Unit-2 Tools of TQM

Measurement Tools

Total quality management (TQM) tools help organizations to identify, analyze and assess qualitative and quantitative data that is relevant to their business. These tools can identify procedures, ideas, statistics, cause and effect concerns and other issues relevant to their organizations. Each of which can be examined and used to enhance the effectiveness, efficiency, standardization and overall quality of procedures, products or work environment, in accordance with ISO 9000 standards (SQ, 2004). According to Quality America, Inc. the number of TQM tools is close to 100 and come in various forms, such as brainstorming, focus groups, check lists, charts and graphs, diagrams and other analysis tools. In a different vein, manuals and standards are TQM tools as well, as they give direction and best practice guidelines to you and/or your staff. TQM tools illustrate and aid in the assimilation of complicated information such as:

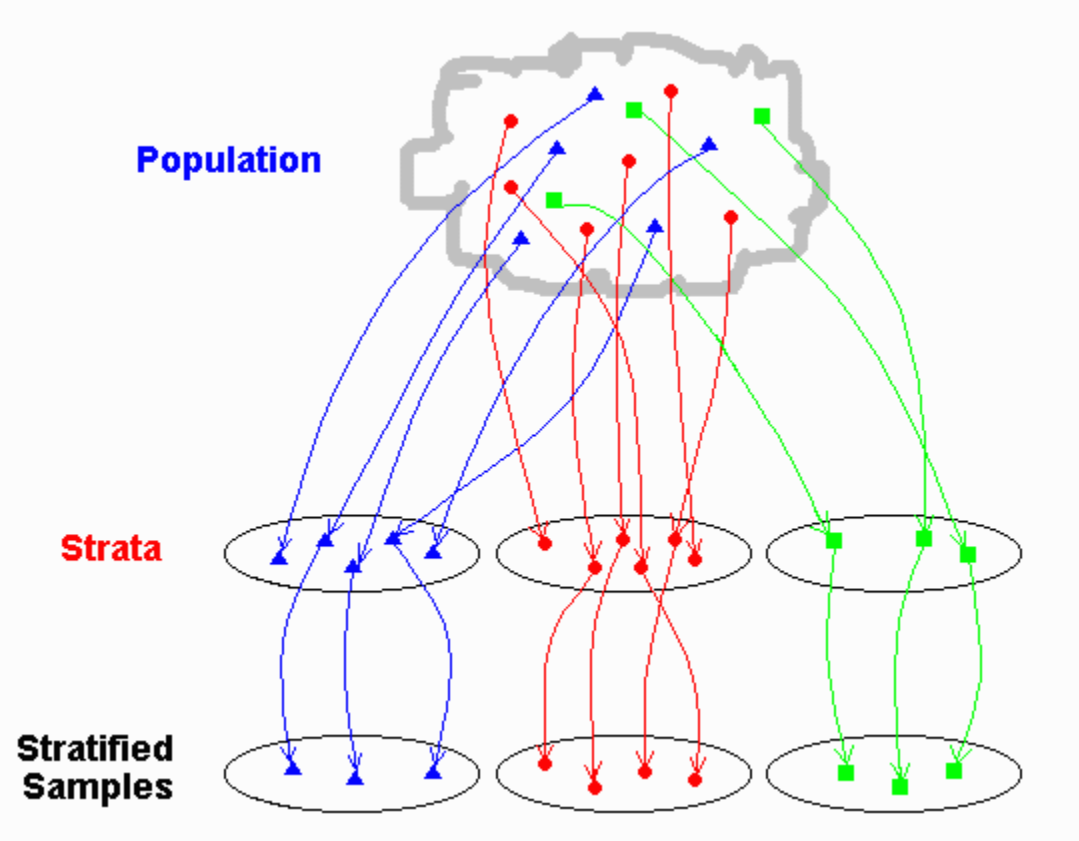
1) Identification of your target audience
2) Assessment of customer needs
3) Competition analysis
4) Market analysis
5) Brainstorming ideas
6) Productivity changes
7) Various statistics
8) Staff duties and work flow analysis
9) Statement of purpose
10) Financial analysis
11) Model creation
12) Business structure
13) Logistic analysis

The list goes on, though essentially TQM tools can be used in any situation, for any number of reasons, and can be extremely effective if used properly.

The Seven Basic Tools of Quality (7 QC Tools) originated in Japan when the country was undergoing major revolution in quality standards. It had become a mandatory topic as part of Japanese's industrial training program. These tools have simple graphical and statistical techniques which are helpful in solving critical quality related issues.

They are also known as Seven Basics Tools of Quality because these tools could be implemented by any person with very basic training in statistics. They are simple to apply and solve quality-related complex issues.

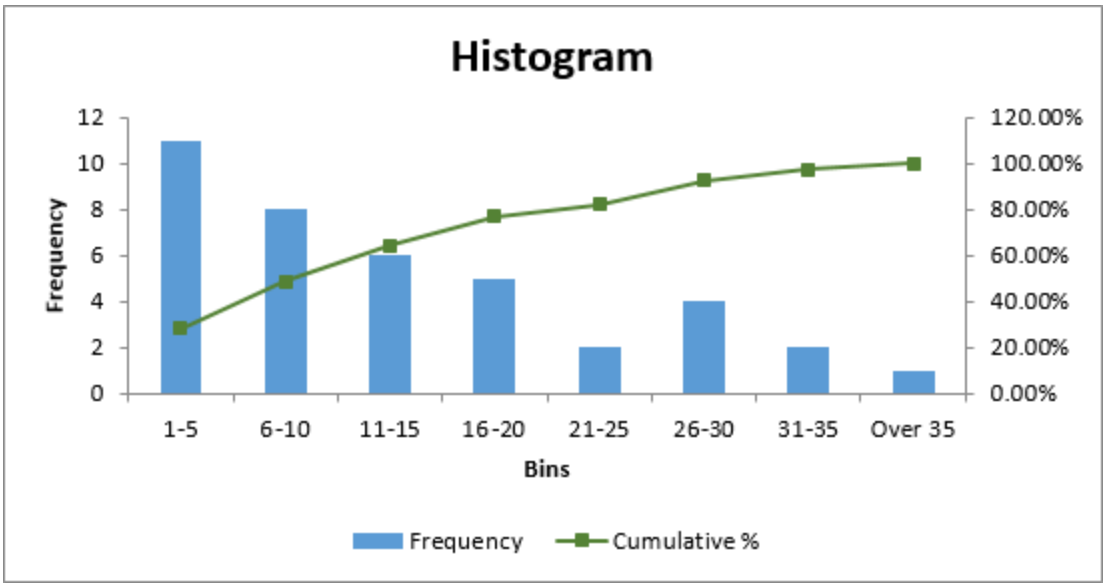
The seven QC tools are:



1. Stratification (Divide and Conquer)

It is a method of dividing data into sub–categories. After that, one has to classify it based on various parameters into groups and sub-groups. It helps in deriving meaningful information and analyse the existing problem.

It helps in dividing the data and deriving meaning out of it to solve a problem.



2. Histogram

Karl Pearson introduced Histogram. It is a bar graph representing the frequency distribution on each bars.

It helps us to study the density of data in any given distribution and understand the factors or data that repeat more often.

