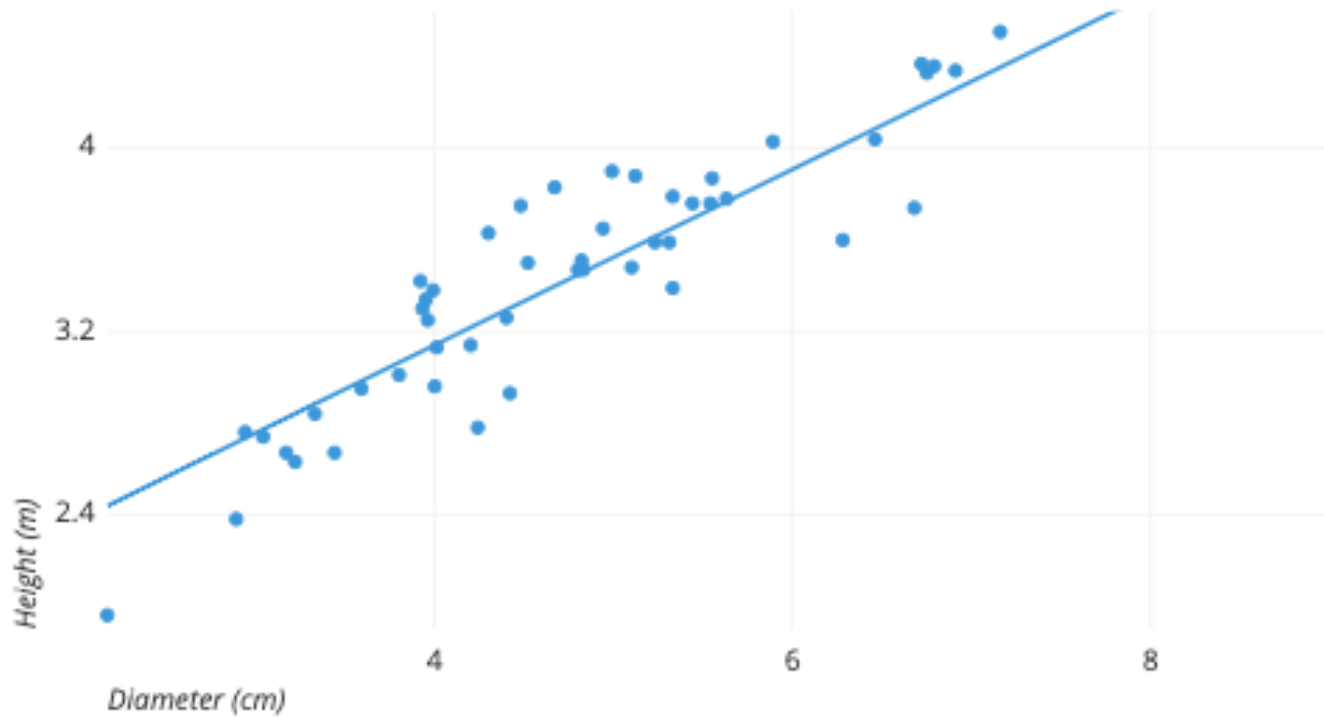
$\bar{x} = 16$ inches
Dies within specifications were acceptable

Upper Limit
17 inches

Lower Limit
15 inches



6. Scatter Diagram



6. Scatter Diagram

- Also called: Scatter plot, X–Y graph
- 2-Dimensional X/Y plots, used to show relationship between independent (x) and dependent (y) variables.
- It graphs pairs of numerical data, *with one variable on each axis*, to look for/ *examine a relationship between them* (direct or indirect relationship).
- If the variables are correlated/connected, the points will fall along a line or curve. The better the correlating, the higher the points will hug the line.

