# Unit - IV

Evolution of Quality Management, Concepts of Product and Service Quality, Introduction to Process Quality, Graphical and statistical techniques for Process Quality Improvement, Zero defect/breakdown approach

# Unit IV

Evolution of Quality Management, Concepts of Product and Service Quality, Introduction to Process Quality, Graphical and statistical techniques for Process Quality Improvement, Zero defect/break down approach

## 2.1 Evolution of Quality Management

| **Approximate Timings** | **1900s ~ 1920s** | **1920s ~ 1950s** | **1950s ~ 1980s** | **1960s ~ 1990s** | **1980s ~ present** |
|---|---|---|---|---|---|
| Dimension | Quality Inspection (QI) | Quality Control (QC) | Quality Assurance (QA) | Total Quality Control (TQC) | Total Quality Management (Business Excellent, Networks and Smart Environment) |
| Focus | Product | Product | Process | System | People in Organisation, People in Network (Network – focus), People in Smart Environment (Smart-focus) |
| Principles | Sorting good from bad | Use of statistical tools to control process output | Systematic but fragmented improvement | Systematic managed continuous improvement | Systematic and habitual continuous improvement |

# Unit IV

Evolution of Quality Management, Concepts of Product and Service Quality, Introduction to Process Quality, Graphical and statistical techniques for Process Quality Improvement, Zero defect/break down approach

## 2.1 Evolution of Quality Management

| Approximate Timings | 1900s ~ 1920s | 1920s ~ 1950s | 1950s ~ 1980s | 1960s ~ 1990s | 1980s ~ present |
|---|---|---|---|---|---|
| Tools & Techniques | Inspection Moving assembly line | Inspection link to quality control, Sampling Acceptable Quality Levels (AQL) Average Outgoing Quality Limit (AOQL) Total Preventive Maintenance | Plan-DoCheck-Act (PDCA), Extend PDCA to become Plan-Do-StudyAct (PDSA), Cause and Effect Diagram, Failure Mode Effect Analysis (FMEA), Reliability Engineering Statistical Process Control (SPC), Kaizen, Kanban, Jidoka, Just-In-Time (JIT) | Quality Loss Function, Quality Functional Deployment (QFD), Quality Control Circle (QCC), 7 Quality Tools (Pareto Analysis, Fish Bone Diagram, Stratification, Check Sheet, Histogram, Scatter Diagram, Control Chart), Benchmarking Lean tools and techniques, Single Minute Exchange of Die (SMED) | Design of Experiments (DOE), 5S, Six Sigma |

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# 2.2 Concepts of Product and Service Quality

## 2.2.1 Product quality

Product quality is focusing on meeting tolerances in the end result of the manufacturing activities. The end result is measured on a standard of "good enough".

## 2.2.2 Service Quality

It is a combination of two words, Service and Quality where we find emphasis on the availability of quality services to the ultimate users. The term quality focuses on standard or specification that a service generating organization promises.

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# 2.3 Introduction to Process Quality

Process quality refers to the degree to which an acceptable process, including measurements and criteria for quality, has been implemented and adhered to in order to produce the product or service.

- Process quality is a measure of excellence of interrelated work items (like tasks, procedures, steps).
- It is a measurement characteristic that indicates whether a given process is carried out with tolerant defects, minimized deficiencies, and insignificant variations.
- Higher quality of a process means that relationships between the process's components are successfully built and sustained throughout the process lifecycle so the entire process is fulfilled according to needs and requirements of the customer.
- Process quality is measured, monitored and managed by undertaking a range of control and assurance activities. The primary goal of such activities is to reduce variations around a targeted process and its components.
- In order to implement a process in a qualitative manner, there should be a quality management plan created to assess, anticipate and fulfil implied needs and requirements stated by the customer.

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 7QC Tools

1. Pareto Diagram
2. Process Flow Diagram
3. Cause and Effect Diagram
4. Check Sheets
5. Histogram
6. Run Charts
7. Scatter diagram

## Statistical tools

1. Hypothesis testing
2. Regression analysis
3. ANOVA (Analysis of Variance)
4. Design of Experiment (DOE)

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

1. Pareto Diagram

History

- Named after Vilfredo Pareto -an Italian economist
- He observed in 1906 that 20% of the Italian population owned 80% of Italy's wealth.

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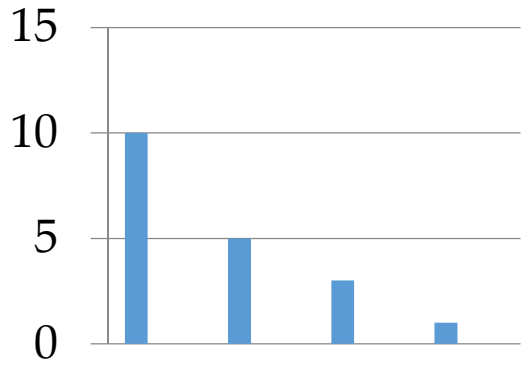
# 2.4 Graphical and statistical techniques for Process Quality Improvement

1. Pareto Diagram




What is it?

- One of the 7 tools of Quality Management
- Statistical technique in decision making for selection of limited tasks which have significant overall impact
- A Pareto Chart is a series of bars whose heights reflect the frequency or impact of problems.
- The bars are arranged in descending order of height from left to right.
- Bars on left are relatively more important than the bars on the right
- Separates the vital from the trivial

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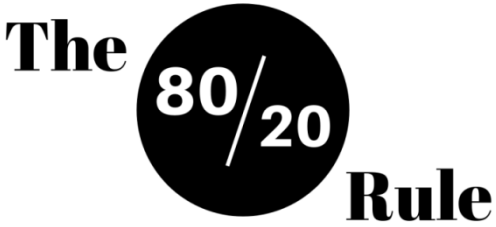
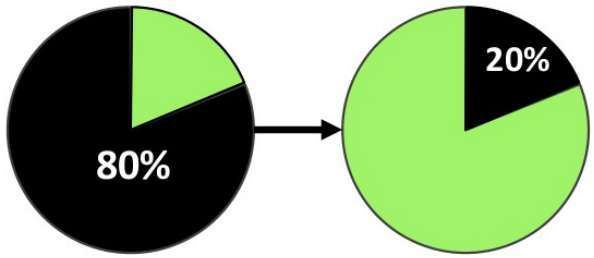
# 2.4 Graphical and statistical techniques for Process Quality Improvement

1. Pareto Diagram

The Pareto Principle:




- Also referred to as the 80-20 rule.
- States that 80% of the problems or effect come from 20% of the causes.
- Focuses on identifying the vital view from the trivial many
- Helps focusing on what really matters



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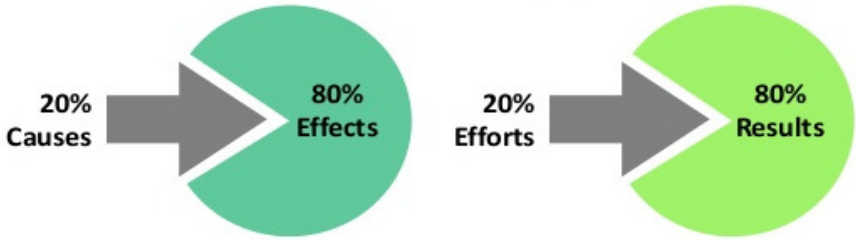
## 2.4 Graphical and statistical techniques for Process Quality Improvement




1. Pareto Diagram

Examples:

- 20% of car drivers cause 80% of the accidents.
- 20% percent of workers do 80% of the work.
- 20% of a company's clients are responsible for 80% of its revenue.
- 20% of the time spent on a task leads to 80% of the results.
- 80% of the customer complaints come from 20% of customers.
- 80% of the wealth belongs to 20% of the population.

