Six Sigma Yellow Belt – Part II

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The 7 Basic Tools

- Check sheets
- Flow chart or Process map
- Histograms
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- Scatter diagram
- Control charts

Types of Data

- Before we get into details of the 7 basic tools, let us familiarize with the concept of data types.
- Data can be broadly categorized into two types: Continuous data and Attribute (discrete) data.
- Continuous data is measurable by some physical instrument and the value is continuous (i.e. it can be any number including decimals, need not be only integers). Example: weight, height, length, density etc.
- Attribute data is countable and they can not be measured by any physical instrument. They are also classified as good or bad, yes or No etc. Example: Number of defects, defectives.

Check sheets

- Check sheets are very important tool for data collection. Inputs gathered from check sheets can be used for creation of Pareto diagrams, Fishbone diagrams etc.
- The purpose of check sheets is to ease the compilation of the data in such a manner that they may be used / analyzed comfortably.
- It is a simple and convenient recording technique for collecting and determining the occurrence of events.
- It is constructed with each observation to give a clearer picture of the facts.

Creating Check sheets – steps involved

- Determine the objective by asking questions such as "*What is the problem?", "Why should data be collected?", "Who will use the information being collected?", "Who will collect the data?“*
- Decide the features/ characteristics and items are to be checked.
- Create a tabular form for collecting data. Traditionally the features/ characteristics, items, type of defects etc. are listed on the left side of the check sheet.
- Collect the frequency of data for the items being measured. Record each occurrence directly on the right side of the Check Sheet as it happens.

Creating Check sheets – steps involved

- Tally the data by totaling the number of occurrences for each category being measured

Sample Check sheet

Defect Type	Tally	Total
	Total	

Histogram

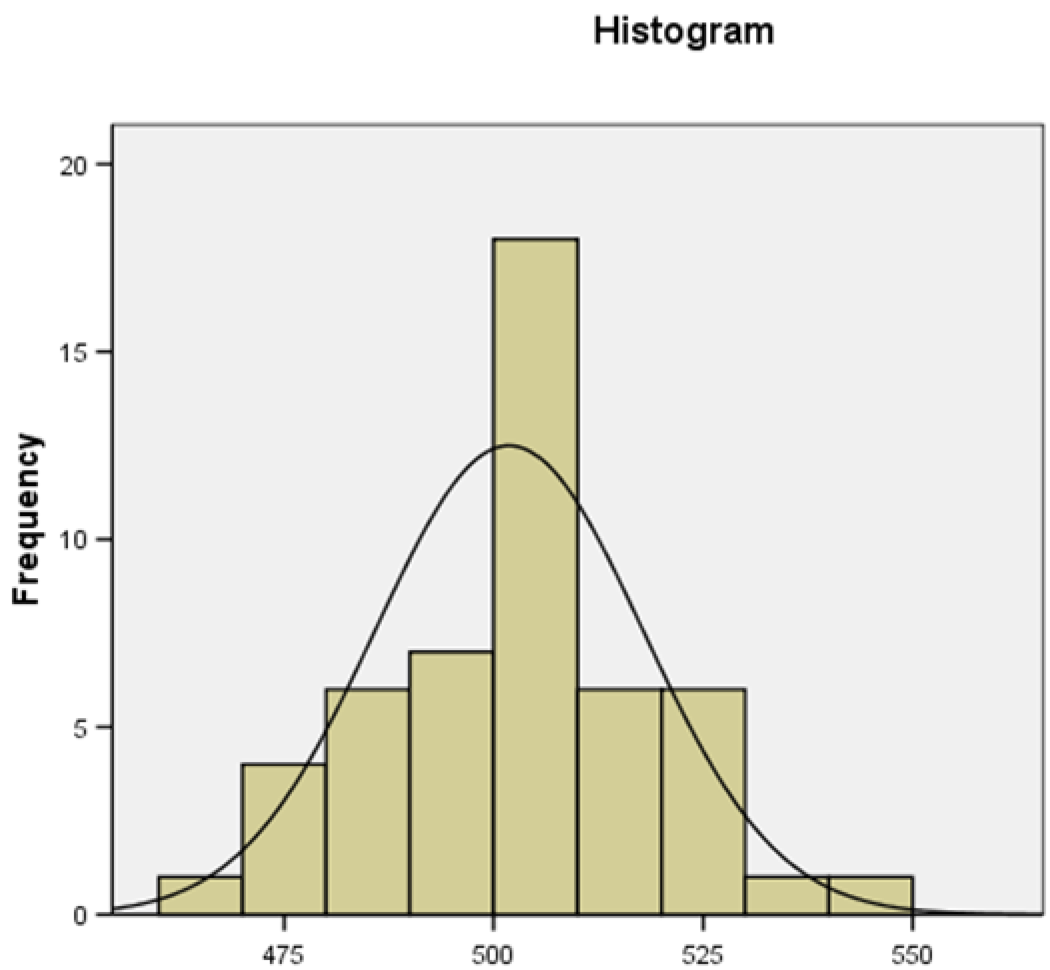
- It is a visual representation of variable data.
- It organizes data to describe process performance.
- It displays centering of the data and pattern of variation.
- It demonstrate the underlying distribution of the data. Histogram can be used to check whether the data is Normally distributed or not.
- It provides valuable information for predicting future performance.
- It helps to identify whether the process is capable of meeting requirements.