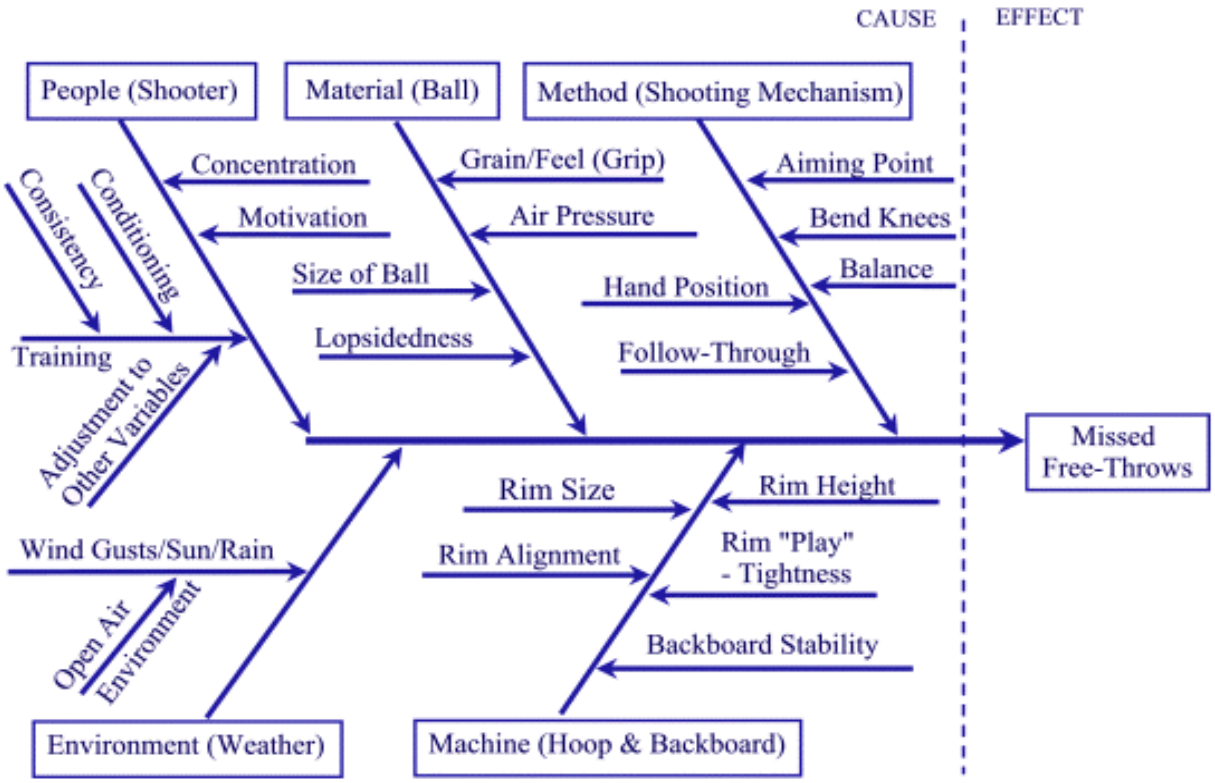
Histogram helps in prioritizing factors and identify which are the areas that needs utmost attention immediately.

Defect Types ? (Major/ Minor)	Defects in Supplied Items							Total Count
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
Rusted Items		𝍸	𝍸		𝍸	𝍸		9
Items with Scratch	𝍸							1
Dirty		𝍸		𝍸		𝍸		6
Broken/ Cracks			𝍸				𝍸	3
Main Body Dent					𝍸			3
Missing Components		𝍸		𝍸			𝍸	5
Labelling Error					𝍸	𝍸		4
Damage in Packaging			𝍸					2
Wrong Item Issued					𝍸		𝍸	3
Film on Parts			𝍸					4
Voids in Casting	𝍸					𝍸	𝍸	4
Incorrect Dimensions			𝍸	𝍸	𝍸			5
Failed to pass the quality test		𝍸				𝍸		3
Total Count	2	9	12	6	10	8	5	52

3. Check Sheet (Tally Sheet)

A check sheet can be metrics, structured table or form for collecting data. After this, it helps us analyse the data. When the information is quantitative in nature, the check sheet can also be called as tally sheet.

It lists down all the important data points and events. Then it presents them in a tabular format. Thus, it keeps on updating or marking the status on their occurrence which helps in understanding the progress, defect patterns and even causes for defects. They are non-statistical and easy to understand. They help us capture data in a standardized manner. This helps us to make decisions based on facts and not assumptions. Data is graphically represented. Thus, one can analyse the areas for improvement, either directly from the check sheet, or by feeding the data into one of the other seven basic tools.



4. Cause-and-effect diagram ("fishbone" or Ishikawa diagram)

Cause–and–effect diagram introduced by Kaoru Ishikawa helps in identifying the various causes (or factors) leading to an effect (or problem) and also helps in deriving meaningful relationship between them. First used by Ishikawa in the 1940s, they are employed to identify the underlying symptoms of a problem or "effect" as a means of finding the root cause.

The structured nature of the method forces the user to consider all the likely causes of a problem, not just the obvious ones, by combining brainstorming techniques with graphical analysis. It is also useful in unraveling the convoluted relationships that may, in combination, drive the problem..

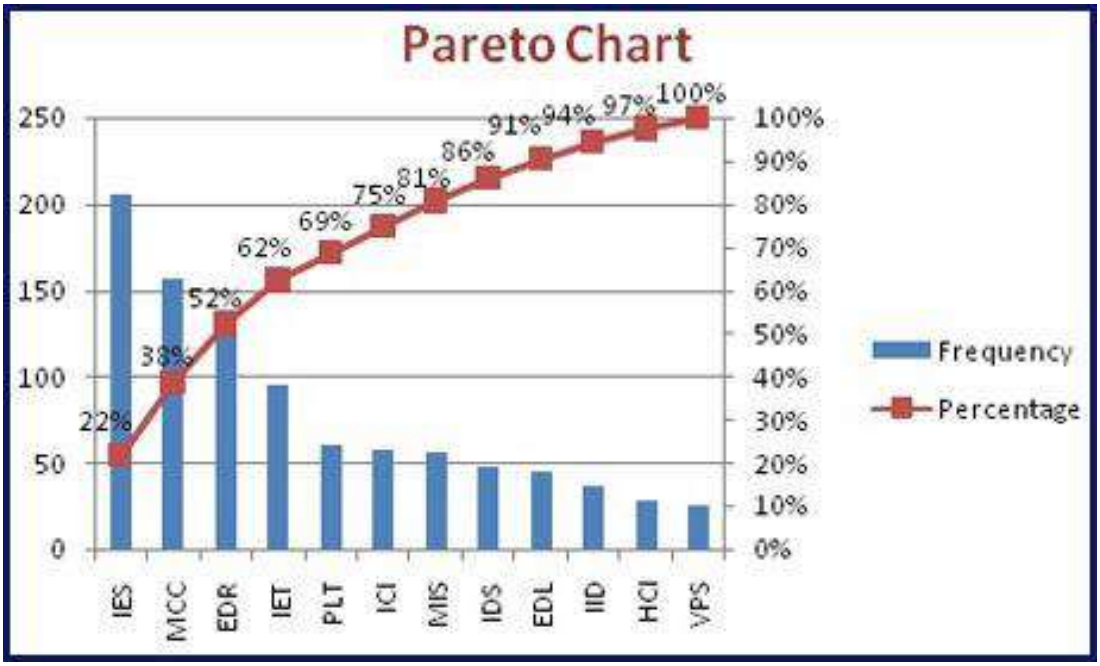
The very purpose of this diagram is to identify all root causes behind a problem.

Once a quality related problem is defined, the factors leading to the causal of the problem are identified. We further keep identifying the sub factors leading to the causal of identified factors till we are able to identify the root cause of the problem. As a result we get a diagram with branches and sub branches of causal factors resembling to a fish bone diagram.

In manufacturing industry, to identify the source of variation the causes are usually grouped into below major categories:

People
Methods

Machines
Material
Measurements



5. Pareto chart (80/20 Rule)

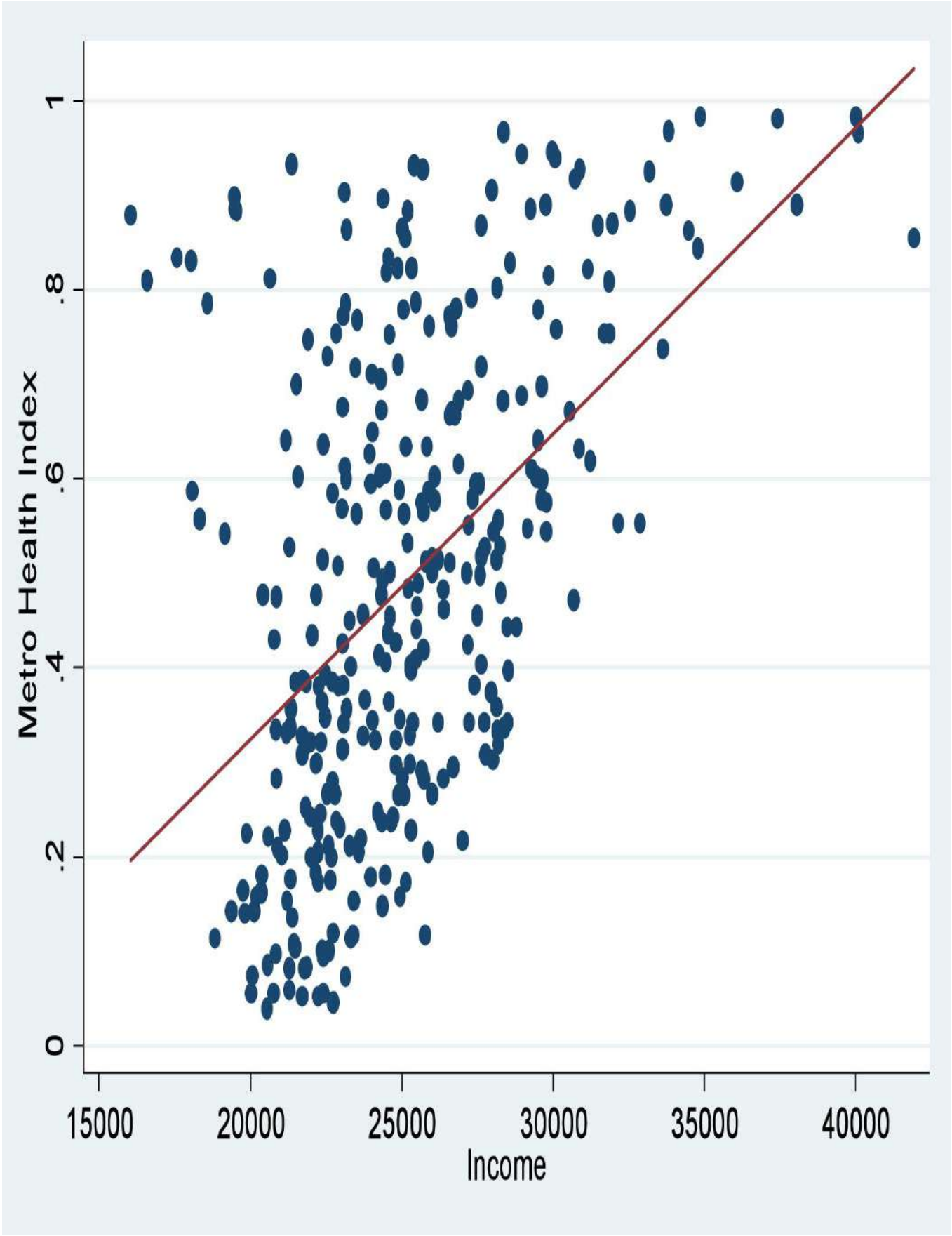
This is named after Vilfredo Pareto. It revolves around the concept of 80-20 rule which underlines that in any process, 80% of problem or failure is just caused by 20% of few major factors which are often referred as Vital Few, whereas remaining 20% of problem or failure is caused by 80% of many minor factors which are also referred as Trivial Many.