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 1. Pareto Diagram

| Category | Total |
|---|---|
| Invoice Error | 6 |
| Wrong Quantity | 4 |
| Quality Certificate Missing | 11 |
| Packing List Error | 5 |
| Quality Certificate Error | 18 |
| Other | 2 |
| | |
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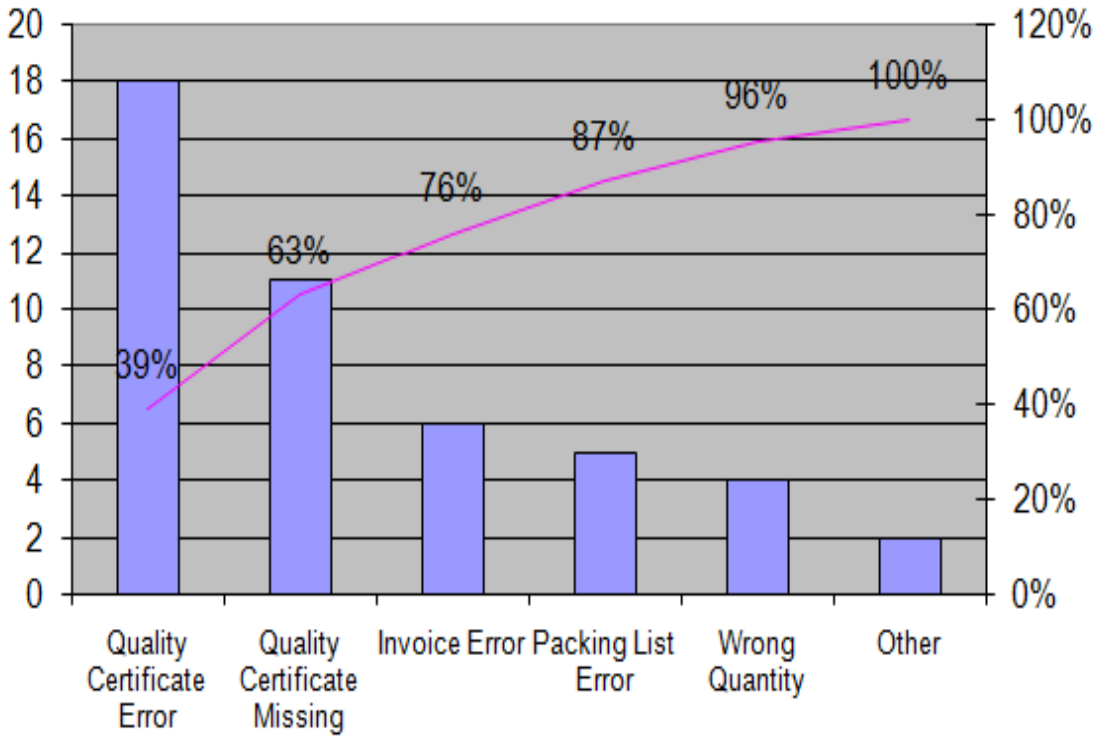


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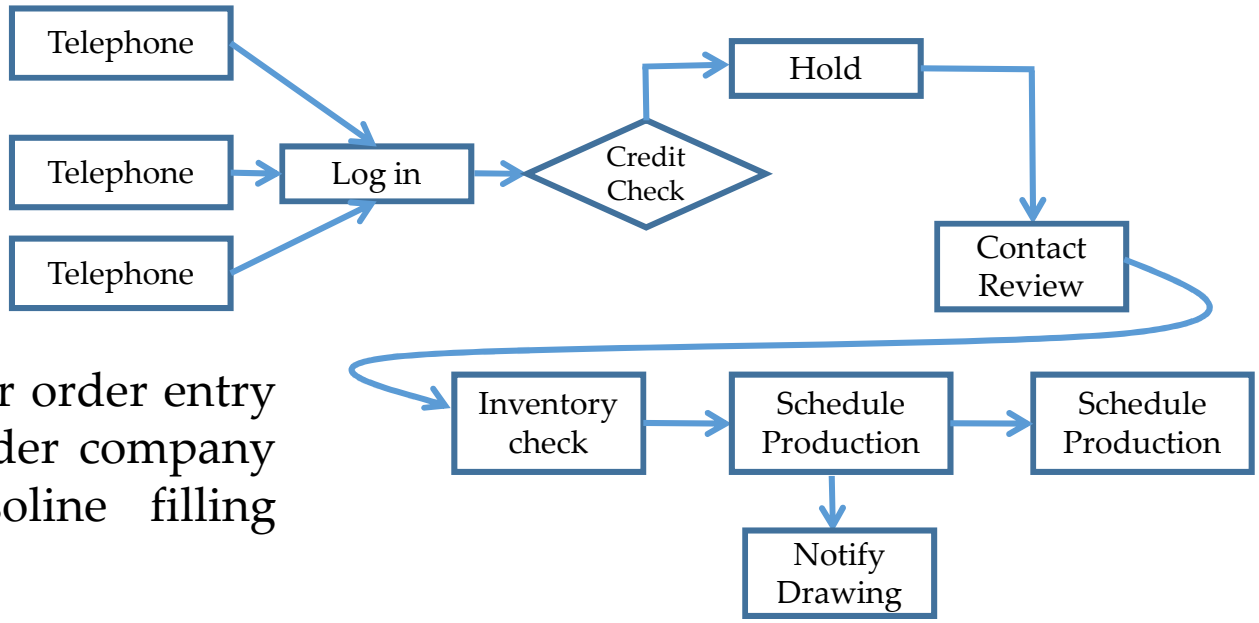
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 2. Process Flow Diagram

For many products and services, it may be useful to construct a process flow diagram




process flow diagram for order entry activity of a make-to-order company that manufactures gasoline filling station hose nozzles.

These diagrams show flow of product or service as it moves through various processing stages. The diagram makes it easy to visualize the entire multistage process, identify potential trouble spots, waste activities, and locate control points. It answers the question, "Who is our next customer?" Improvements can be accomplished by changing (reengineering), reducing, combining, or eliminating process steps.

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 3. Cause and Effect Diagram (Graphical technique)

- A cause-and-effect (C&E) diagram is a picture composed of lines and symbols designed to represent a meaningful relationship between an effect (say Y) and its potential causes (say X). Potential causes (which have evidence) are not all possible causes that come up in brain storming exercise.
- It was developed by Dr. Kaoru Ishikawa in 1968, and sometimes referred to as the 'Ishikawa diagram' or a 'fish bone diagram'.
- C&E diagram is used to investigate either a "bad" effect and to take action to rectify the potential causes or a "good" effect and to learn those potential causes that are responsible for the effect. For every effect, there are likely to be numerous potential causes.