Creating Histogram – steps involved

- Collect the variable data in a table.
- Ensure that all the measurements are in the same unit
- Arrange the data in ascending order such that the minimum and maximum value can be identified
- Choose some suitable interval length of uniform size
- Use a check sheet to count the number of observations corresponding to each interval
- The number of observations for a particular interval is said to be the height of that interval and displayed as vertical bars.

Histogram

- A sample diagram is given here where the raw data are displayed in the form of a histogram.
- Also we can see the shape of the underlying distribution



Study of Histogram

Important aspects to be considered when studying Histogram:

- Location of mean of the process
- Spread (variation) of the process
- Shape (pattern) of the process

Flow chart/ Process Map

- It is a graphical representation of processes in an organization displaying the sequence of tasks performed and their relationships.
- It is a prerequisite to obtain an in depth understanding of a process, before application of quality management tools such as FMEA, SPC etc.
- Process maps are progressively elaborated: i.e. a high level process map is defined early on in the six sigma project which shows major processes and this will be made more explicit and detailed as project team develops a better and more complete understanding of all the processes.
- Standard symbols are used in creation of process maps.

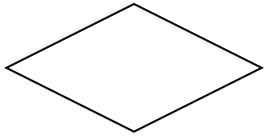
Benefits of Process Map

- Helps clarify several process steps and process flow which may not be understood clearly before.
- Shows problem areas, unexpected complexity, redundancy, idle time, unnecessary loops and where simplification may be incorporated.
- Visually shows the various alternatives possible and helps in selecting an appropriate solution.
- Helps all members of the team gain appreciation for the work being done by others in the team.
- Compares and contrasts actual versus the ideal flow of a process.
- Can be used as a training tool.

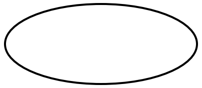
Symbols used in Process Map

- Rectangle: represents a process step or action taken. Each process step has one or more inputs, does some activity, and creates one or more outputs.

- Diamond: represents a decision step i.e. different alternatives possible depending on the input to this step.



- Oval: represents the start of stop of a process map, also used to depict if the process map continues in another page.



- Arrow: represents the direction of flow in a process map.

Creating Process Map – steps involved

- Put together a cross functional team who have knowledge of the process and appropriate subject matter expertise to create the process maps.
- Define the process and its boundaries, including the start and end points.
- Describe the stages of the process in a sequential manner.
- Assess whether the stages are in correct sequence.
- Draw the process map using the conventional symbols
- Get it reviewed by the people involved in the process to check its accuracy.