6. Scatter Diagram

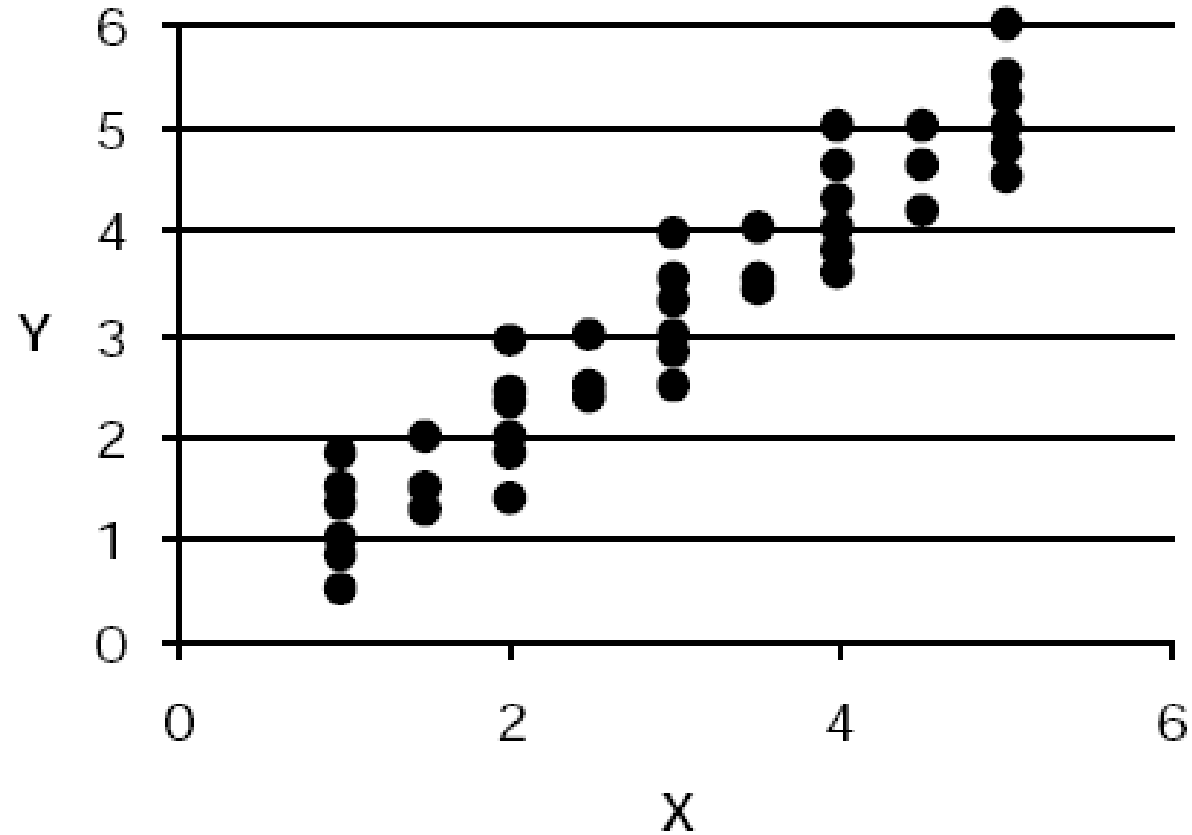
Constructing Scatter Diagram

1. Collect pairs of data where a relationship is suspected.
2. Draw a graph with the independent variable on the horizontal axis and the dependent variable on the vertical axis. For each pair of data, put a dot or a symbol where the x-axis value intersects the y-axis value. (If two dots fall together, put them side by side, touching, so that you can see both).
3. Look at the pattern of points to see if a relationship is obvious. If the data clearly form a line or a curve, you may stop. The variables are *correlated*. Otherwise, complete plotting points. Scatter diagrams will generally show one of six possible correlations between the variables:

6. Scatter Diagram

Strong Positive Correlation

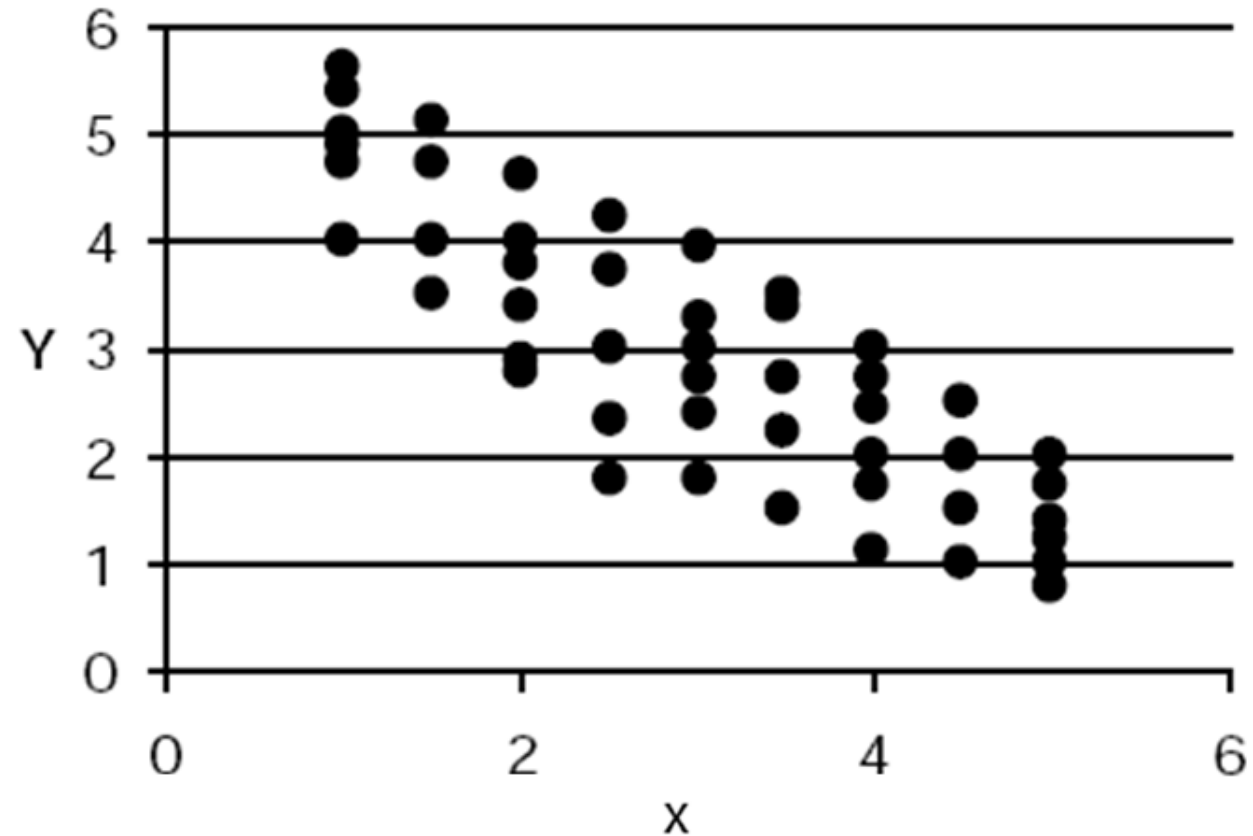
The value of Y clearly increases as the value of X increases.



6. Scatter Diagram

Strong Negative Correlation

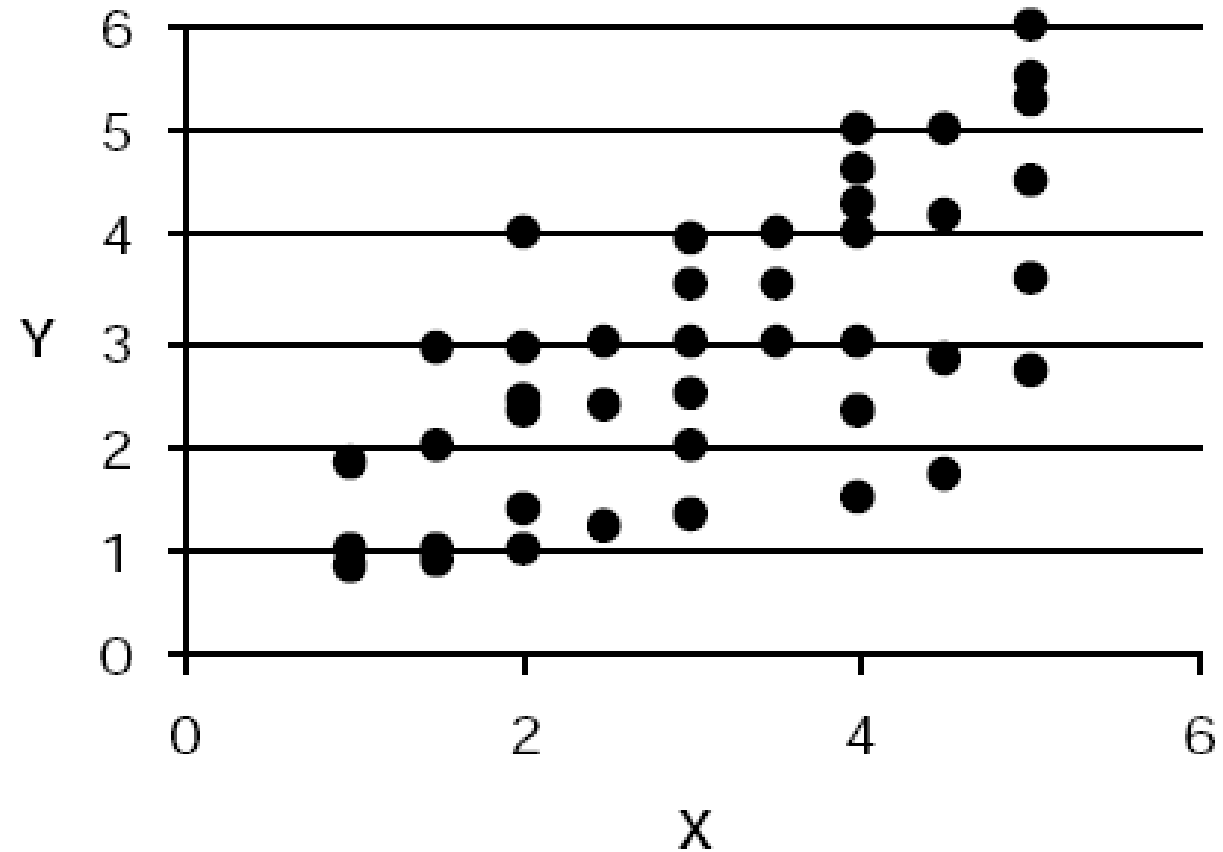
The value of Y clearly decreases as the value of X increases.