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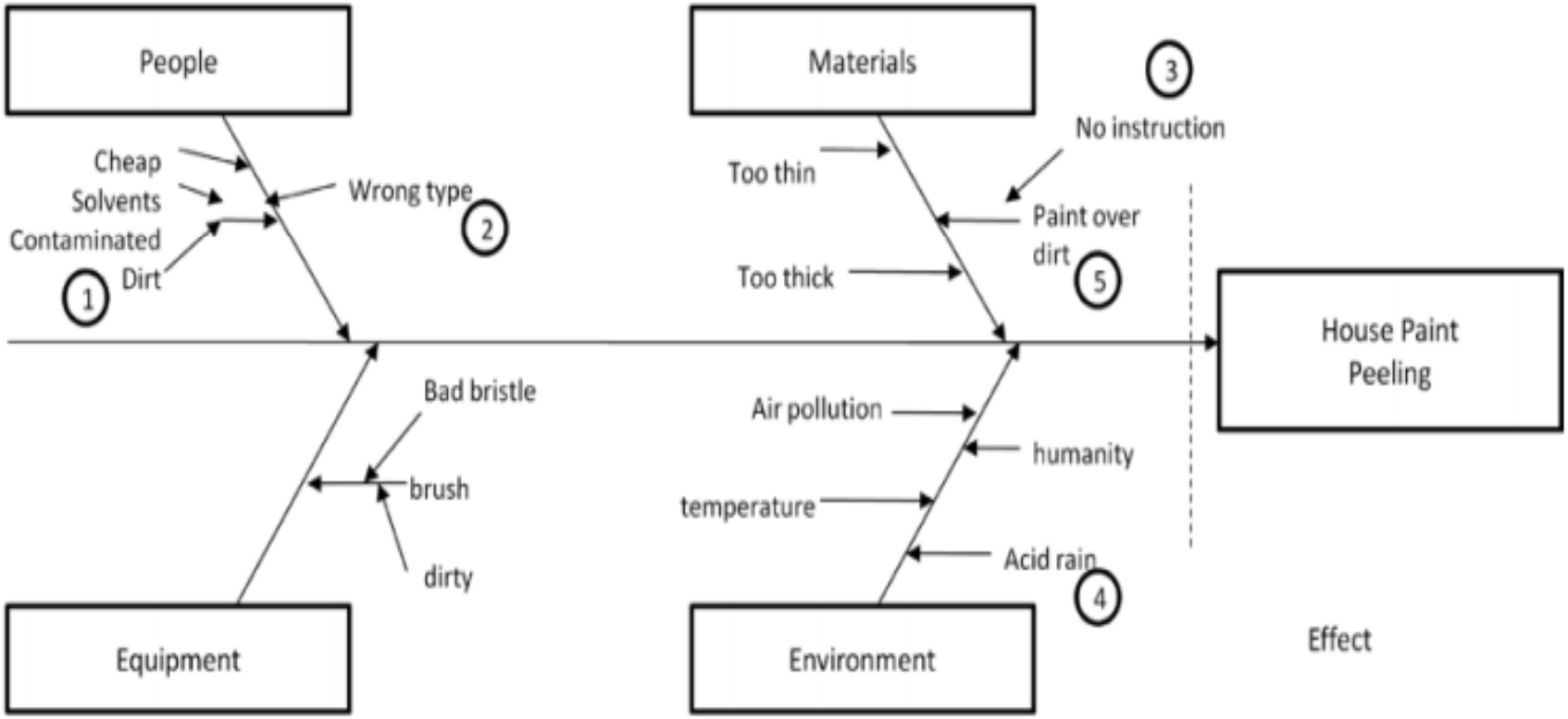
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 3. Cause and Effect Diagram



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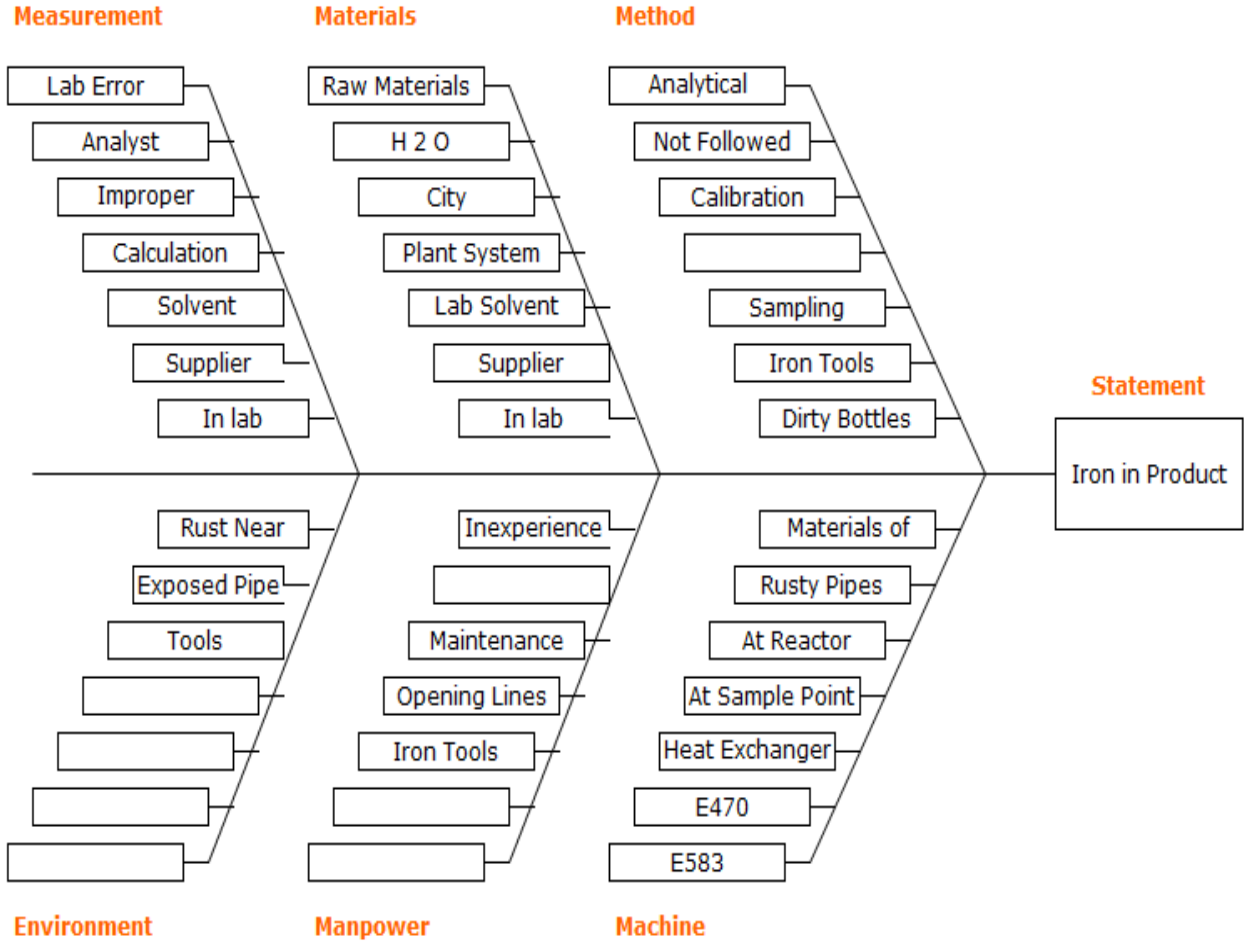
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 3. Cause and Effect Diagram