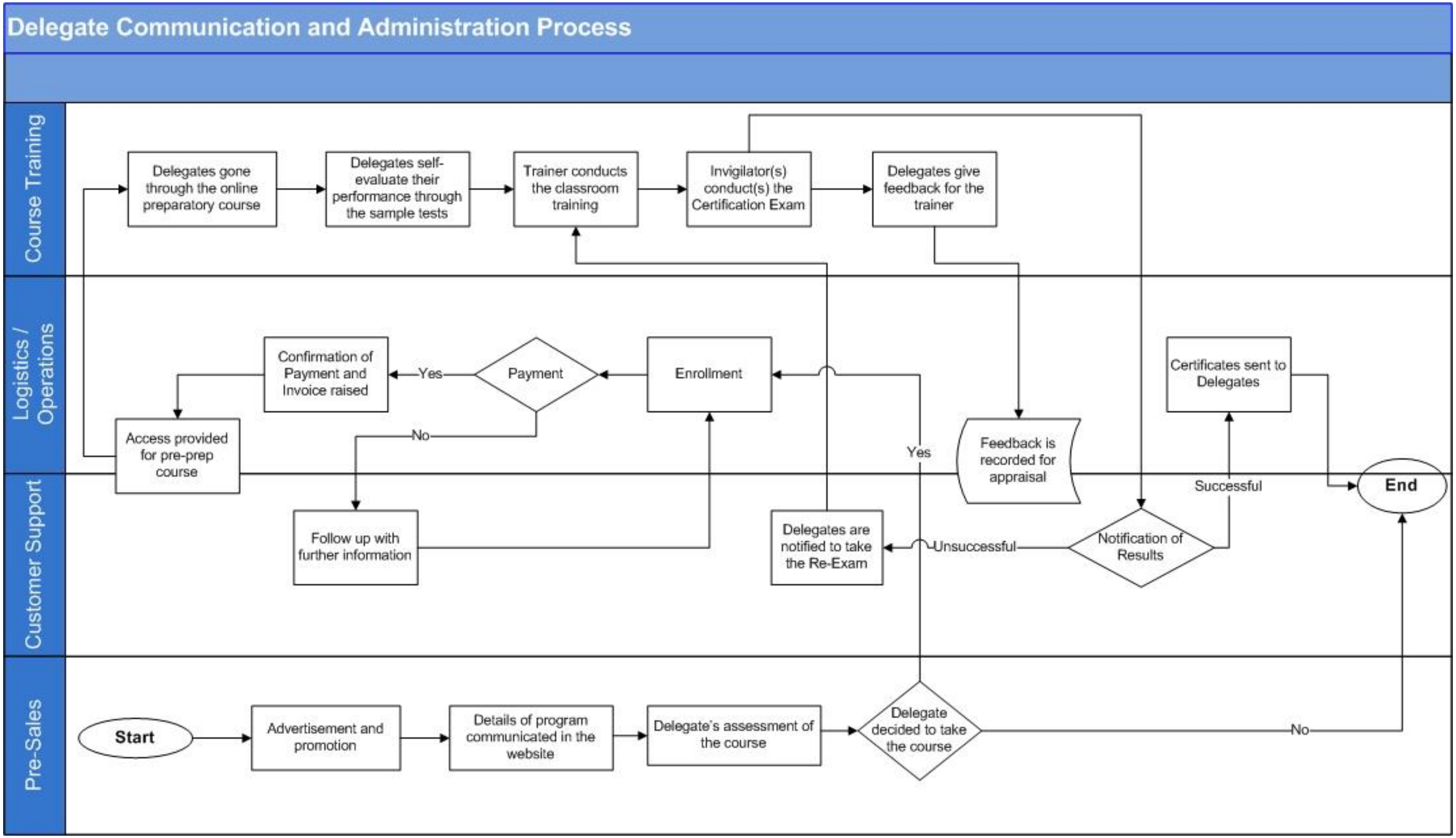
“As-is” & “To-be” Process Map

- Try to find out existing process maps which may already be in existence in the company.
- Map all the “As-is” high level processes i.e. processes as they exist now. This will create an awareness within the team about the processes in existence currently, and also let all team-members understand the contribution from others. This is the “As-is” Process map.
- Ask the cross-functional team to study the process and identify opportunities for improvement.
- Based on the inputs from cross functional team, map all the “To-be” processes. This is the “To be” Process map.