6. Scatter Diagram

Weak Positive Correlation

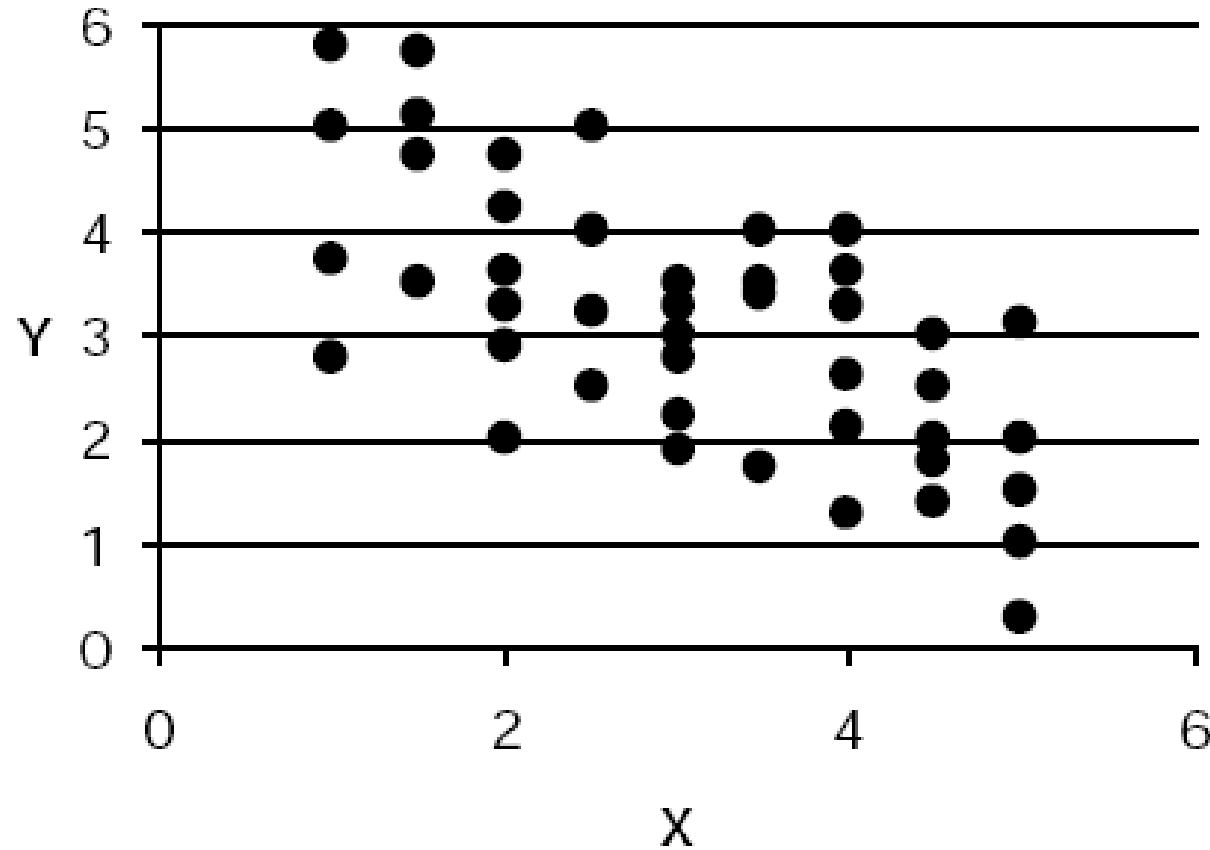
The value of Y increases slightly as the value of X increases.