The very purpose of Pareto Chart is to highlight the most important factors that is the reason for major cause of problem or failure.

Pareto chart is having bars graphs and line graphs where individual factors are represented by a bar graph in descending order of their impact and the cumulative total is shown by a line graph.

Pareto charts help experts in following ways:

Distinguish between vital few and trivial many.
Displays relative importance of causes of a problem.
Helps to focus on causes that will have the greatest impact when solved.


Metro Health Index
0
.2
.4
.6
.8
1
15000
20000
25000
30000
35000
40000
Income

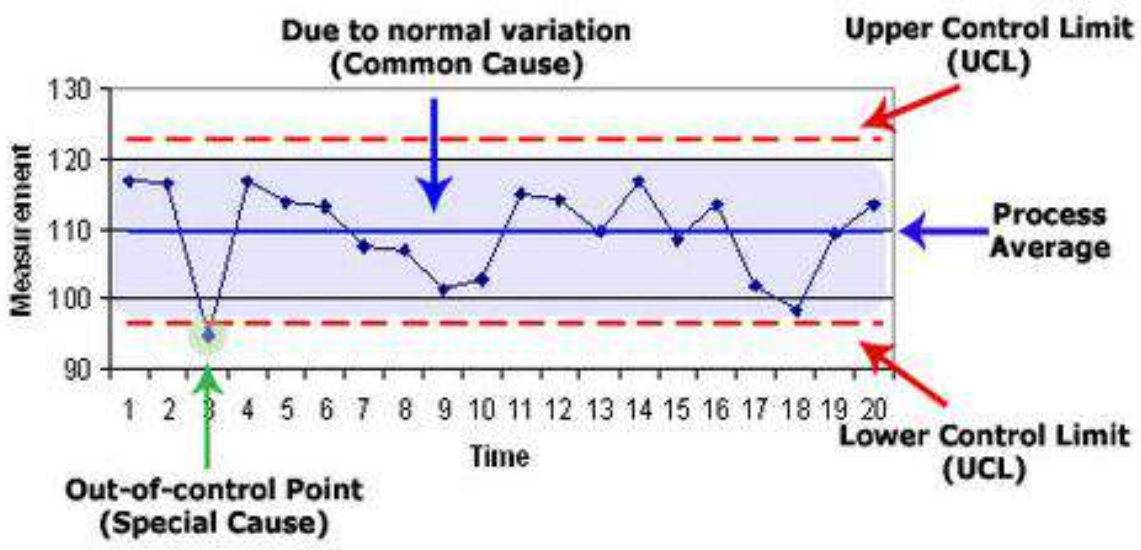
6. Scatter diagram (Shewhart Chart)

Scatter diagram or scatter plot is basically a statistical tool that depicts dependent variables on Y – Axis and Independent Variable on X – axis plotted as dots on their common intersection points. Joining these dots can highlight any existing relationship among these variables or an equation in format Y = F(X) + C, where is C is an arbitrary constant.

Very purpose of scatter Diagram is to establish a relationship between problem (overall effect) and causes that are affecting.

The relationship can be linear, curvilinear, exponential, logarithmic, quadratic, polynomial etc. Stronger the correlation, stronger the relationship will hold true. The variables can be positively or negatively related defined by the slope of equation derived from the scatter diagram.

Environment



7. Control chart

Control chart is also called as Shewhart Chart named after Walter A. Shewhart is basically a statistical chart which helps in determining if an industrial process is within control and capable to meet the customer defined specification limits.

The very purpose of control chart is to determine if the process is stable and capable within current conditions.

In Control Chart, data are plotted against time in X-axis. Control chart will always have a central line (average or mean), an upper line for the upper control limit and a lower line for the lower control limit. These lines are determined from historical data.

By comparing current data to these lines, experts can draw conclusions about whether the process variation is consistent (in control, affected by common causes of variation). We can understand if it is unpredictable (out of control, affected by special causes of variation) or not. It helps in differentiating common causes from special cause of variation.

Control charts are very popular and one can use it in Quality Control Techniques, Six Sigma (Control Phase). It also plays an important role in defining process capability and variations in productions. This tool also helps in identifying how well any manufacturing process is in line with respect to customer's expectation.

Control chart helps in predicting process performance, understand the various production patterns. Also, we can study how a process changes or shifts from normally specified control limits over a period of time.

8. Run charts are one of the most useful tools in quality improvement. They allow us to:

- Monitor the performance of one or more processes over time to detect trends, shifts or cycles.
- Compare a performance measure before and after implementation of a solution to measure its impact.
- Focus attention on truly vital changes in the process.
- Assess whether improved performance has been sustained.

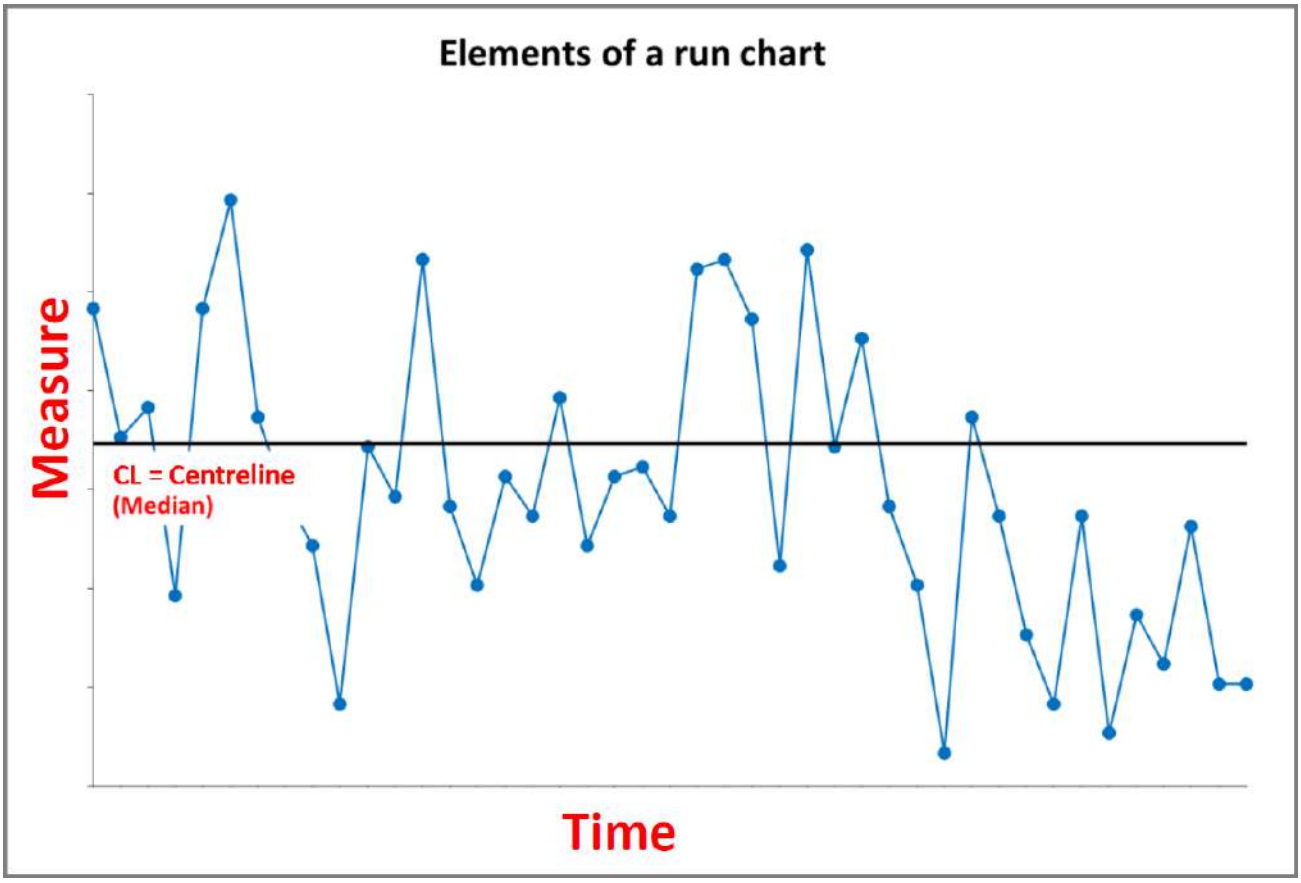
Run charts are a valuable tool at the beginning of a project, as it reveals important information about a process before you have collected enough data to create a Stewhart control chart.