Cross Functional Process Map

- When more than one functions or departments of an organization are involved in a process (which is very likely in general) then we need to create cross functional process map instead of simple flow chart.
- It is the simple process map along with the various functions displayed on the left side of the diagram.
- Sequence of tasks are mapped in such a way that they correspond to the respective functions.
- It may be possible that some task(s) is performed by two functions. Hence this activity to be displayed in such a manner that it falls in both the functional zone. Lets take an example:

Cross Functional Process Map



Cause and Effect Diagram

- It is a graphic representation of possible causes for any particular problem under study.
- This tool was developed by Kaoru Ishikawa in 1960's to determine and break down the main causes of a given problem.
- This tool is employed where there is only one problem and the possible causes are hierarchical in nature.
- This diagram is also known as Fish bone diagram (because of its fish bone like structure) or Ishikawa diagram.
- It gives the relationship between quality characteristics and its factors.
- It focuses on causes and not the symptoms.

Cause and Effect Diagram

- Usually created by a group of people who have knowledge of the process and understand the problems in the present system.
- It assist in helping to find the root causes of a problem and in generating improvement ideas.
- It clarifies the understanding the team has regarding the process. If an Ishikawa diagram does not show appropriate level of detail, it indicates that the team has a superficial knowledge of the problem. Hence, additional study of the system or involvement of Subject Matter Experts is required.

Cause and Effect Diagram – steps involved

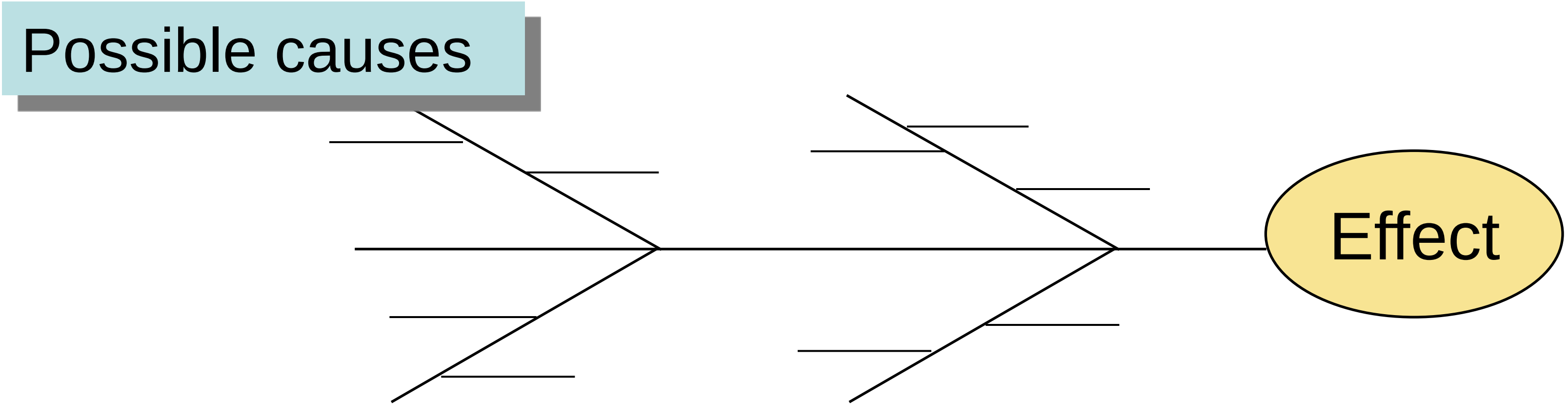
- The effect (a specific problem or a quality characteristics) is considered to be the head, and the potential causes and sub-causes of the problem, or quality characteristics to be the bone structure of the fish. Hence write the key symptom or effect of the problem in a box to the right-hand side.
- Draw a horizontal line from the left-hand side of the box.
- Identify the major categories for causes of the effect, which form the main branches of the diagram.

Cause and Effect Diagram – steps involved

- Conventionally the main bone structure or branches are the 5Ms: Machine, Manpower, Method, Materials, Maintenance (followed in manufacturing industry) and the 4Ps: Policies, Procedure, people, Plant (followed in non-manufacturing industry). The team may come out with other relevant major categories according to the problem.
- Ensure that the team have a good knowledge of the process and understand the problem under study.
- Conduct a brainstorming session with all the team members to generate the possible causes of the problem.