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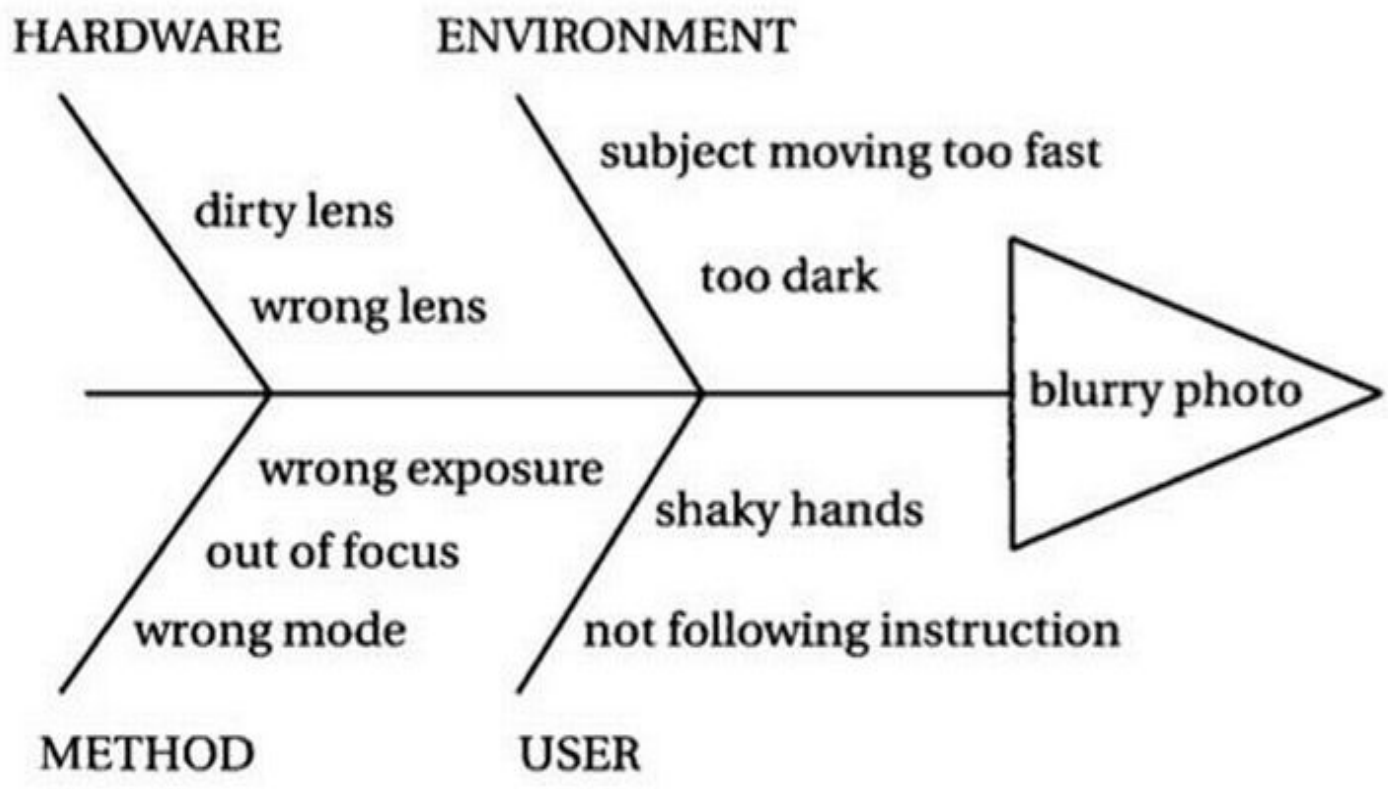
# 2.4 Graphical and statistical techniques for Process Quality Improvement

3. Cause and Effect Diagram



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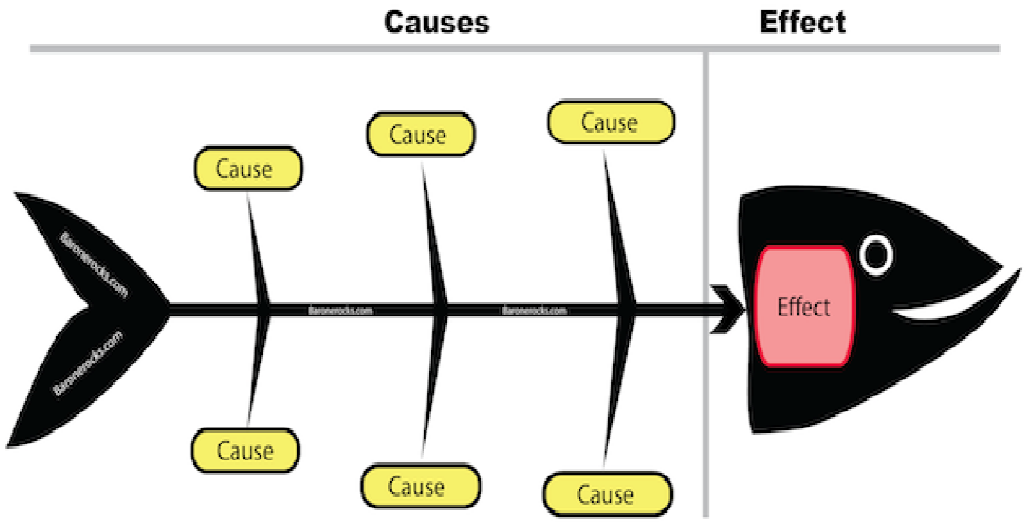
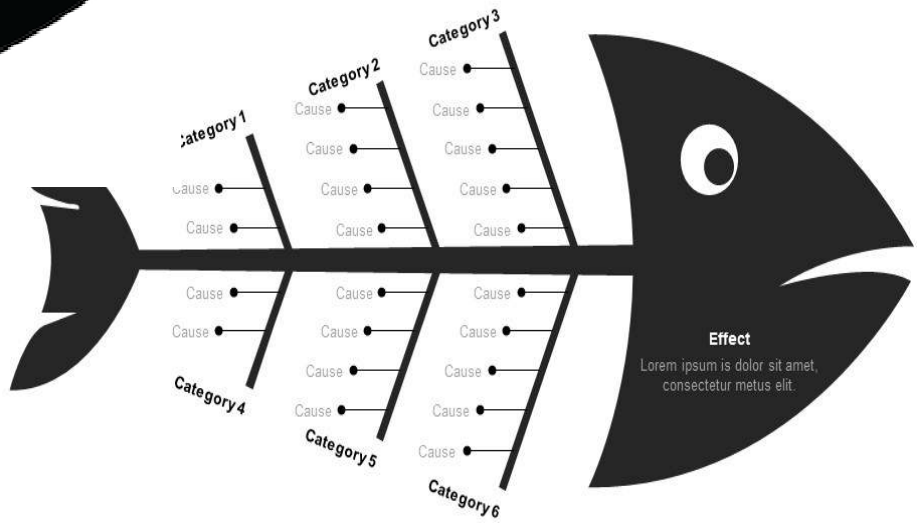
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 3. Cause and Effect Diagram




Fish bone diagram

Fish bone diagram



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## 2.4 Graphical and statistical techniques for Process Quality Improvement

3. Cause and Effect Diagram

C & E diagrams are useful to

1. Identify potential causes and not all possible causes,
2. Analyze actual conditions for the purpose of product or service quality improvement
3. Eliminate conditions which cause nonconformities and customer complaints.
4. Statistical Experimentation, Decision-making and corrective-action activities.

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## 2.4 Graphical and statistical techniques for Process Quality Improvement

4. Check Sheets

- Main purpose of check sheets in earlier days is to ensure that data was collected carefully and accurately by concerned personnel. Data is to be collected in such a manner that it can be quickly and easily used and analyzed. The form of check sheet is individualized for each situation and is designed by the project team.

- Check sheets can also be designed to show location of defects.