Characteristics of a run chart

- On the X axis you have data in some sort of chronological order e.g. Jan, Feb, Mar
- On the Y axis you have the measure of interest e.g. %, count
- Once the data points are connected you put a center line (CL) between the graph. For a run chart the CL is called the **Median**.

The **median** is the number in the middle of the data set when the data are reordered from the highest to the lowest value. If the number of observations is even, the median is the average of the two middle values.

A Typical run chart looks like this:



An example of a typical run chart

How to create a run chart

Step 1 – State the question that the run chart will answer and obtain data necessary to answer this question.

For example, if you were looking at how long it takes to travel to work in the morning you will make note of the time taken (in minutes) to get to work over a period of a month.

Step 2 – Gather data, generally collect 10-12 data points to detect meaningful patterns.

Step 3 – Create a graph with vertical line (y axis) and a horizontal line (x axis).

On the vertical line (y axis), draw the scale related to the variable you are measuring.

Please note: it is good practice to ensure the y axis covers the full range of the measurements and then some (e.g. 1 ½ times the range of data). This is to ensure the chart can accommodate any future results.

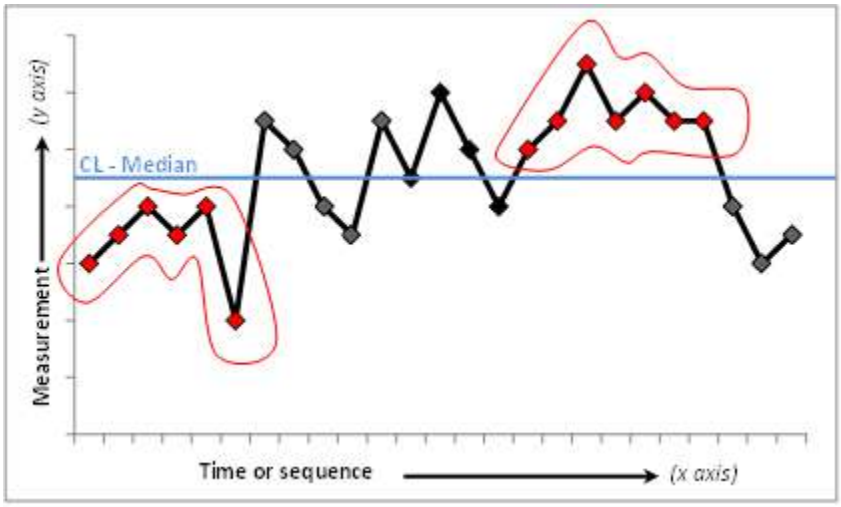
- On the horizontal line (x axis), draw the time or sequence scale.

Step 4 – Plot the data, calculate the median and include into the graph.
Step 5 – Interpret the chart. Four simple rules can be used to distinguish between random and non-random variations.

Interpreting a run chart
There are four rules that help you identify non-random variation:

Rule 1 - Shift

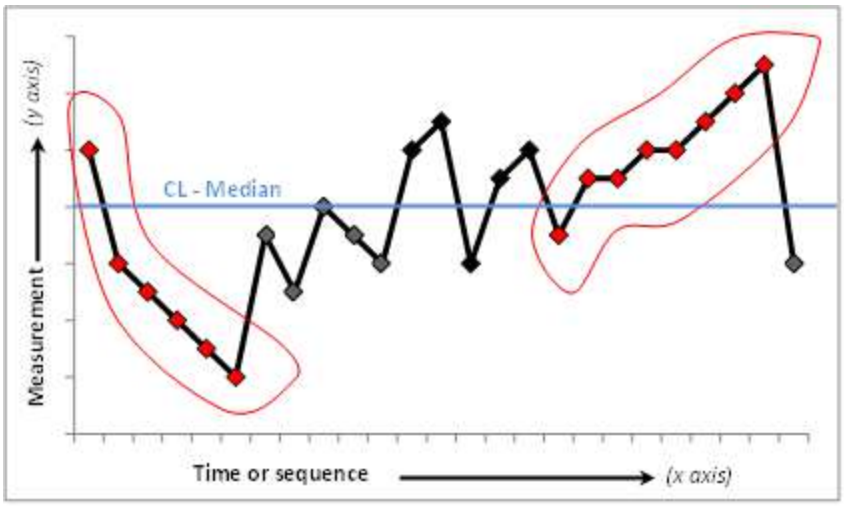
Six or more consecutive points either all above or all below the center line (CL). Values that fall on the CL do not add to nor break a shift. Skip values that fall on the median and continue counting.



Rule 1 - Shift

Rule 2 - Trend

Five or more consecutive points all going up or all going down. If the value of two or more successive points is the same (repeats), ignore the like points when counting.



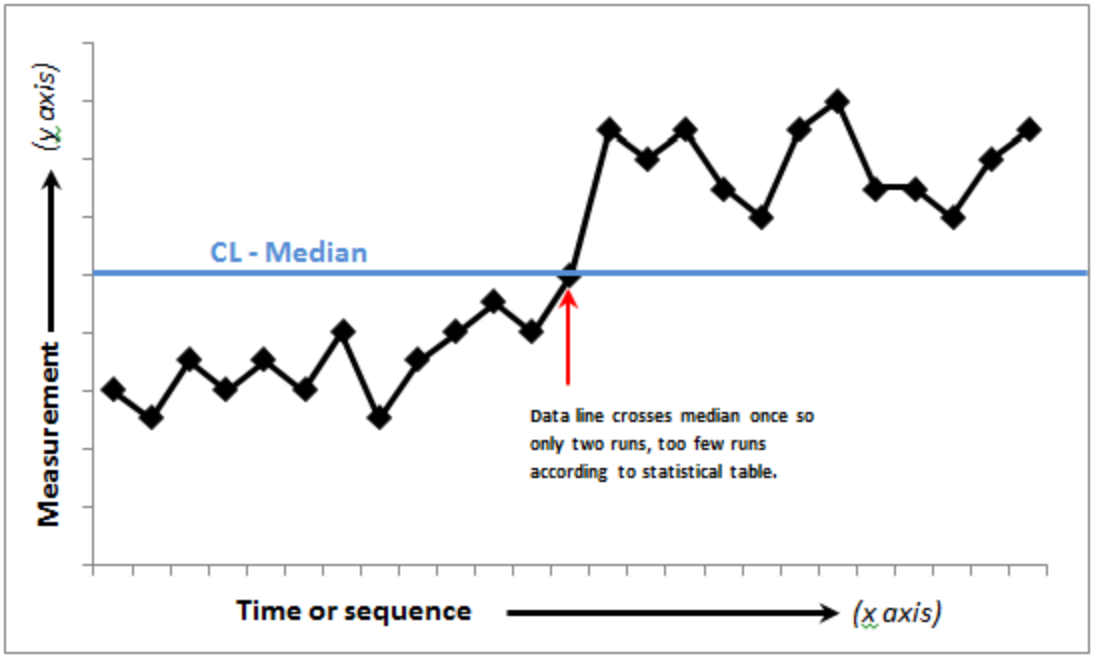
Rule 2 - Trend

Rule 3 - Too many or too few runs

A non-random pattern is signalled by too few or too many runs, or crossings of the median line. If there are too many or too few runs, this is a sign of non-random variation. To see what an appropriate number of runs for a given number of data sets, **refer to this statistical table**. An easy way to count the number of runs is to count the number of times the line connecting all the data points crosses the median and add one.