Cause and Effect Diagram – steps involved

- Categorize the causes identified into groups and subgroups. A popular way to do this is through using Affinity diagrams.
- Write the names of categories above and below the horizontal line. Start with high level groups and expand each group (up to 3 or 4 levels). Write down the detailed cause data for each category



Pareto Analysis

- It is a ranked comparison of factors related to a quality problem.
- Pareto diagram displays the relative importance of problems is a simple visual format.
- Since availability of money, time and other resources are restricted, Pareto analysis helps the team to consider only vital few problematic factors out of trivial many, which if addressed with due care, will bring greatest rewards with minimum resources.
- Pareto diagram is based on the Pareto principle, also known as 80-20 rule, which states that a small number of causes (20%) is responsible for a large percentage (80%) of the effect.

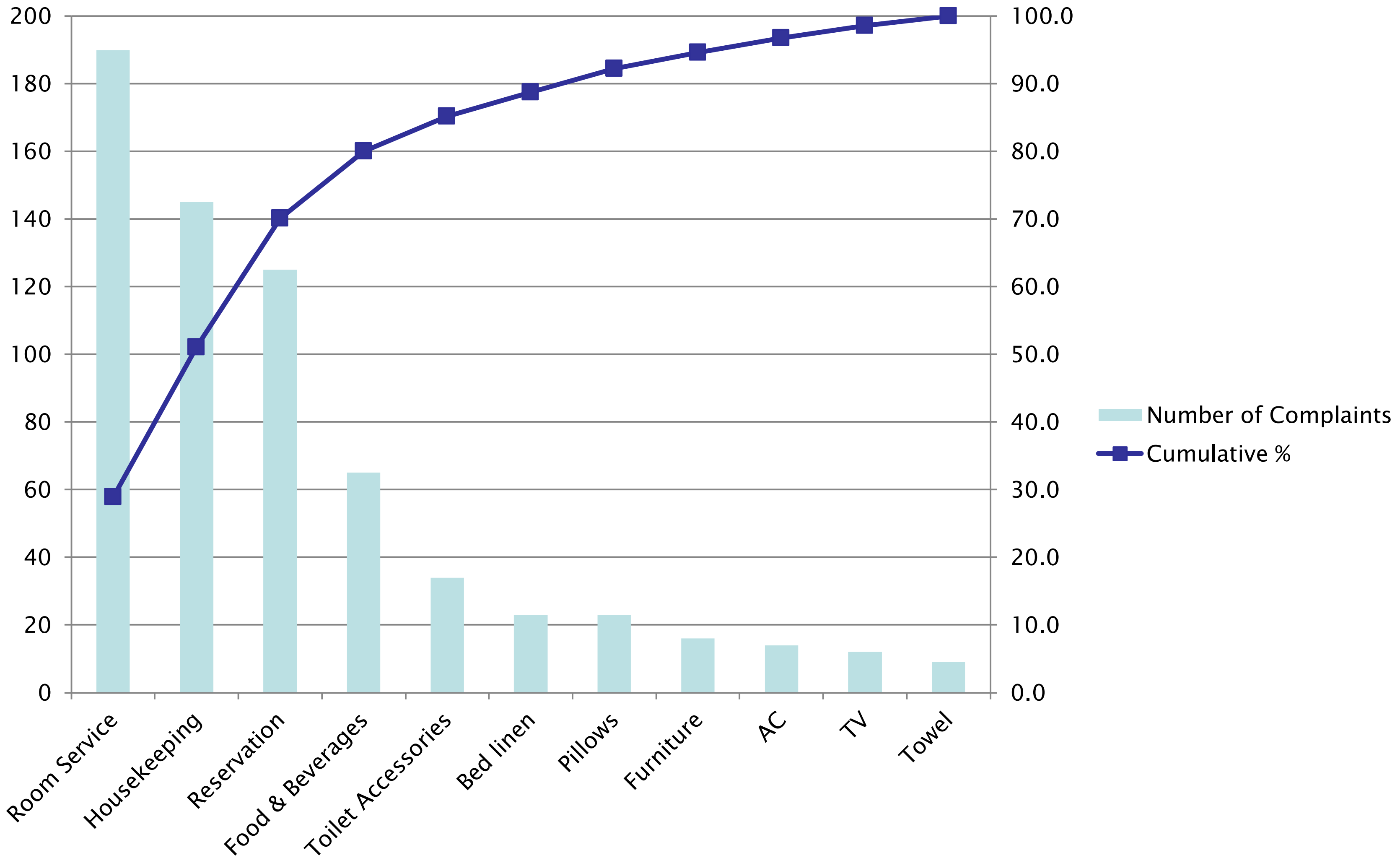
Pareto Analysis

- The Pareto Diagram is named after Vilfredo Pareto, an economist from Italy. Pareto studied distribution of wealth and found that the distribution was not equal across the population. He found – majority of the wealth is concentrated in relatively few.
- Pareto's theory was popularized by Dr. Joseph M. Juran, who is regarded as the father of quality control. It was Dr. Juran who called the eighty-twenty ratio propounded by Pareto as the "Pareto principle".
- Dr. Juran termed those few contributors which account for bulk of the effect as 'Vital few'.
- He termed other sources which do not contribute significantly to the effect as 'Trivial many'.

Pareto Diagram – steps involved

- Put together a cross functional team who have knowledge of the different opportunities or problems.
- Create different categories for the opportunities.
- Select a time interval for the analysis which is reasonable.
- Determine the total occurrences of events in each category.
- Rank the total occurrences in each category from maximum to minimum.
- Compute the percentage for each category by dividing by the category total and multiplying by 100.
- Create a graph of the opportunities – with the category names in the X Axis and the % of opportunities in the Y Axis.

Example: Pareto Diagram



Example: Pareto Diagram

- This is an example of a Pareto diagram of the complaints received in a Hotel over a period of last three months. The Hotel management is concerned about the increasing customer complaints.
- The horizontal axis represents various types of complaints and the vertical axis displays the number of complaints in each category.
- The right-hand vertical axis displays the cumulative percentage of the complaints. The blue curve represent this data.
- From this we can see that only the first four complaint category (Room service, Housekeeping, Reservation, Food and Beverages) constitute 80% share of the total complaints. Hence these four areas need immediate attention to improve the process performance.

