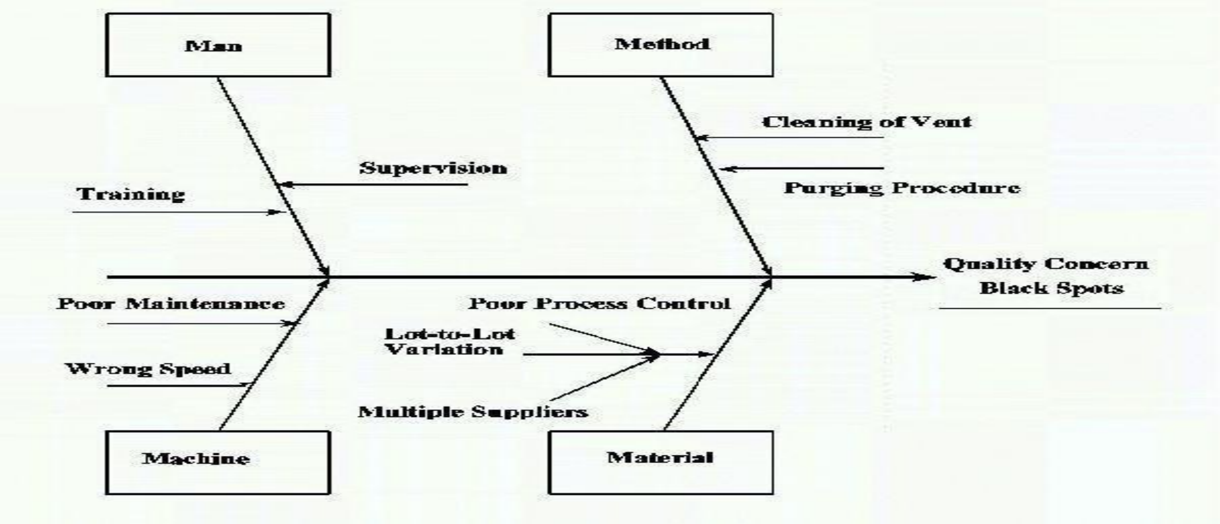
3.1 SEVEN TOOLS OF QUALITY

1. Cause-and-effect diagram (also called Ishikawa or fishbone diagrams): Identifies many possible causes for an effect or problem and sorts ideas into useful categories.

Cause-and-Effect Diagrams - 1943 by Mr. Kaoru Ishikawa at the University of Tokyo

Purpose: One important part of process improvement is continuously striving to obtain more information about the process and its output. Cause-and-effect diagrams allow us to do not just that, but also can lead us to the root cause, or causes, of problems.



Constructing the Cause-and-Effect Diagram:

Step 1: Select the team members and a leader. Team members knowledgeable about the quality. Team members focus on the problem under investigation.

Step 2: Write the problem statement on the right hand side of the page, and draw a box around it with an arrow running to it. This quality concern is now the effect.

Step 3: Brain-storming. The team members generate ideas as to what is causingthe effect.

Step 4: This step could be combined with step 3. Identify, for each main cause, its related sub-causes that might affect our quality concern or problem (our Effect). Always check to see if all the factors contributing to the problem have been identified. Start by asking why the problem exists.

Step 5: Focus on one or two causes for which an improvement action(s) can be developed using other quality tools such as Pareto charts, check sheets, and other gathering and analysis tools.

Check sheet: A structured, prepared form for collecting and analyzing data; ageneric tool that can be adapted for a wide variety of purposes.

The check sheet is a simple document that is used for collecting data in real-time and at the location where the data is generated. The document is typically a blank form that is designed for the quick, easy, and efficient recording of the desired information, which can be either quantitative or qualitative. When the information is quantitative, the check sheet is sometimes called a tally sheet.

Defect Types? Event occurrence	Events							Total
	Sun	Mon	Tue	Wed	Thur	Fri	Sat	
Supplied parts rusted		✓✓✓ ✓✓✓ ✓✓	✓✓✓✓ ✓	✓✓✓✓	✓✓			19
Misaligned Weld			✓✓✓			✓✓		5
Improper Test Procedure		✓		✓✓				3
Wrong Part Issued					✓✓			2
Film on Parts				✓✓✓✓		✓✓		6
Voids in Casting								0
Incorrect Dimensions								0
Adhesive Failure					✓			1
Masking Insufficient								0
Spray Failure				✓✓✓✓				4
Total		*9*	*8*	*14*	*5*	*4*	*0*	*40*

A defining characteristic of a check sheet is that data is recorded by making marks (“checks”) on it. A typical check sheet is divided into regions, and marks made in different regions have different significance. Data is read by observing the location and number of marks on the sheet. 5 Basic types of Check Sheets:

Classification: A trait such as a defect or failure mode must be classifiedinto a category.

Location: The physical location of a trait is indicated on a picture of a partor item being evaluated.