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 4. Check Sheets

Telephone Interruptions

| Reason | Day | | | | | |
|---|---|---|---|---|---|---|
| | Mon | Tues | Wed | Thurs | Fri | Total |
| Wrong number | 𝍸 | \|\| | \| | 𝍸 | 𝍸 \|\| | 20 |
| Info request | \|\| | \|\| | \|\| | \|\| | \|\| | 10 |
| Boss | 𝍸 | \|\| | 𝍸 \|\| | \| | \|\|\|\| | 19 |
| Total | 12 | 6 | 10 | 8 | 13 | 49 |

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 4. Check Sheets

| Product Bicycle 32<br>Nonconformity type | Number inspected: 2217<br>Check | Total |
|---|---|---|
| Blister | 𝍸 𝍸 \| | 21 |
| Light spray | 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 \|\|\| | 38 |
| Drips | 𝍸 𝍸 𝍸 𝍸 \|\| | 22 |
| Overspray | 𝍸 𝍸 \| | 11 |
| Runs | 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 \|\| | 47 |
| Others | 𝍸 | 5 |
| | Total | 144 |

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 4. Check Sheets

| Defect Types | Frequency | | | | | |
|---|---|---|---|---|---|---|
| | Vehicle 1 | Vehicle 2 | Vehicle 3 | Vehicle 4 | Vehicle 5 | Total |
| Brake pads worn out | X | | X | | | 2 |
| Fuel tank leakage | | X | | | | 1 |
| Steering locked | | | | X | | 1 |
| Engine oil seepage | | X | X | | | 2 |
| AC not working | X | | | X | | 2 |
| Battery darined out | | | X | | | 1 |
| Lights not working | X | | | | X | 2 |
| Total | 3 | 2 | 3 | 2 | 1 | |

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

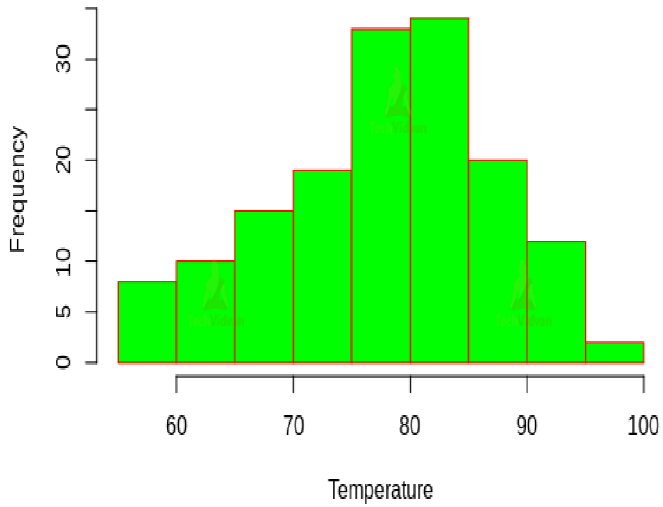
## 5. Histogram

What is histogram?

- Graphical representation of the frequency distribution of data in bar form is called histogram.
- Summarizes data from a process that has been collected over a period of time.
- Histograms provide the easiest way to evaluate the distribution of data.

When Are Histograms Used?

- Summarize large data sets graphically.
- Compare measurements to specifications.
- Communicate information to the team.
- Assist in decision making.



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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 5. Histogram

Advantages of Histogram

1. Display large amount of data that are difficult to interpret in a tabular form.
2. Show the relative frequency of occurrences of the various data values.
3. Reveal the variation ,centering and distribution shape of the data.
4. Very useful when calculating capability of a process.
5. Helps predict future performance of process

Disadvantages of Histogram

1. Use only with continuous data.
2. More difficult to compare two data sets.
3. Cannot read exact values because data is grouped into categories.

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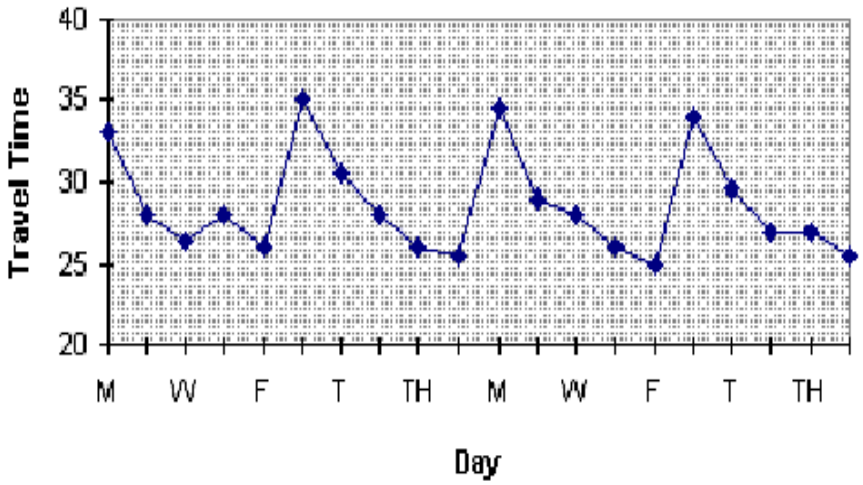
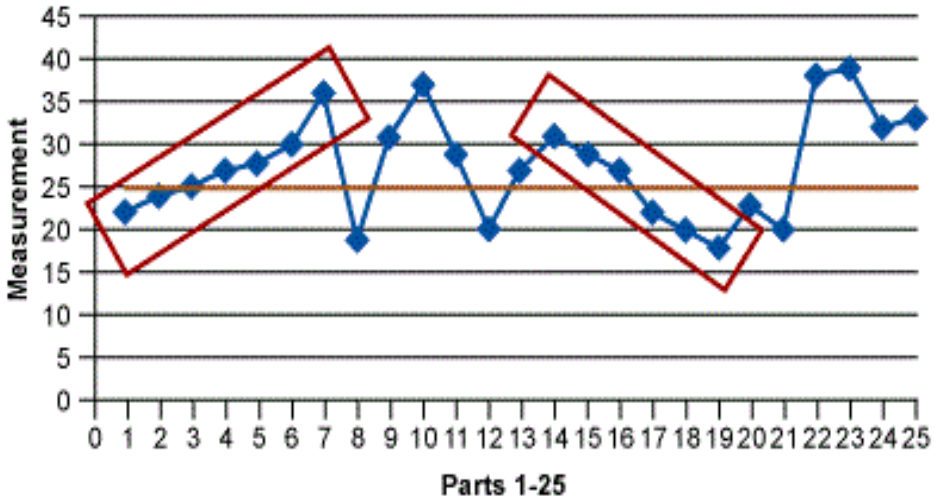
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 6. Run Charts

A run chart is a very simple quality tool for analyzing process with respect to (w.r.t) time in development stage or, for that matter, when other charting techniques are not quite relevant.