If the number of runs you have are:

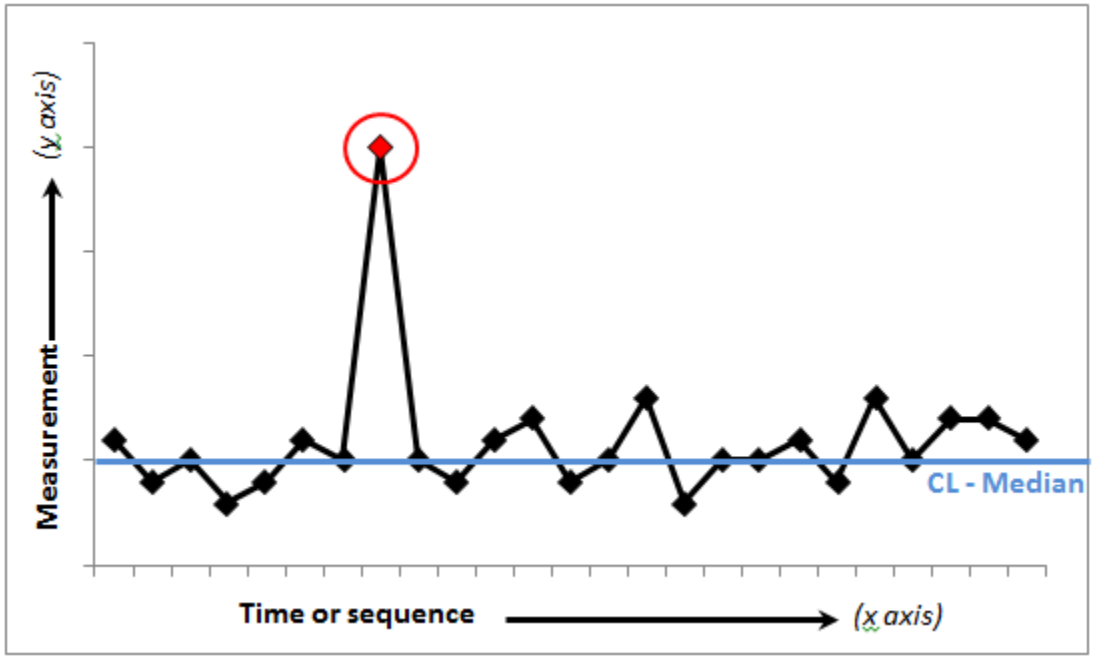
- Within the range outlined in the table, then you have a random pattern.
- Outside the range outline in the table, then you have a non-random pattern or signal of change.



Rule 3 - Too many or too few runs

Rule 4 - An astronomical data point

This is a data point that is clearly different from all others. This is a judgment call. Different people looking at the same graph would be expected to recognize the same data point as astronomical.



Rule 4 - An astronomical data point

By applying each of the four rules, you can evaluate the run chart for a signal for change (through a non-random variation). However, it is not necessary to find evidence of change with each of the four rules to determine that a change has occurred. Any single rule occurring is sufficient evidence of a non-random signal of change.

Process Capability Measurement

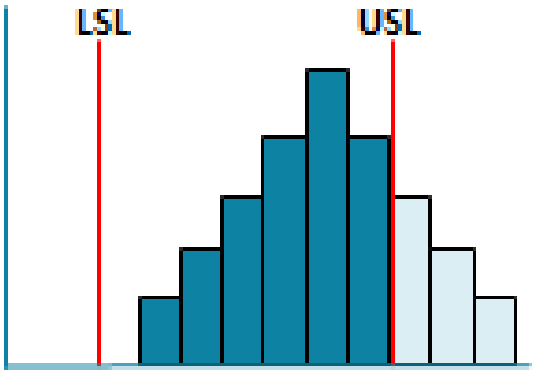
A process has been defined as a sequence of interdependent procedures, operations or steps that consume resources and convert the inputs into outputs. Each operation or step adds to the next to achieve a goal or desired result. In every process, there exists a certain amount of variation. Variation in a process cannot be eliminated, but it can be measured, monitored, reduced and controlled.

If we look at a simple example of making a cup of coffee, we can identify the inputs, steps, equipment and output of the process. Some of the inputs are coffee and water. The steps include turning on the coffee maker, measuring and adding the coffee and water and the output is a pot or cup of coffee. The variation can occur in the amount of coffee or water introduced in the process and the performance of the coffee maker itself. Not every cup of coffee is exactly the same but in most cases, if the measurements are controlled and reasonably consistent, it tastes the same. By utilizing process controls, taking measurements and using reliable, well-maintained equipment, variation in a process can have less effect on the quality of the output. The process can be capable of producing acceptable product on a consistent basis. We can maintain Process Capability.

Process capability compares the output of an *in-control* process to the specification limits by using *capability indices*. The comparison is made by forming the ratio of the spread between the process specifications (the specification "width") to the spread of the process values, as measured by 6 process standard deviation units (the process "width").

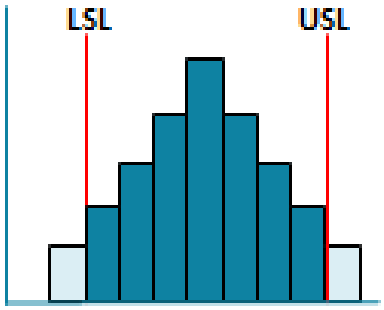
A capable process meets customer requirements 100% of the time. Customer requirements are defined using an upper specification limit (USL) and a lower specification limit (LSL). Think of these specification limits as goal posts.

Not Capable



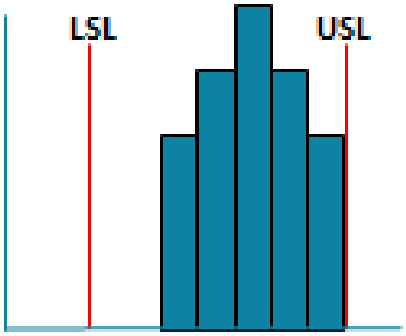
Cp < 1, Cpk <1

Centered - Does not Fit



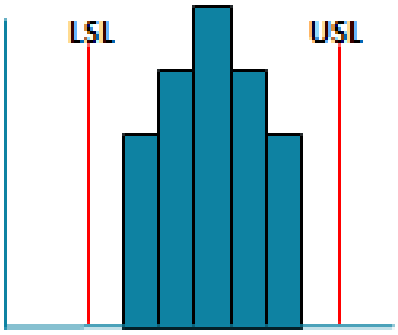
Cp < 1, Cpk >= 1

Fits Not Centered



Cp >= 1, Cpk <1

Capable



Cp >= 1, Cpk >= 1

Cp and Cpk Process Capability Metrics	
Cp	How well the data **wouldfit within** the spec limits (USL, LSL)
Cpk	How centered the data is between the spec limits.
Use Cp Cpk	When you have a **sample**, not the population, and are testing the potential capability of a process to meet customer needs.
Cp Cpk	**Formulas use Sigma estimator.**

Capability Analysis Metrics Rules of Thumb

- **Cp > 1** Process is capable (product will fit between the customer's upper and lower specification limits if the process is centered).
- **Cpk > 1** Process is capable and centered between the LSL and USL.
- If Cp = Cpk the process is centered at the midpoint of the specification limits.
- If Cp > Cpk the process is off-center.
- Cp and Cpk should be close in value to Pp and Ppk.
- If Cp and Cpk are much greater than Pp or Ppk (*33% greater*), your process may not be stable enough to conduct a capability analysis. Use control charts to evaluate the stability of your process.

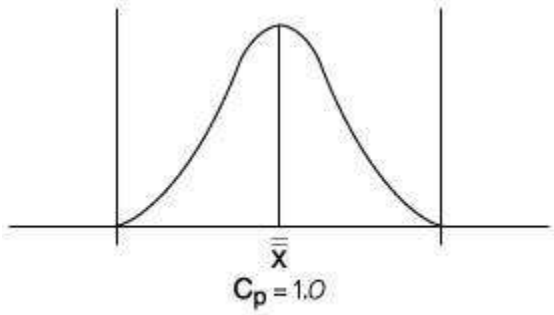
Cp is an index used to assess the width of the process spread in comparison to the width of the specification. It is calculated by dividing the allowable spread by the actual spread. The

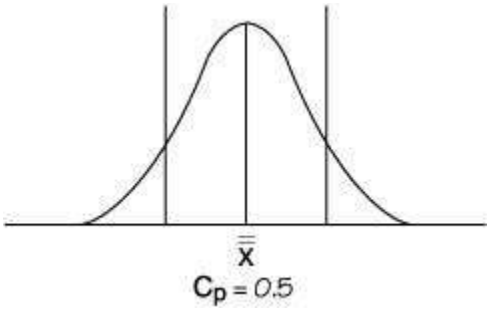
allowable spread is the difference between the upper and lower specification limits. The actual spread is 6 times the estimated standard deviation. Plus or minus 3 times the estimated standard deviation contains 99.73 percent of the data and is commonly used to describe actual spread.