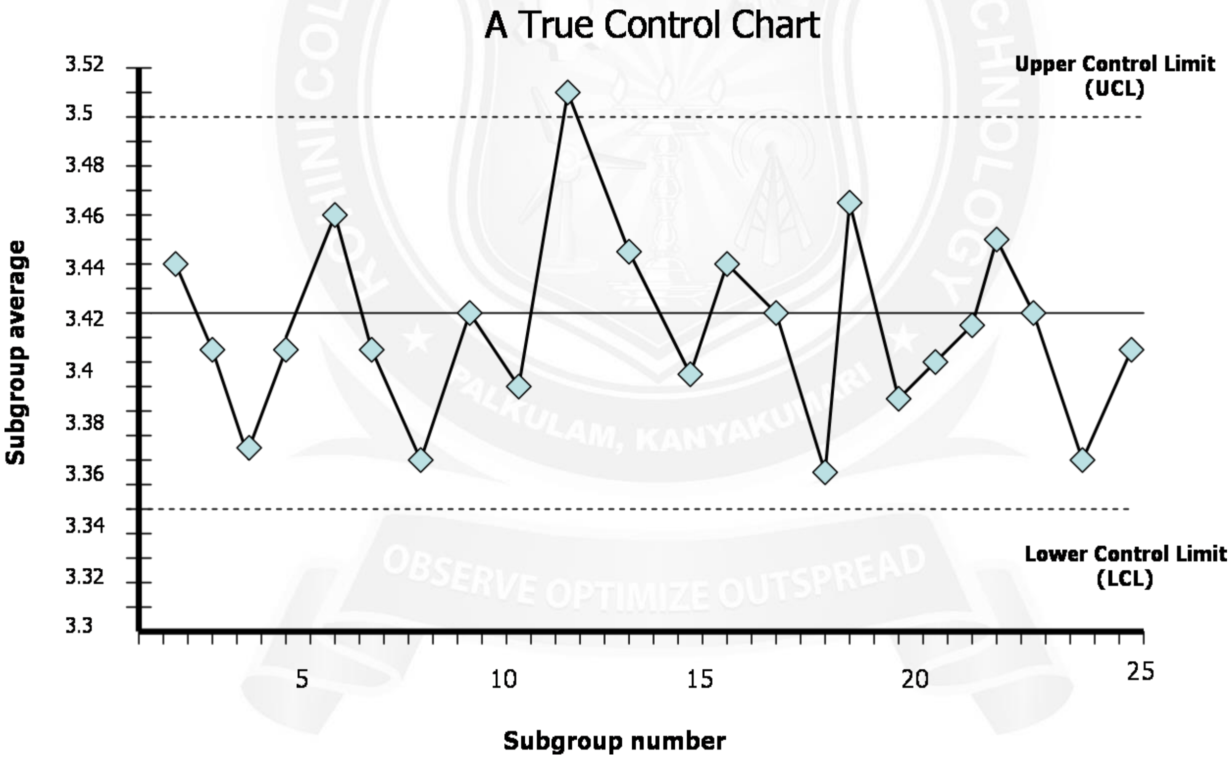
Frequency: The presence or absence of a trait or combination of traits isindicated. Also number of occurrences of a trait on a part can be indicated.

Measurement Scale: A measurement scale is divided into intervals, andmeasurements are indicated by checking an appropriate interval.

Check List: The items to be performed for a task are listed so that, as each is accomplished, it can be indicated as having been completed.

Control chart: Graph used to study how a process changes over time. Comparing current data to historical control limits leads to conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).Control charts have long been used in manufacturing, stock trading algorithms, and process improvement methodologies like Six Sigma and Total Quality Management (TQM). The purpose of a control chart is to set upper and lower bounds of acceptable performance given normal variation. In other words, they provide a great way to monitor any sort of process you have in place so you canlearn how to improve your poor performance and continue with your successes.

The control chart serves to "sound the alarm" when a process shifts (for instance, a machine suddenly breaking on a factory floor) or if someone has a breakthrough that needs to be documented and standardized across the larger organization. Simply put (without taking



anomalies into consideration).

Histogram: The most commonly used graph for showing frequency distributions, or how often each different value in a set of data occurs.

Error Causes	Total		Serious		Moderate		Minor	
Error	No.	%	No	%	No	%	No.	%
IES	205	22%	34	27%	68	18%	103	24%
MCC	156	17%	12	9%	68	18%	76	17%
IDS	48	5%	1	1%	24	6%	23	5%
VPS	25	3%	0	0%	15	4%	10	2%
EDR	130	14%	26	20%	68	18%	36	8%
ICI	58	6%	9	7%	18	5%	31	7%
EDL	45	5%	14	11%	12	3%	19	4%
IET	95	10%	12	9%	35	9%	48	11%
IID	36	4%	2	2%	20	5%	14	3%
PLT	60	6%	15	12%	19	5%	26	6%
HCI	28	3%	3	2%	17	4%	8	2%
MIS	56	6%	0	0%	15	4%	41	9%
Total	942	100%	128	100%	379	100%	435	100%

Let's see usage of Histogram in context of "Plan Quality Management" and "Control Quality" for your The Project Management Professional (PMP examination.