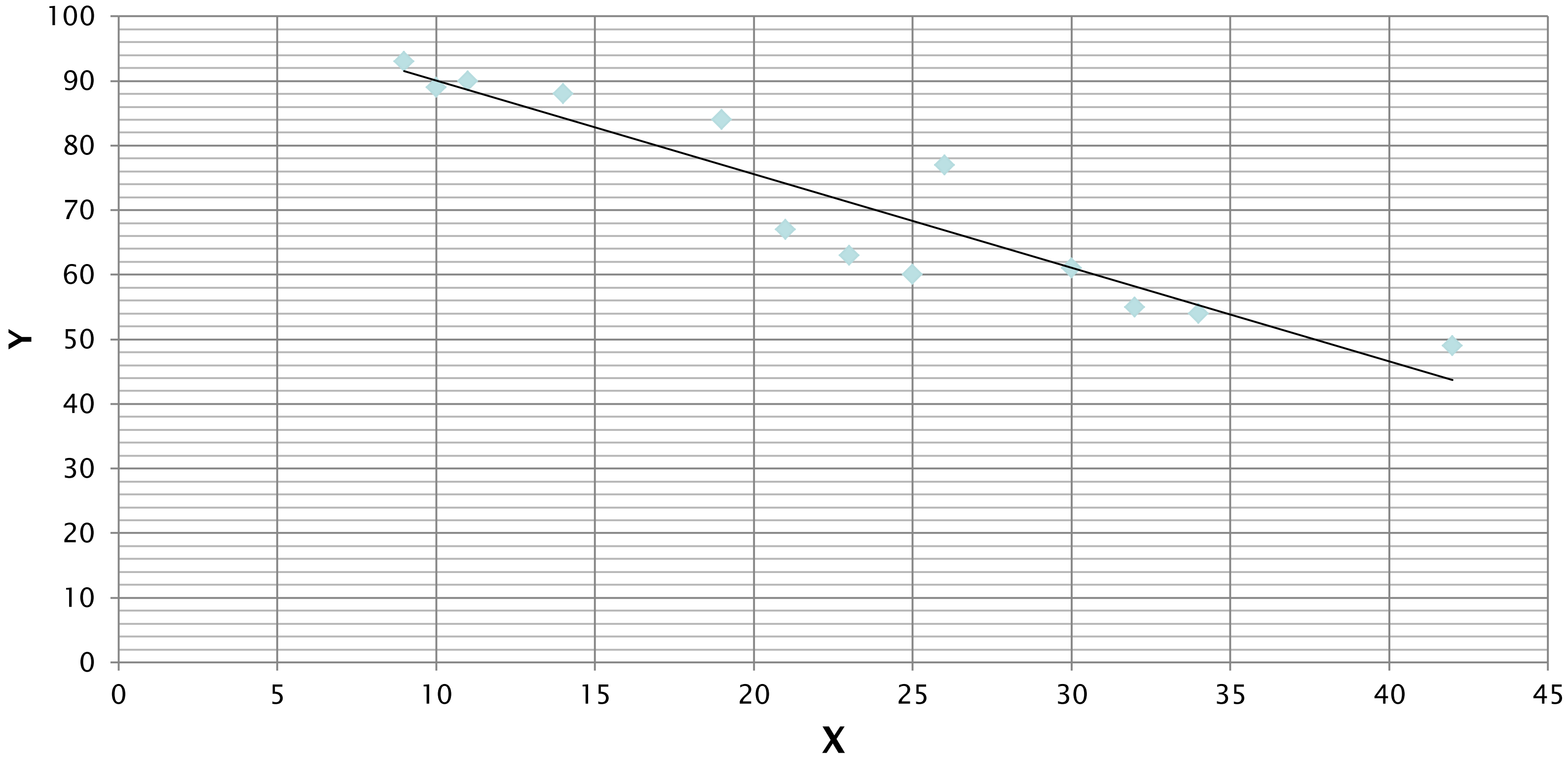
Scatter Diagram

- It is a graphical representation that depicts the possible relationship or association between two variables, factors or characteristics.
- It provides both a visual and statistical means to test the strength of a relationship.

Construction of a Scatter diagram:

- Collect the data on both variables, preferable sample size of 20 or more.
- Plot the data points on a XY plane where variable 1 is plotted along X axis and variable 2 is plotted along Y axis.