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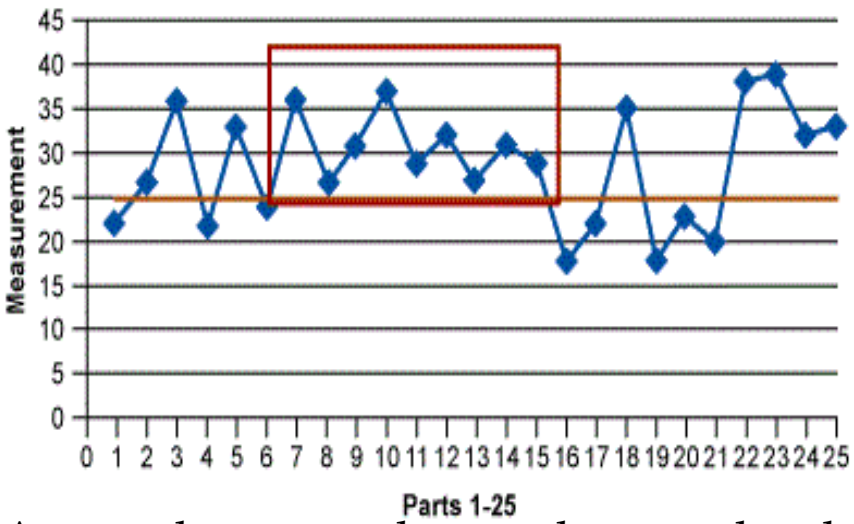
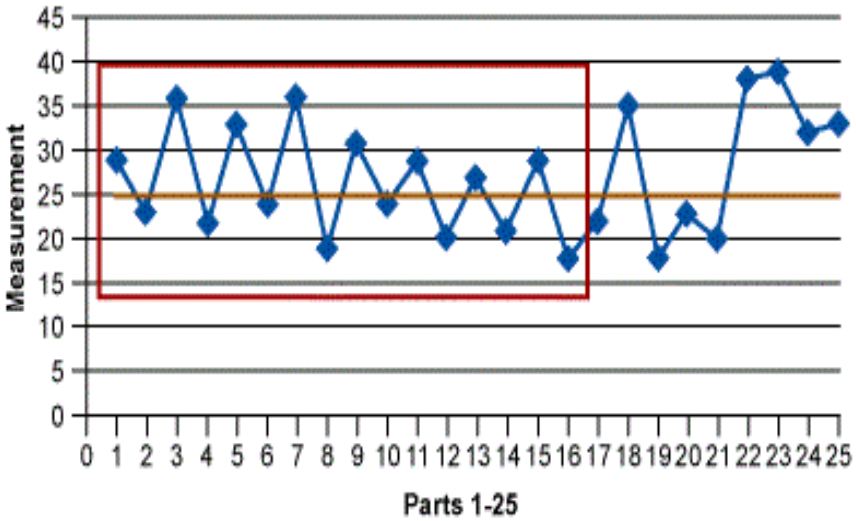
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 6. Run Charts




A run chart may be used to study observed data for trends or patterns over a specified period of time and focus attention on vital changes in the process. The run chart is useful for tracking information and predicting trends or patterns. It can determine if a process has common cause or special cause variation. It can also reveal whether a process is stable by looking for a consistent central tendency, variation and randomness of pattern. This is important because processes fall into one of four states: Ideal, Threshold, Brink of chaos, State of chaos

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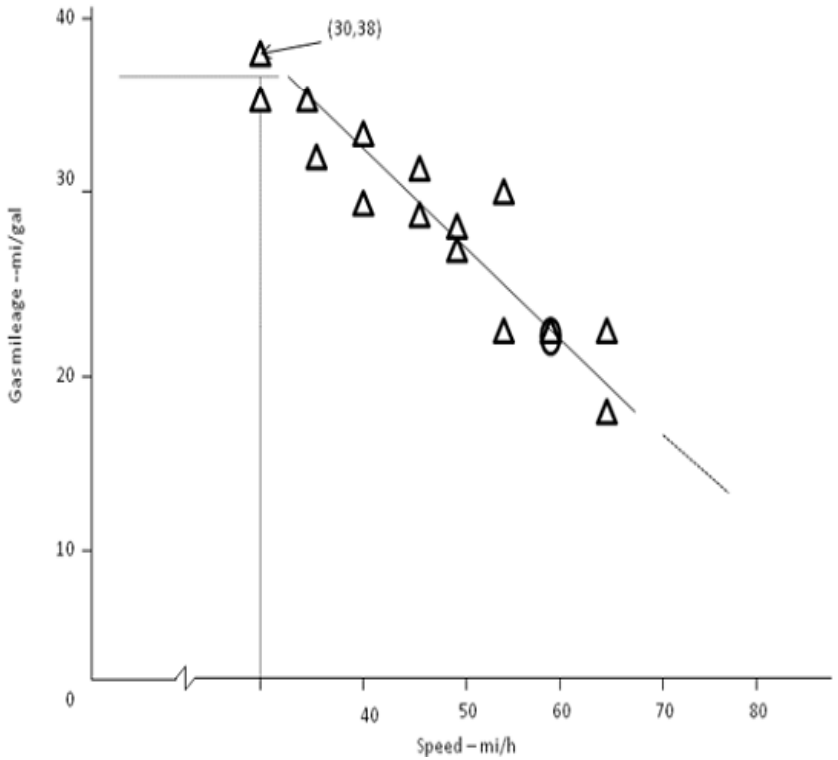
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## 7. Scatter diagram

The simplest way to determine if a relationship exists between TWO variables is to plot a scatter diagram.

Example: Relationship between automotive speed and gas mileage.

- The figure indicates that as speed increases, gas mileage decreases or a negative relationship exist between the variables of interest.
- Automotive speed is plotted on x-axis and so-called independent variable. The independent variable is usually controllable.
- Here, gas mileage is on the y-axis and is the dependent or so-called response variable.



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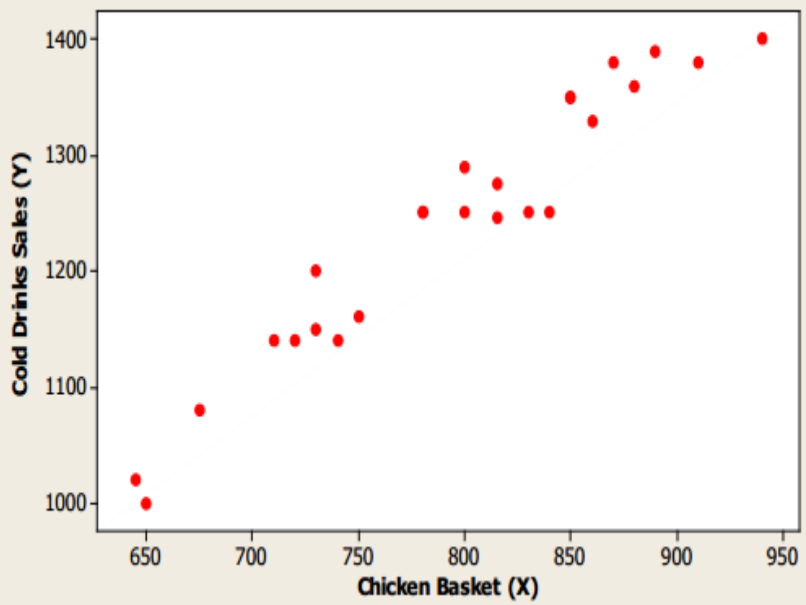
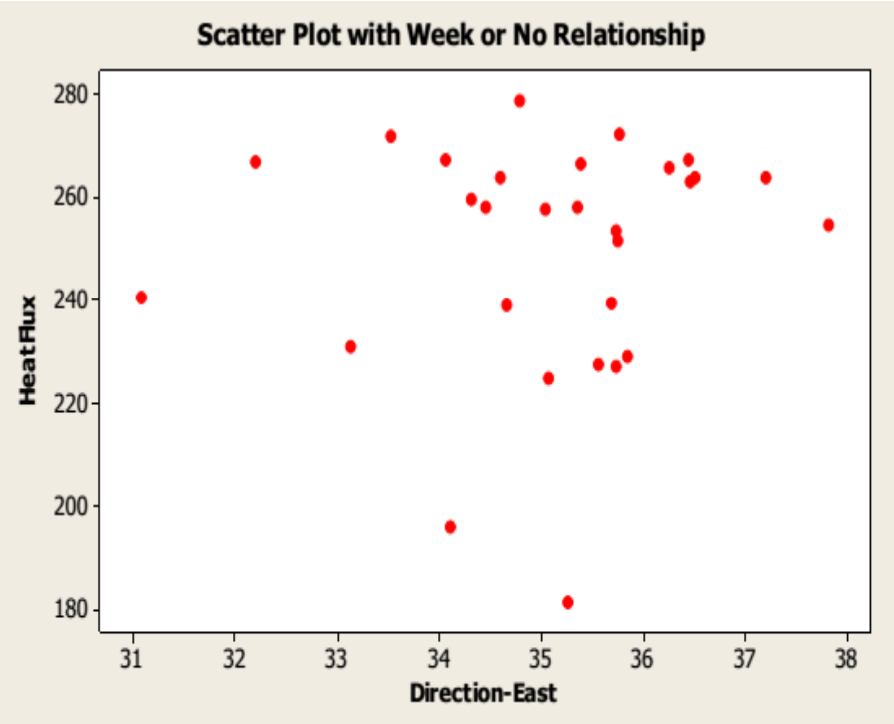
# 2.4 Graphical and statistical techniques for Process Quality Improvement