6. Scatter Diagram

Weak Positive Correlation

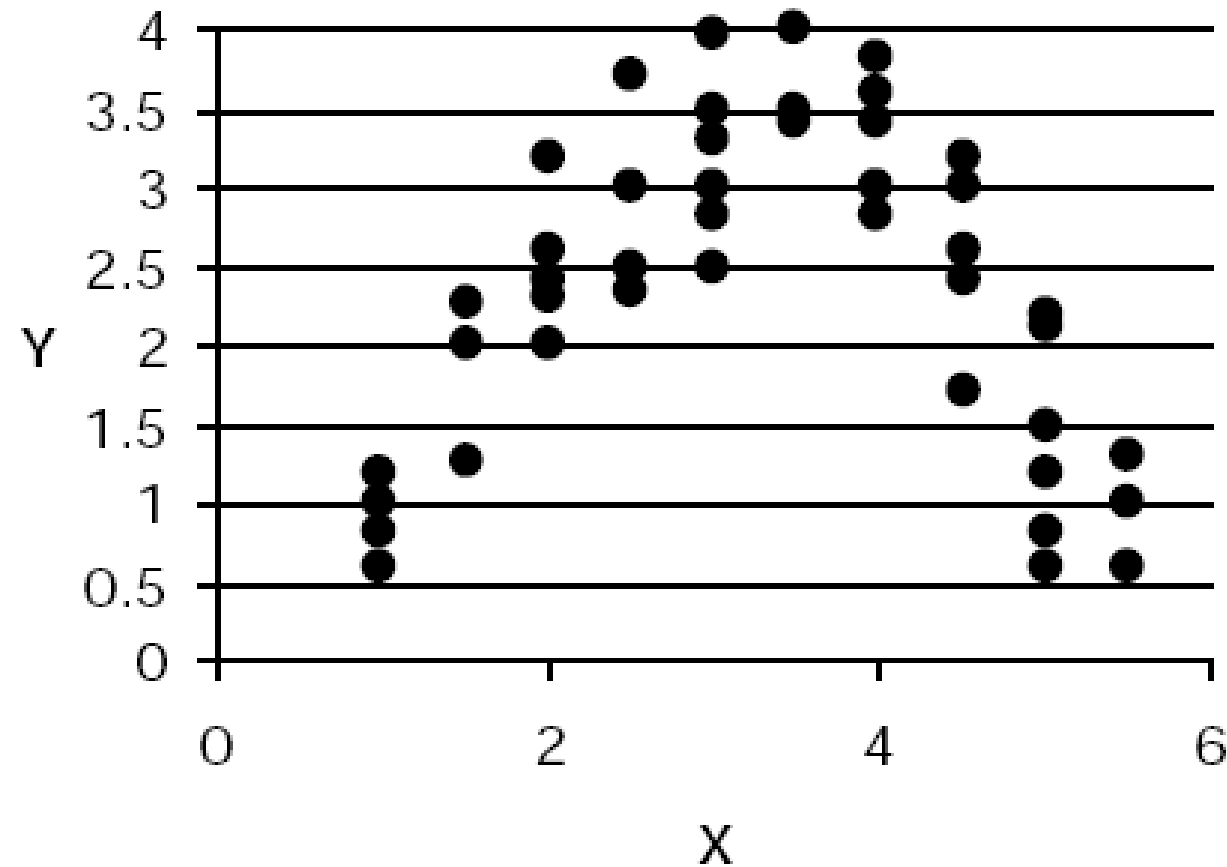
The value of Y decreases slightly as the value of X increases.



6. Scatter Diagram

Complex Correlation

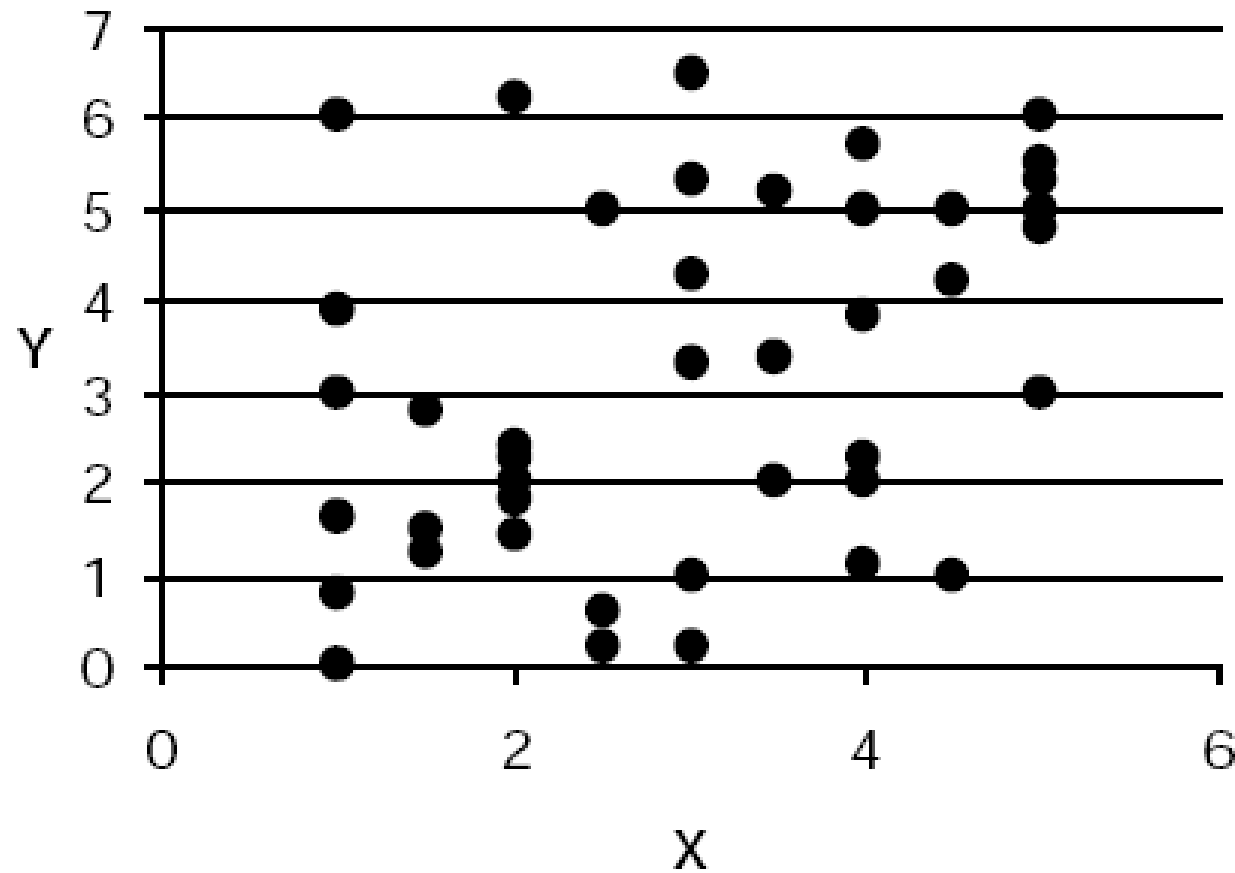
The value of Y seems to be related to the value of X, but the relationship is not easily determined.



6. Scatter Diagram

No Correlation

There is no demonstrated connection between the two variables.