- Identify the linear relationship between them if it exists.
- Identify the strength of the linear relationship as strong/ weak positive, and strong/ weak negative.

Example: Scatter Diagram



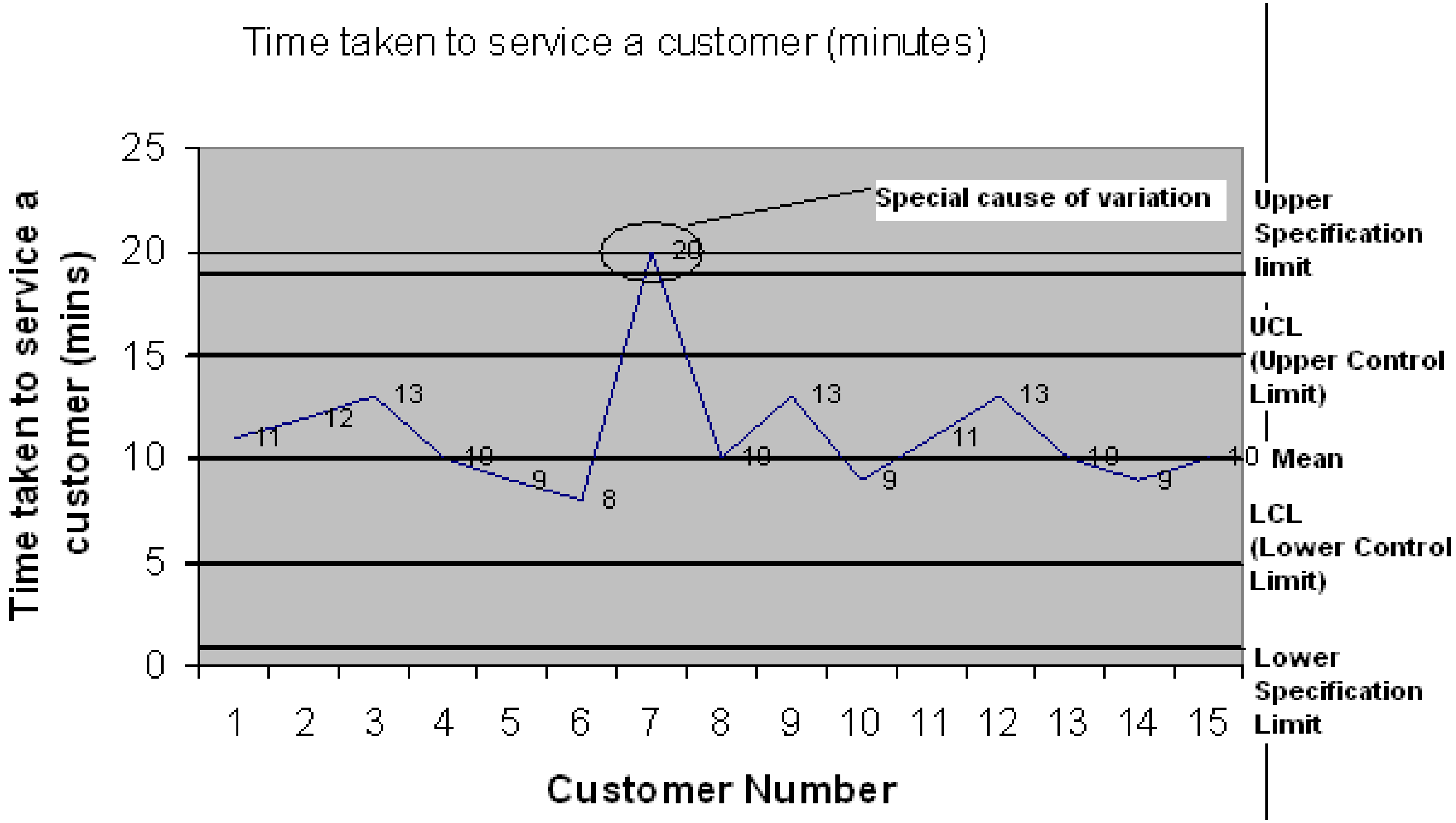
- From the above scatter diagram we can see that the factors X and Y are having a negative liner relationship. Individual data points are plotted as bullet points and the trend line indicates there is a linear relationship.