7. Scatter diagram



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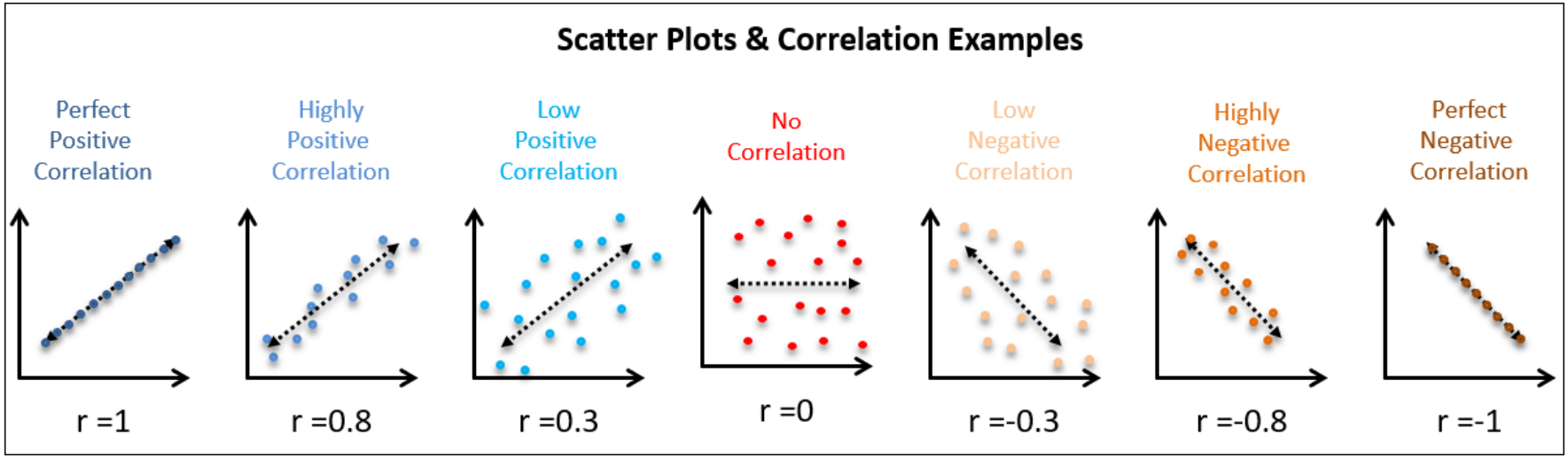
7. Scatter diagram



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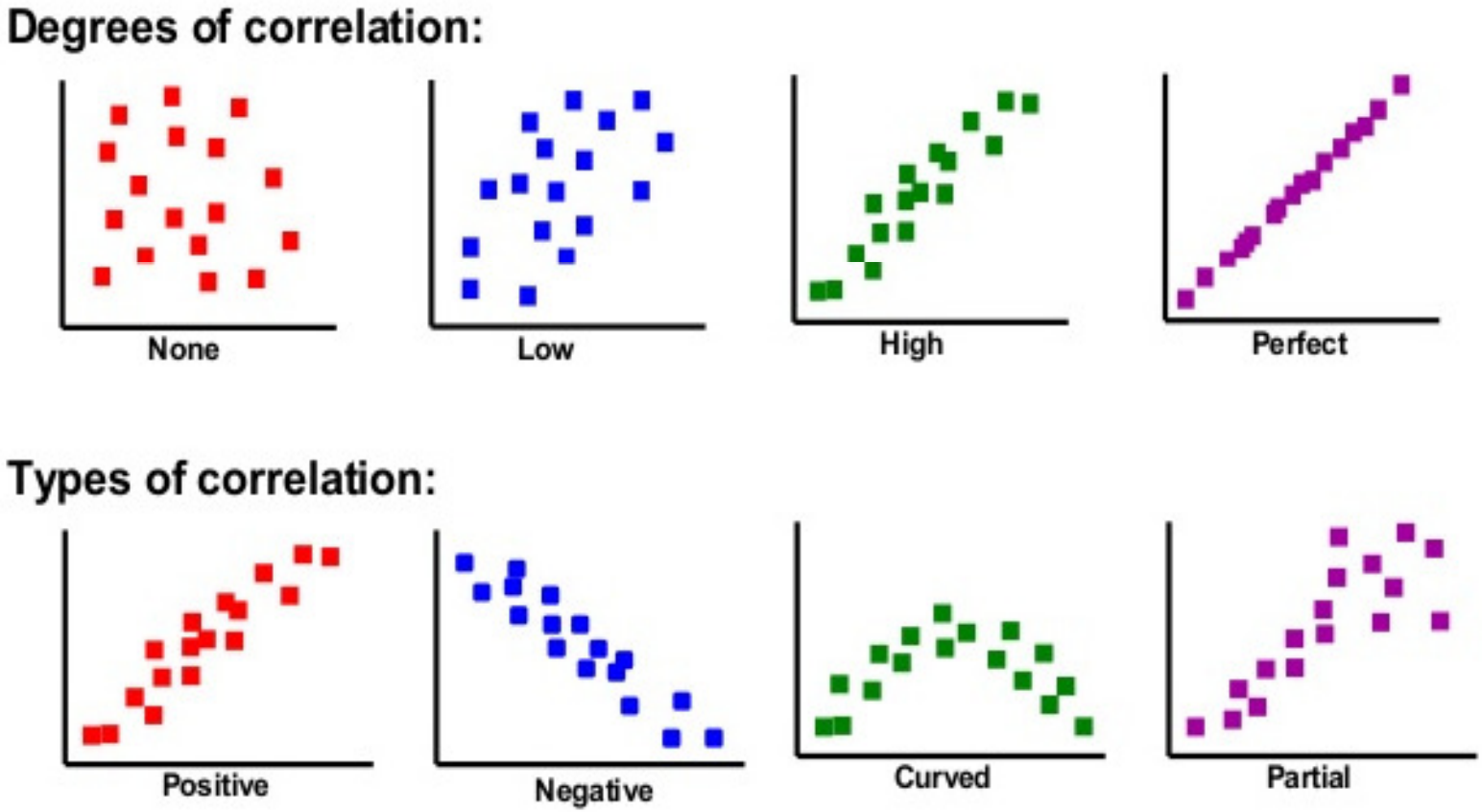