6. Scatter Diagram

Scatter Diagram – *Factory* Example

Minutes

Defective products

10

1

45

8

30

5

75

20

60

14

20

4

25

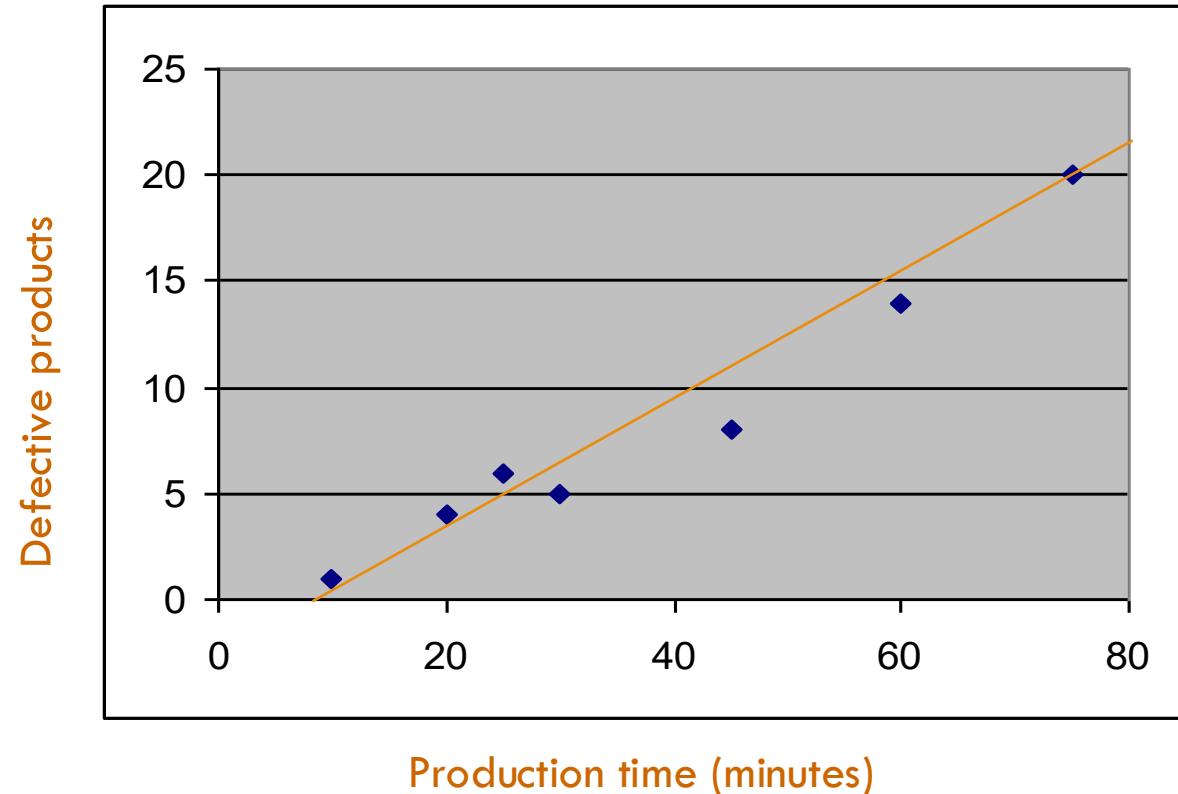
6

- ☐ In this simple example, you can find the existing relationship without much difficulty but... the Scatter Plot will make this easier to see.

6. Scatter Diagram

Scatter Diagram – *Factory* Example

- There is a *direct relationship* between time spent in production by employees and defects. As Time production increases, so does the number of defects.



6. Scatter Diagram

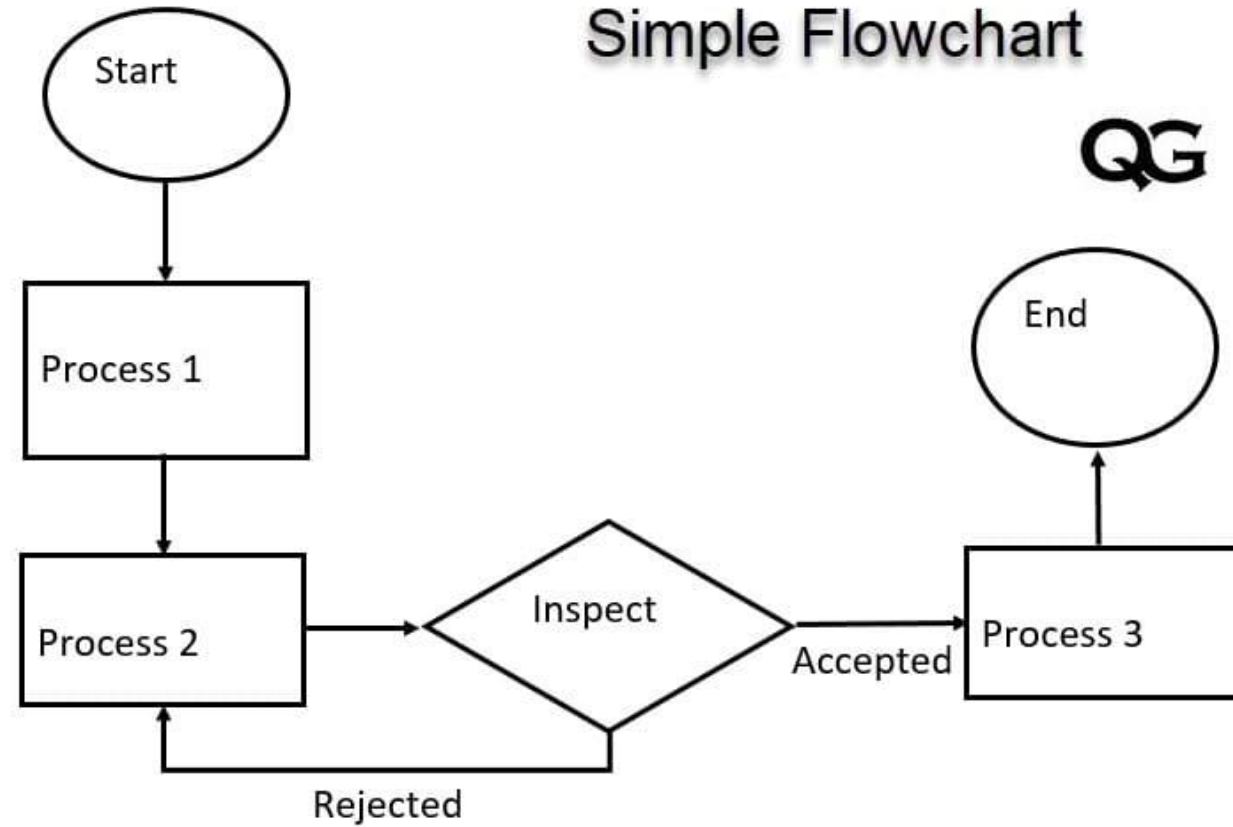
Scatter Diagram – *Factory* Example

- There is obviously some kind of process problem with the number of defective products being produced.
- Maybe the machine are not good from working too fast.
- Or maybe morale is low and there is just uninterested work being done.
- Whatever the case, if this was happening, quality improvements would have to be studied and implemented.