Control Chart

- It is a tool used in the control phase of the six sigma project.
- It distinguishes special from common causes of variation.
- Common causes of variation are natural in the process. They are small in magnitude and difficult to identify / remove from the process.
- Special causes of variation occurs due to some special causes. They are large in magnitude and easy to identify / remove from the process.
- There are three major components of a control chart: Upper Control Limit (UCL), Lower Control Limit (LCL), and Center Line (Mean).
- Information required for a control chart is a count or measurement from a process whenever an event occurs or at regular time intervals.

Control Chart

Lets take a look at a sample control chart. Data obtained from the process is plotted in a chart as shown below.



Components of Control Chart

- Mean: It is the simple average of the process data. It is displayed as a center line in the control chart and individual data points are scattered around it.
- Upper and Lower Specification Limits (USL and LSL): These are obtained by taking the voice of the customer. A process would satisfy customer requirements if it falls within the specification limits.
- Upper and Lower Control Limits (UCL and LCL): These are calculated from the process data and if all the process data stays within the control limits then it is very likely that the variation is inherent in the process i.e. common cause of variation. UCL and LCL lie within the upper and lower specification limits. If the process data lies outside the control limits, then it is a special cause of variation.

DFSS

- Design for Six Sigma (DFSS) is an application of Six Sigma which focuses on the design or redesign of the different processes used in product manufacturing or service delivery by taking into account the customer needs and expectations.
- DMADV is a common DFSS methodology used to develop a process or product which does not exist in the company.
- DMADV is used when the existing product or process doesn't meet the level of customer specification or six sigma level even after optimization with or without using DMAIC.

- Companies using DFSS: GE, Motorola, Honeywell, etc.

DFSS

DMADV (Define, Measure, Analyze, Design, and Validate)

- DEFINE the project goals and customer deliverables
- MEASURE the process to determine the current performance level
- ANALYZE and determine the root causes of the defects
- DESIGN the process in detail to meet customer needs
- VALIDATE the design performance and its ability to meet the customer needs

We have learned the following topics in this course:

- Evolution of Six Sigma
- What is Six Sigma?
- Goals of Six Sigma
- Six Sigma Approach
- Why do organizations adopt Six Sigma?
- Six Sigma –Mathematical Interpretation
- Roles in Six Sigma Organization
- Key Stakeholders
- DMAIC Methodology
- 7 Basic Quality Tools
- Types of data
- DFSS