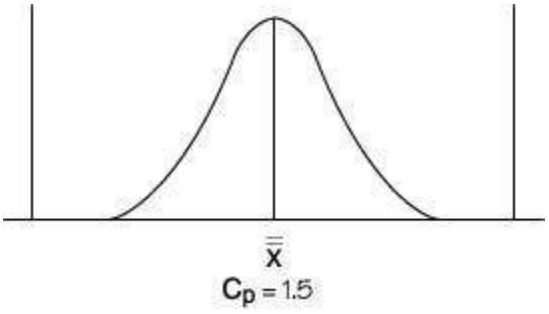
Cp for the example is:

$$C_p = \frac{USL - LSL}{6\,\hat{\sigma}} = \frac{14.00-0.00}{6 \times 2.00} = 1.17$$

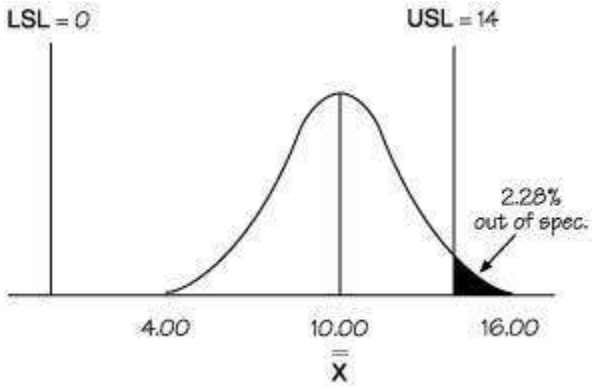
A Cp of one indicates that the width of the process and the width of the specification are the same. A Cp of less than one indicates that the process spread is greater than the specification. This means that some of the data lies outside the specification. A Cp of greater than one indicates that the process spread is less than the width of the specification. Potentially this means that the process can fit inside the specification limits. The following diagrams show this graphically.







In fact, the Cp states how many times the process can fit inside the specification. So a Cp of 1.5 means the process can fit inside the specification 1.5 times. A Cp greater than one is obviously desirable. However, the example has a Cp greater than one and yet it still has data outside the specification. This is due to the position of the overall average relative to the specification. When the overall average is away from the center of the specification, the system can still produce data outside the specification even though the Cp is greater than one, as in the example below:



To overcome this problem, Cpk was created.

Cpk takes into account the center of the data relative to the specifications, as well as the variation in the process. Cpk is simple to calculate. The smaller of the two Z values is selected. This is known as Z_{min} . When Z_{min} has been selected, it is divided by 3. The formula is:

$$Cpk = \frac{Z_{min}}{3}$$

The Z values for the example are Z_{upper} of 2.00 and Z_{lower} of 5.00, therefore Z_{min} is 2.00. Cpk for the example is:

$$Cpk = \frac{2.00}{3} = 0.67$$

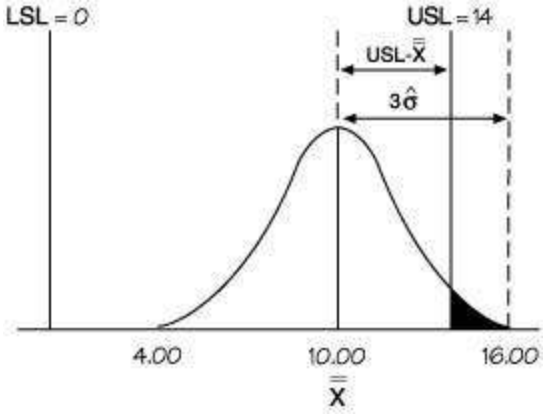
If the Cpk formula is written in full, it becomes more apparent how Cpk works.

$$Cpk = \frac{Z_{min}}{3}$$

This is the smaller of:

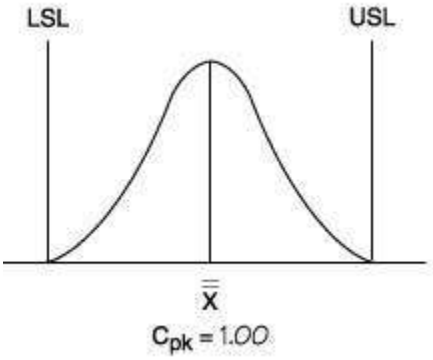
$$\frac{USL - \bar{\bar{X}}}{3\hat{\sigma}} \text{ or } \frac{\bar{\bar{X}} - LSL}{3\hat{\sigma}}$$

Graphically this can be drawn for the example as follows:



The diagram clearly shows that the overall average is too close to the upper specification. By taking the smaller of the two Z values, Cpk is always looking at the worst side, where the specification is closest to the overall average. Since it is looking only at half the picture, instead of dividing by $6\hat{\sigma}$ as in Cp, it is divided by $3\hat{\sigma}$.

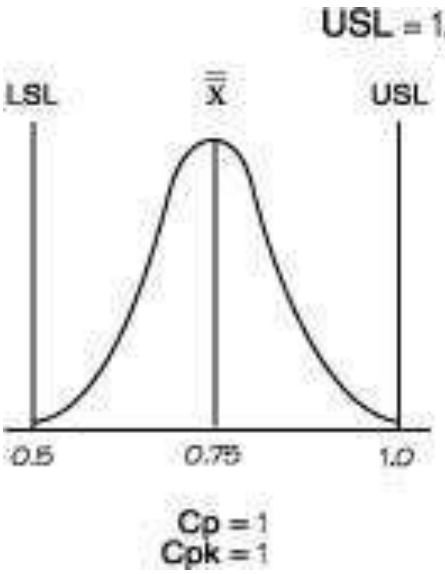
A Cpk value of one indicates that the tail of the distribution and the specification are an equal distance from the overall average, as shown below:

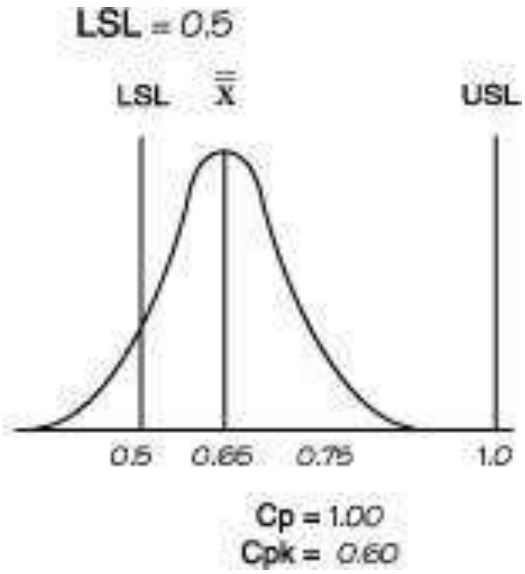


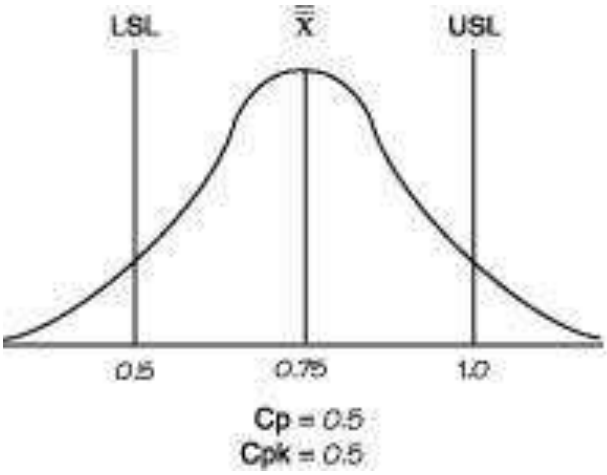
A Cpk of less than one, as in the example, means that some of the data is beyond the specification limit. A Cpk greater than one indicates that the data is within the specification. The larger the Cpk, the more central and within specification the data.