In "Plan Quality Management" a Histogram serves as a preventive approach to improve processes. We use historical data to identify categories of causes effecting most. Based on effecting most categories, we select processes to improve. For example due to higher frequencies in IES, MCC and EDR, we may select improvements in "Collect Requirement", and "Define Scope" processes.

Using "Control Quality" we identify causes of poor performance help in improving processes and their work products. In this way, causes of poor performance analysis make Histogram a powerful tool to take corrective actions.

Pareto chart: A bar graph that shows which factors are more significant.

Pareto analysis is a technique for recording and analysing information relating to a problem or cause, which easily enables the most significant aspects to be identified.

A Pareto diagram is a special form of vertical bar chart, or column chart, which allows the information to be visually displayed.

When to use it

Separating the 'vital few' from the 'useful many' problems, (80/20 rule).

Selecting major problem areas

Identifying major effects and causes

What does it achieve?

"First things first" is the thought behind the Pareto diagram; the properly constructed diagram should suggest on which error or activity resources should be used first to make the best improvement. Very often the simple process of arranging data may suggest something of importance that would otherwise have gone unnoticed. Selecting classifications, tabulating data, ordering data, and constructing the Pareto diagram have often served a useful purpose in problem investigation. The communication process between people takes on many forms, and Pareto diagrams are a form of language using a display in a commonly understood format. The continued use of the Pareto diagram enhances communication between members of staff and through all levels of management.

Key steps

List the activities to be analyzed

Calculate totals

Order totals

Draw the Pareto diagram

Interpret results

Pareto Diagram example

Difference between Pareto Chart and Histogram:

Histogram	Pareto Chart
The Histogram is a kind of bar chart showing a distribution of variables or causes of problems.	A Pareto chart is a specific type of histogram that represents the causes of problems by their influence. It is a useful tool to prioritize corrective action as errors with the greatest impact displayed in descending order of frequency.
A histogram represents cause of a problem as a column and the frequency of each cause of problem as the height of the column.	In Pareto chat, an arc representing the cumulative percentage of frequencies of causes also included.

Scatter diagram: Graphs pairs of numerical data, one variable on each axis, tolook for a relationship.

Also called: scatter plot, X-Y graph

The scatter diagram graphs pairs of numerical data, with one variable on eachaxis, to look for a relationship between them. If the variables are correlated, the points will fall along a line or curve. The better the correlation, the tighter the points will hug the line. This cause analysis tool is considered one of the sevenbasic quality tools.

WHEN TO USE A SCATTER DIAGRAM

When you have paired numerical data

When your dependent variable may have multiple values for each value ofyour independent variable

When trying to determine whether the two variables are related, such as:

When trying to identify potential root causes of problems

After brainstorming causes and effects using a fishbone diagram to determine objectively whether a particular cause and effect are related

When determining whether two effects that appear to be related both occurwith the same cause

When testing for autocorrelation before constructing a control chart

SCATTER DIAGRAM PROCEDURE

Collect pairs of data where a relationship is suspected.

Draw a graph with the independent variable on the horizontal axis and thedependent 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.)

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 because variables are correlated. You may wish to use regression or correlation analysis now. Otherwise, complete steps 4 through 7.

Divide points on the graph into four quadrants. If there are X points on the graph:

Count X/2 points from top to bottom and draw a horizontal line.

Count X/2 points from left to right and draw a vertical line.

If number of points is odd, draw the line through the middle point.

Count the points in each quadrant. Do not count points on a line.

Add the diagonally opposite quadrants. Find the smaller sum and the total of points in all quadrants.

A = points in upper left + points in lower rightB = points in upper right + points in lower leftQ = the smaller of A and B

N = A + B

If Q is less than the limit, the two variables are related.

If Q is greater than or equal to the limit, the pattern could have occurred from random chance.

Stratification (also known as Flow Chart and/or Run Chart)

A technique that separates data gathered from a variety of sources so thatpatterns can be seen (some lists replace "stratification" with "flowchart" or "run chart").

Stratification is a way to organize data, and in particular of separating data into meaningful groups. Stratification is also known as a flow chart or run chart.

In stratification, you should include each data point in only one group, and you should leave no data point(s) out.

Below is an example of stratification.

WHEN TO USE STRATIFICATION?

Before collecting data

When data come from several sources or conditions, such as shifts, days ofthe week, suppliers, or population groups

When data analysis may require separating different sources or conditions Here are examples of different sources that might require data to be stratified:

Equipment

Shifts

Departments

Materials

Suppliers

Day of the week

Time of day

Products

STRATIFICATION PROCEDURE

Before collecting data, consider which information about the sources of the data might have an effect on the results. Set up the data collection so that you collectthat information as well.

When plotting or graphing the collected data on a scatter diagram, control chart, histogram, or other analysis tool, use different marks or colors to distinguish data from various sources. Data that are distinguished in this way are said to be "stratified."

Analyze the subsets of stratified data separately.

For example, on a scatter diagram where data are stratified into data from source 1 and data from source 2, draw quadrants, count points, and determine the critical value only for the data from source 1, then only for the data from source 2.