Chapter
03

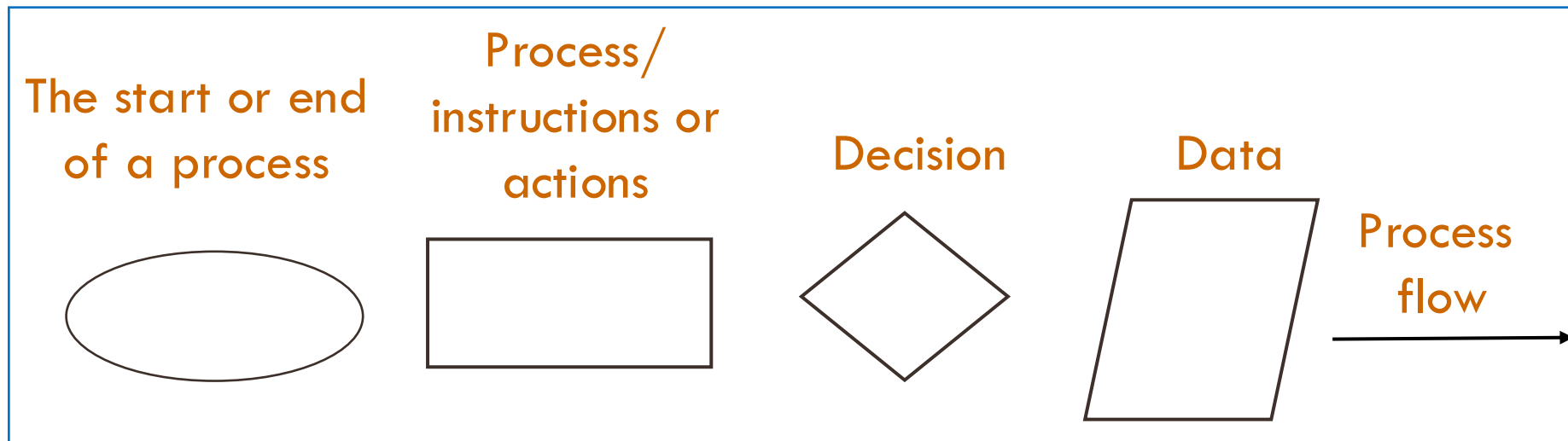
7. Flowchart

Simple Flowchart



7. Flowchart

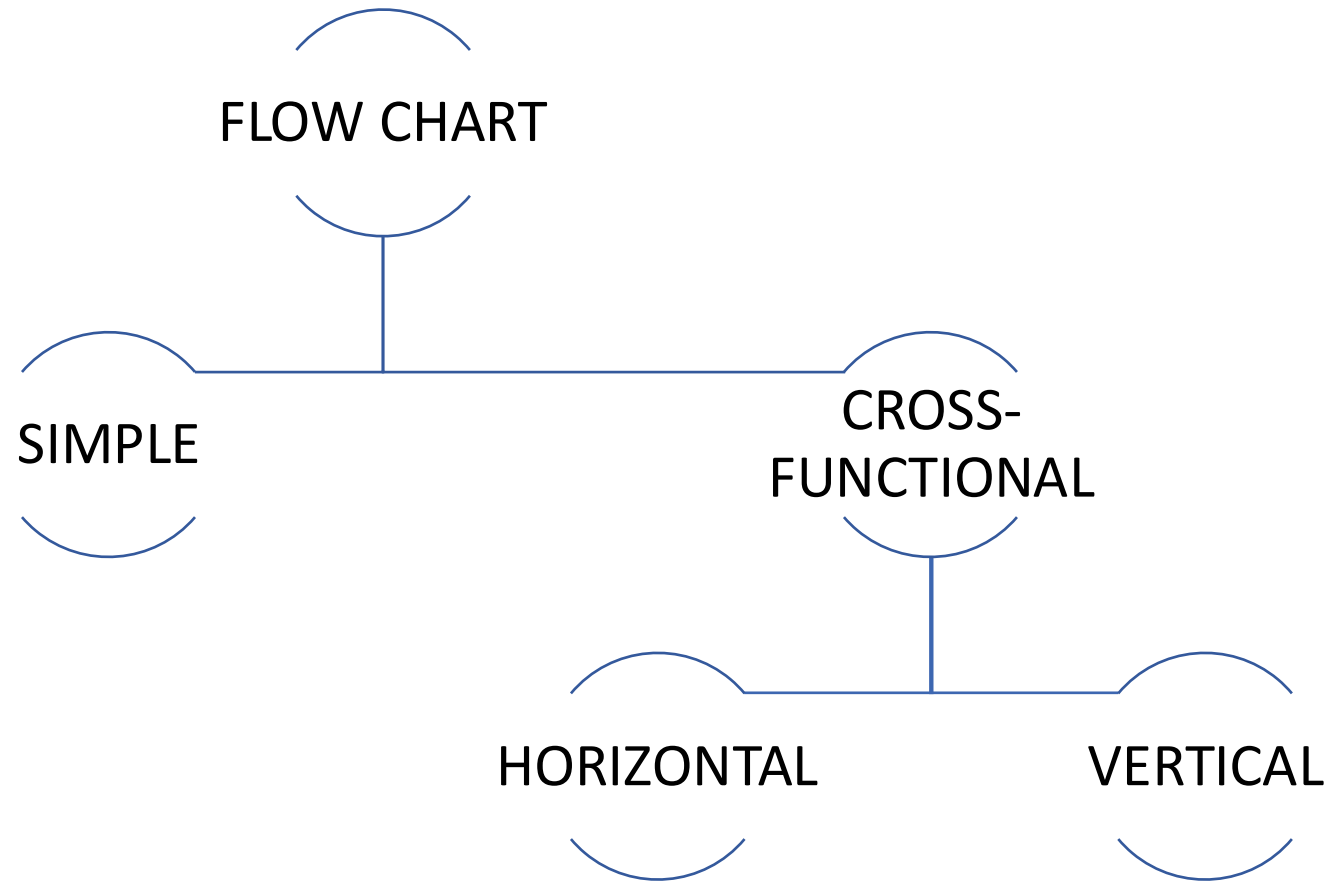
- A flow chart is a symbolic representation showing all of the steps of a process in a *sequence* to show the nature and *flow* of the steps in a process.
- Flow charts can be used in *identify problem* areas and opportunities for process improvement.