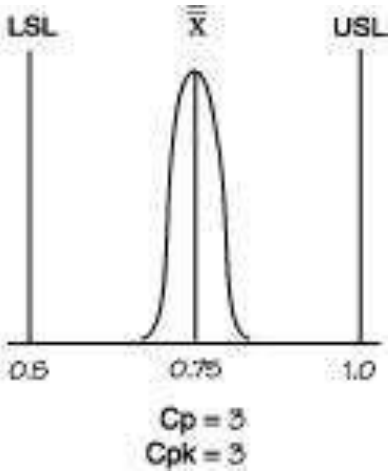
Interpretation

The Cp and Cpk indices are the primary capability indices. Cp shows whether the distribution can potentially fit inside the specification, while Cpk shows whether the overall average is centrally located. If the overall average is in the center of the specification, the Cp and Cpk values will be the same. If the Cp and Cpk values are different, the overall average is not centrally located. The larger the difference in the values, the more offset the overall average. This concept is shown graphically below.









Cpk can never exceed Cp, so Cp can be seen as the potential Cpk if the overall average is centrally set. In the example, Cp is 1.17 and Cpk is 0.67. This shows that the distribution can potentially fit within the specification. However, the overall average is currently off center. The Cpk value does not state whether the overall average is offset on the upper or lower side. It is necessary to go to the Z values to discern this. An alternative is to show the capability indices Cpu and Cpl.

Process mapping is a term used to describe any activities involved in identifying what a business or department does, who is responsible for doing it, the standards to which it should be done, and how successes will be measured. This process is used in many types of businesses to help companies streamline their production, increase profitability, reduce waste, and much more.

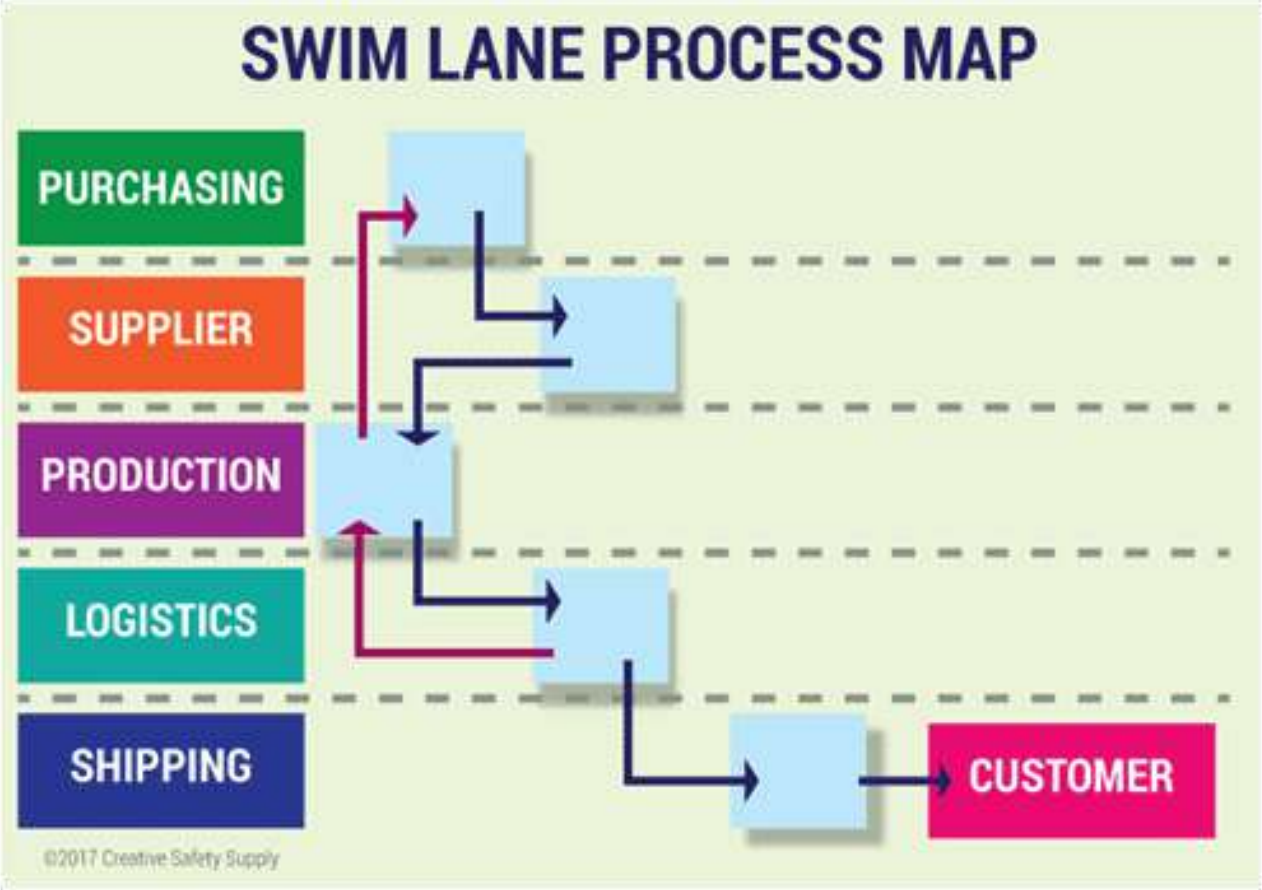
The activities used for **process mapping** are part of the overall quality management of the business. When done correctly, the process map will look at an objective and help measure it against the company's overall objectives to ensure that all work being done helps achieve the business goals. In short, anything that is not contributing to the main goals of a business is considered waste and will therefore be eliminated.

Why Process Mapping

When people think about process mapping, they often just look at it as a good way to document processes so everyone knows how things are done. While this is certainly one of the benefits of this strategy, it is not the only one. The following are some of the many reasons why business process mapping is so popular and why all businesses should put forth the effort to implement it in their facilities.

- **Training** - The process maps can be a key component of training new employees. The maps can be given to them so they can see how things should be done.
- **Problem Solving** - When there are problems in the process, it will be much easier to see exactly where they are taking place. This can help find solutions to the problems much more quickly.
- **Standardization** - Standardization is a great way to eliminate waste and ensure consistency throughout all shifts, all facilities, and anywhere else where there would otherwise be variation.
- **Big Picture** - When a good process map is in place, everyone can see the big picture. This helps each individual department, or even each employee, see where they fit into the overall scheme of things.
- **Compliance** - In industries with regulations, a process map can be used to ensure everyone is in compliance with those regulations at all times. The map itself can even be given to inspectors to show how things are done to prove compliance.
- **Team Involvement** - When creating a process map for a company, all employees need to contribute by working on the steps they are involved in. This team involvement can help keep people engaged and even identify improvement opportunities that may exist.

Examples of Application



One of the best ways to understand this concept is to look at different process mapping examples. This can illustrate how different types of businesses benefit from the strategy. These examples will also show how the Lean strategy can be used in a variety of industries to effectively improve the way things are done.

Process Mapping for Manufacturing

The manufacturing industry is one of the most common places where process mapping is used. In the auto manufacturing industry, there could be dozens or even hundreds of different processes that need to be mapped. By looking at just one of the possible maps, it is easy to see how they can be beneficial. For example, one process creates the frame of the vehicles. Each vehicle model needs a different frame, and therefore a different process.

One step in each process is ordering or acquiring the materials used for the frame. The next is melting the metals so they can be formed into the right shapes. Cooling the steel, testing it for strength, cutting out any needed areas, and positioning the frame so other parts can be added are all additional steps. Simply put, every little thing that needs to be done in the manufacturing process is one step within the process map.

Process Mapping for Restaurants

The restaurant industry would follow the same general concept where each activity within the restaurant has its own list of steps that need to be taken. This starts with the ordering of the necessary ingredients and goes through the actual recipes that need to be followed to make each dish, the plating of the dish, and finally how it is to be sent out to the table for the customers.

Each restaurant needs to have its own list of process maps to standardize the way things are done. This will help ensure everyone, no matter which shift they are on, does things the same way so they are done efficiently and so customers will always get the product they expect.

Process Mapping for the Office

In the banking industry, a process can be made for finding a new client and opening an account. This can start out with advertising to bring new potential customers into a branch. Once they enter, the bank employees go through the paperwork needed to open the account. Then any follow-up communications or other work needed to complete the process is done.

This is also a good example to show how one process map step can lead into another. Once a new savings account is opened, the process map can recommend additional services for the customers. Asking if they would be interested in transferring their retirement accounts, mortgage, or other financial services can be a great way to 'up-sell' customers. Using the process map can recommend the right products based on available information about the customers.

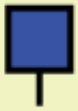
Tools & Techniques

When implementing in a facility, it can be beneficial to use specific tools. Depending on how the process mapping is being done, its complexity, and other factors, a facility can choose from many options.

A company can use pre-printed charts, which can be filled in with all the steps. This can be used either to make a complete process map or to create a rough draft before it is entered into something more advanced.