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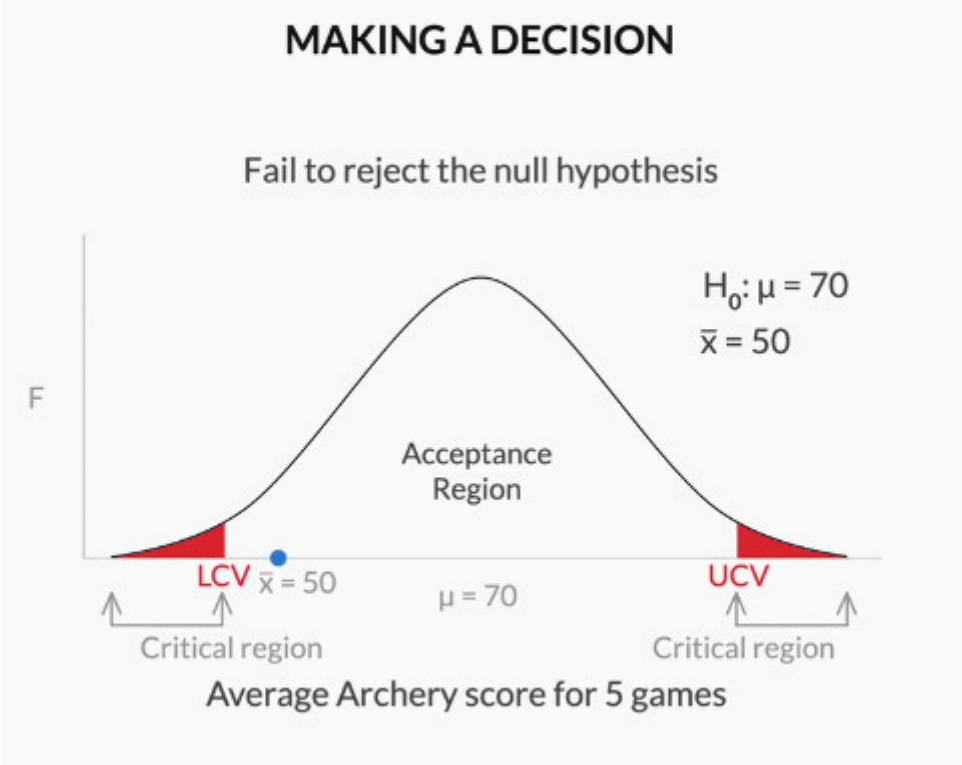
# 2.4 Graphical and statistical techniques for Process Quality Improvement

## Statistical technique

1. Hypothesis testing



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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## Statistical technique

1. Hypothesis testing

## Hypothesis testing

What is a Hypothesis?

A hypothesis is an assumption about the population parameter. A parameter is characteristic of the population, like its mean or variance. The parameter must be identified before analysis.

e.g: the average weight of this class is 58 kg.

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## Statistical technique

## 1. Hypothesis testing

Testing of Hypothesis

A hypothesis is an assumption about the population parameter (say population mean) which is to be tested. For that we collect sample data, then we calculate sample statistics (say sample mean) and then use this information to judge/decide whether hypothesized value of population parameter is correct or not.

The smaller the difference, the greater the likelihood that our hypothesized value for the mean is correct. The larger the difference, the smaller the likelihood.

Then we judge whether the difference is significant or not.

To test the validity of assumed or hypothetical value of population , we gather sample data and determine the difference between hypothesized value and actual value of the sample mean.

In hypothesis testing the first step is to state the assumed or hypothesized( numerical) value of the population parameter.

The assumption we wish/ want to test is called the null hypothesis. The symbol for null hypothesis is H0.

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## Statistical technique

## 1. Hypothesis testing

The Null Hypothesis, H0

State the Assumption (numerical) to be tested Begin

e.g. The average weight of the semester 2 student is 58kgs (H0: $\mu = 58$)

with the assumption that the null hypothesis is TRUE. (Similar to the notion of innocent until proven guilty)

The Alternative Hypothesis, H1

Is the opposite of the null hypothesis eg. The average weight of the students is not equal to 58kgs. (H1: $\mu \neq 58$)

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## Statistical technique

## 1. Hypothesis testing

### Procedure of Hypothesis Testing

The Hypothesis Testing comprises the following steps:

1. Step 1 Set up a hypothesis.
2. Step 2 Set up a suitable significance level.

   The confidence with which an experimenter rejects or accepts Null Hypothesis depends on the significance level adopted. Level of significance is the rejection region (which is outside the confidence or acceptance region).The level of significance, usually denoted by the $\alpha$.

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# 2.4 Graphical and statistical techniques for Process Quality Improvement

## Statistical techniques

### 1. Hypothesis testing

#### Selecting a significance level

Though any level of significance can be adopted, in practice we either take 5% or 1% level of significance .

When we take 5% level of significance($\alpha$= .05), then there are about 5 chances out of 100 that we would reject the null hypothesis. In other words out of 100, 95% chances are there that the null hypothesis will be accepted i.e. we are about 95% confident that we have made the right decision.

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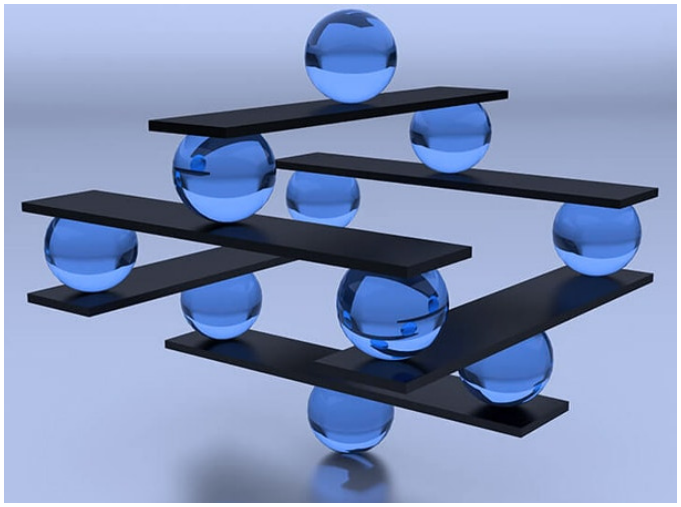
# 2.5 Zero defect/breakdown approach

Zero defects: Zero Waste | Zero breakdown | Zero Accident

Zero defects theory ensures that there is no waste existing in a project. Waste refers to all unproductive processes, tools, employees and so on. Anything that is unproductive and does not add value to a project should be eliminated, called the process of elimination of waste. Eliminating waste creates a process of improvement and correspondingly lowers costs. Common with the zero defects theory is the concept of "doing it right the first time" to avoid costly and time-consuming fixes later in the project management process.



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# 2.5 Zero defect/breakdown approach

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The zero defects theory is based on four elements for implementation in real projects.

1. Quality is a state of assurance to requirements. Therefore, zero defects in a project mean fulfilling requirements at that point in time.
2. Right the first time. Quality should be integrated into the process from the beginning, rather than solving problems at a later stage.
3. Quality is measured in financial terms. One needs to judge waste, production, and revenue in terms of budgetary impact.
4. Performance should be judged by the accepted standards, as close to perfection as possible.