7. Flowchart

- Flow chart help facilitator guide the discussion by asking questions such as "*What happens next?*" "*Who makes the decision at this point?*" and "*What operation is performed here?*"
- Flow chart can answer these questions:
 - How does this operation affect the customer?
 - Can we improve or eliminate this operation?
 - Should we control a critical quality characteristic at this point?

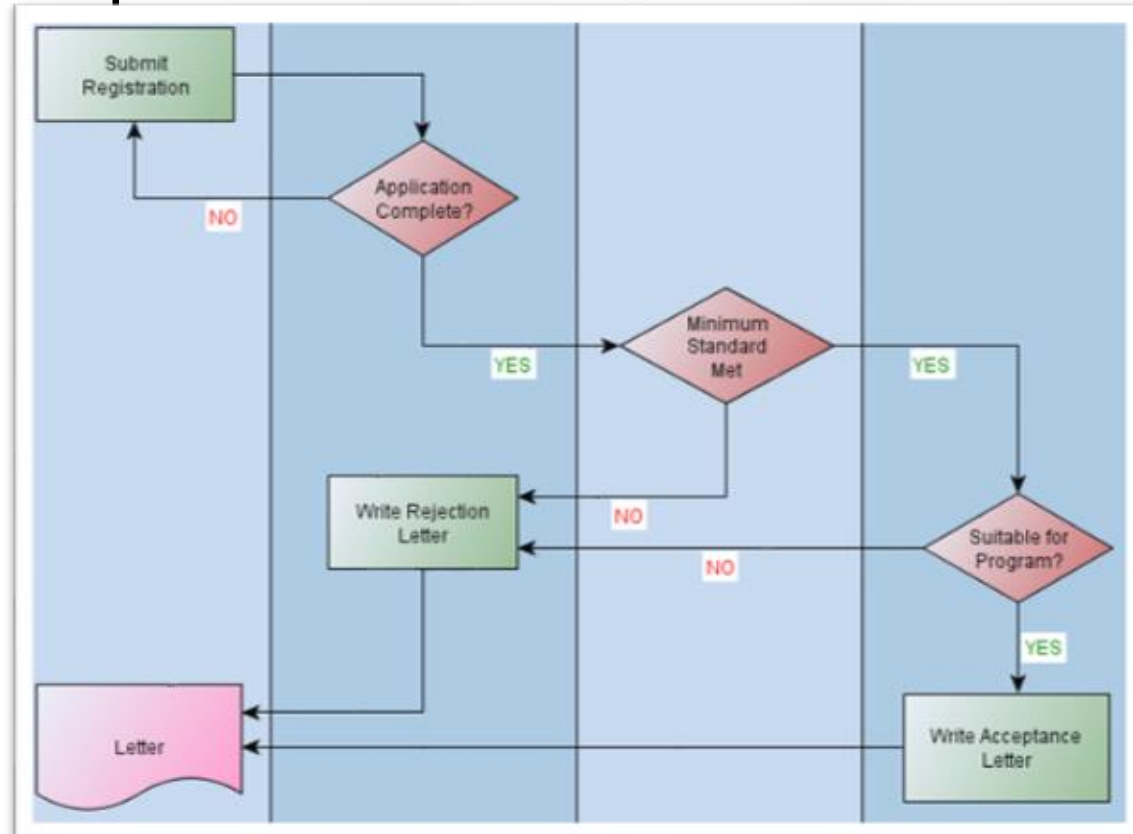
7. Flowchart



7. Flowchart

Simple Flowchart Example

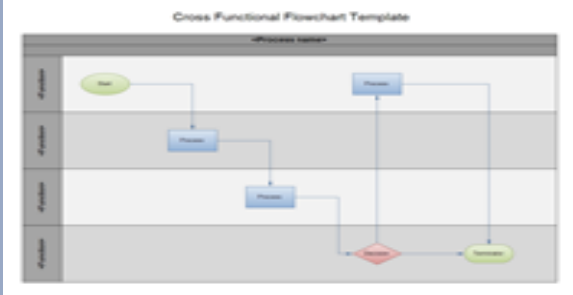
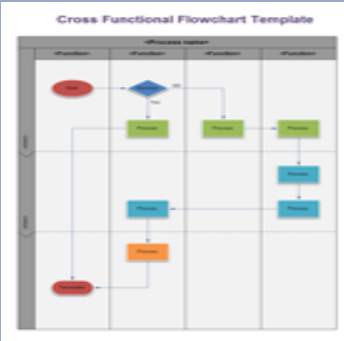
Make sure every feedback loop is closed



Chapter
03

7. Flowchart

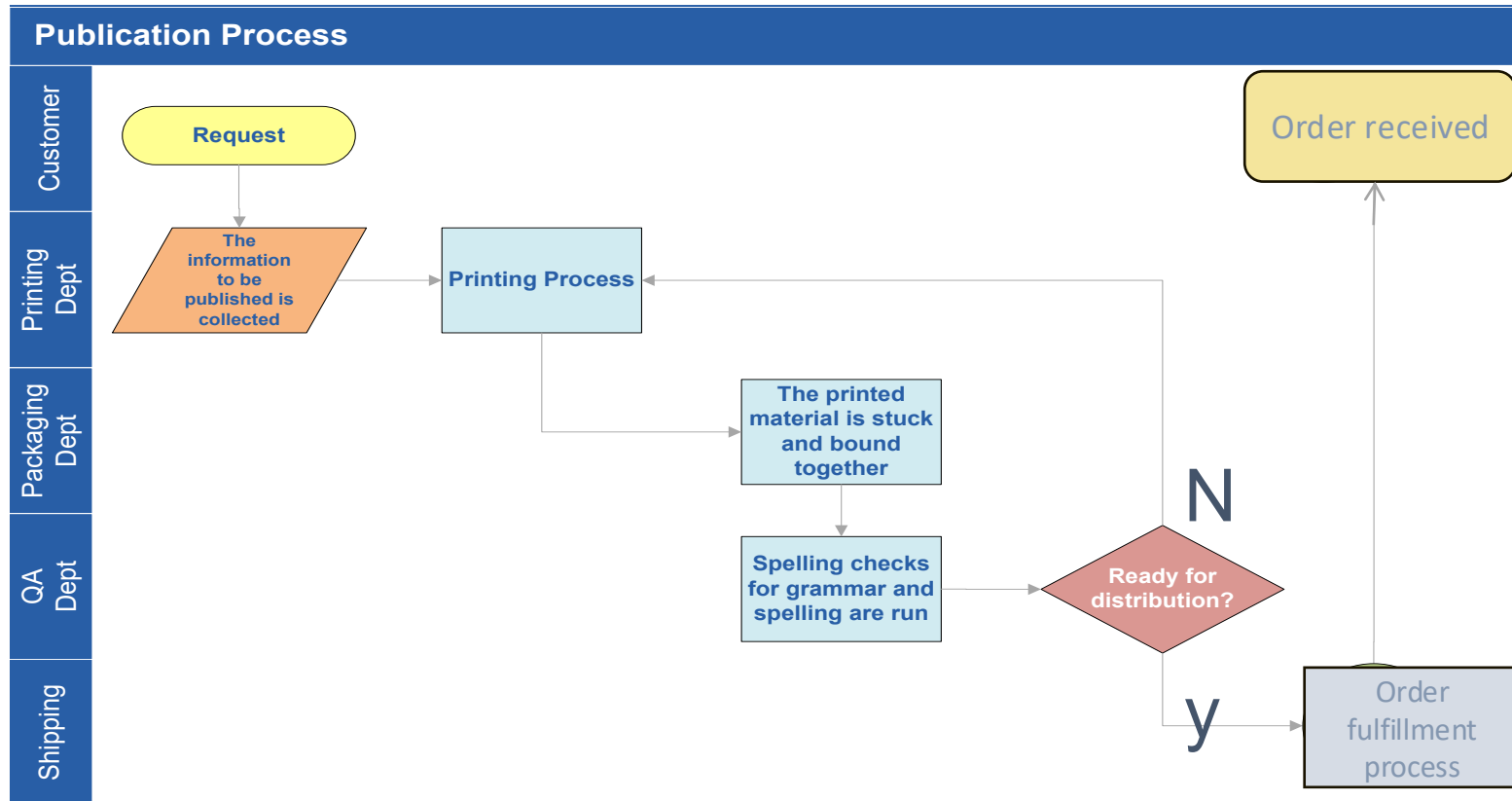
Cross-functional Flowchart

Types	Sample	Description
Horizontal		Bands representing functional units run horizontally across the drawing page, highlighting the functional unit .
Vertical		Bands representing the functional units run vertically from the top to the bottom of the page, highlighting the milestones/phases

Chapter
03

7. Flowchart

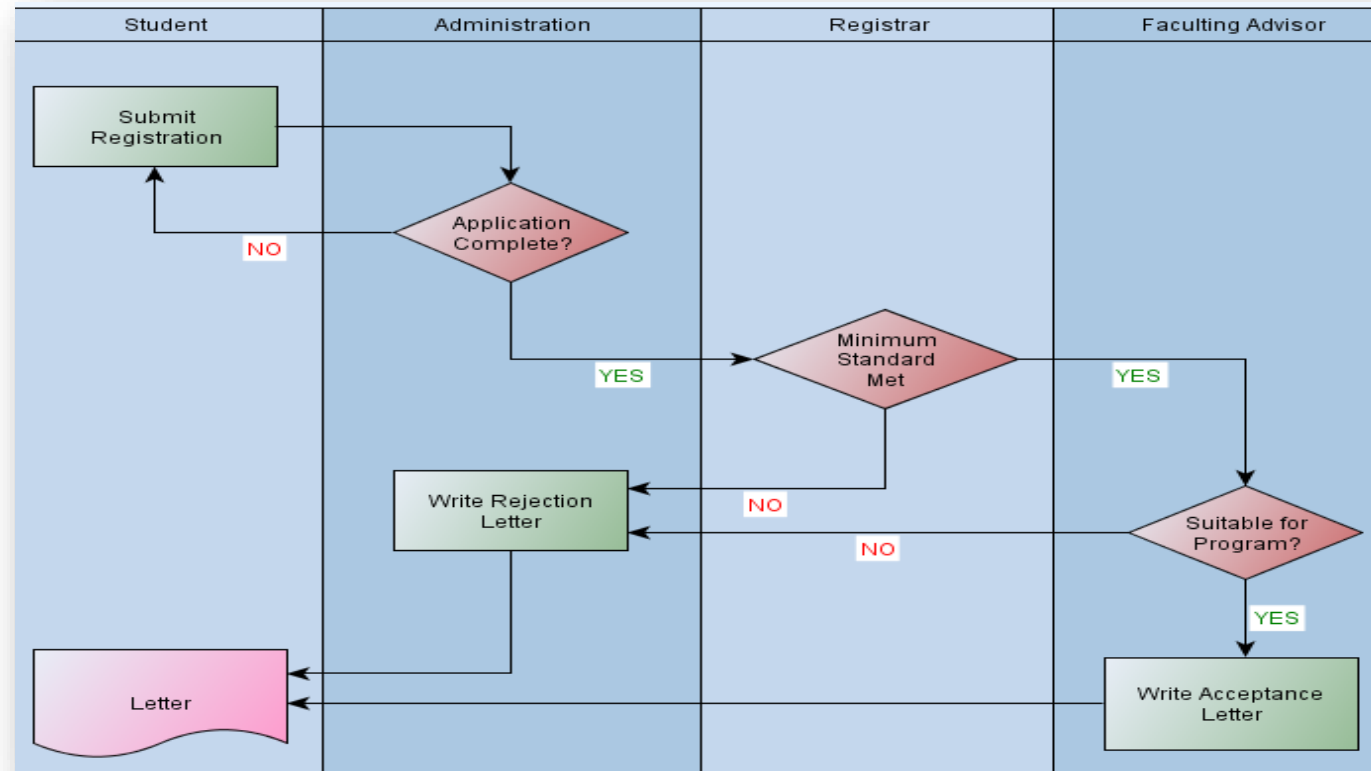
Horizontal Cross-functional Flowchart Example



Chapter
03

7. Flowchart

Horizontal Cross-functional Flowchart Example





Thank You