Another type of mapping tool is software that digitally creates the maps. Digital process maps have a lot of advantages since they can be easily edited and improved over time. They can also be copied and sent to other departments for further applications.

PROCESS CHART SYMBOLS

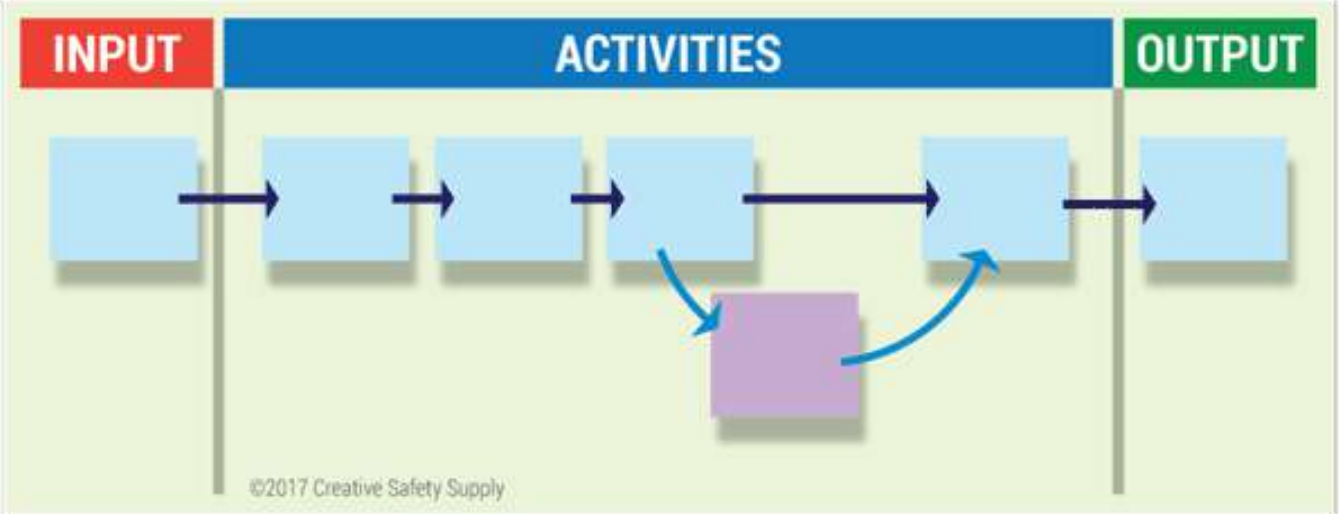
Name	Symbol	Action	Example
Operation		Adds value	 Saw, cut, paint, solder, or package
Transport		Moves some distance	 Convey, forklift, OTR truck
Inspect		Checks for defects	 Visual inspect, dimensional inspect
Delay		Temporary delay/hold	 WIP Hold, Queue
Storage		Formal warehousing	 Warehouse or tracked storage location
Handle		Transfer or sort	 Repackage, transfer to conveyor
Decide		Make a decision	 Approve/deny purchase

While there are many mapping techniques that can be used, the vast majority of them are laid out in steps. The map itself is 'written' just like normal reading, left to right, top to bottom. Shapes and symbols are used throughout the process maps to identify the different components of the map. Some examples of the components include:

- **Decision Points - If human decisions need to be made during a process, a decision point is added to the process map.**
- **Documentation - When documentation is required, the process map has a 'documentation' symbol that identifies where the documentation is located.**
- **Transport - When the product parts need to move some distance, the transport symbol needs to be used.**
- **Handle - Anytime the products need to be handled by a worker, this is the symbol that should be used.**

There are many other symbols used in process mapping. While there are no required standards that must be used across industries, there are some commonly used charts that have proven effective. The following image shows some of the most common symbols and what they are used for.

Simple Workflow Process Mapping



Workflow process mapping is often seen as an extremely complex strategy that will take a lot of time and effort to implement. While it can be as complex as is needed, many companies find it helpful to break a full process map into smaller, more manageable parts. Creating simple maps for each process in the company can be done one at a time to break it down into bite sized pieces.

The following image shows just how easy it can be to create a process map for a single process. Enter in the input on the left, fill out each of the steps necessary in the middle, and then the output on the right creates a full process map for each activity in a facility.

Benefits of Process mapping

As you are already reading about process mapping, we'd guess you know at least a few benefits of doing it. However read this section carefully as it will help you convince others!

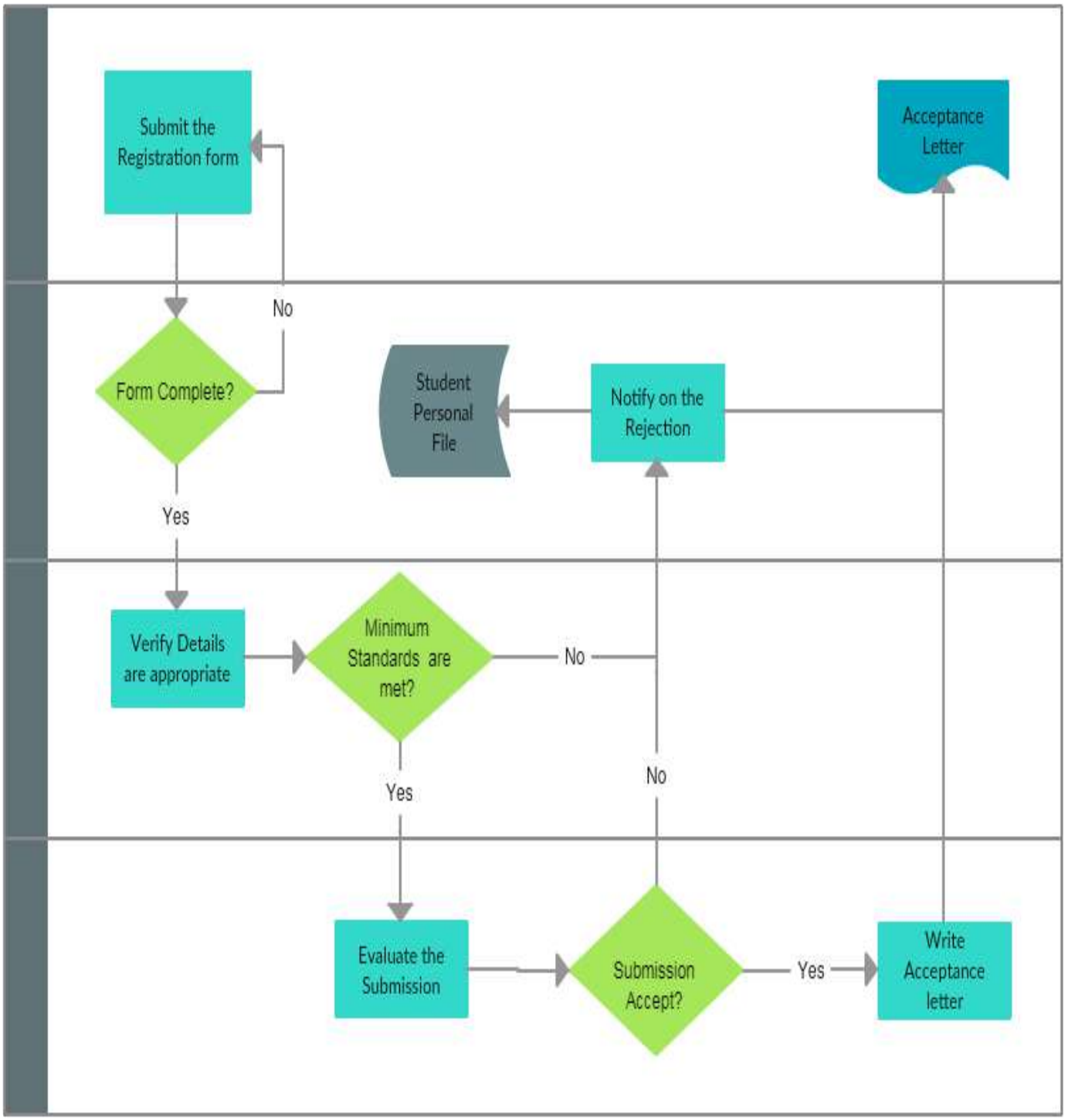
- Makes understanding and communicating the process much easier among teams, stakeholders or customers
- Serves as a useful tool for scenario testing and what-if assessments
- Can be used as a marketing tool to prove to your investors or industrial customers that your business processes are reliable
- Is a requirement of many types of standards and certification like ISO 9000

- Makes process documentation more reader-friendly
- Spread awareness of the roles and responsibilities of those who are involved
- Helps identify flaws in the process and where improvements should be made
- Aids teams brainstorm ideas for improvement or new changes that will help tackle challenges like retaining employees, declining revenue etc.
- Helps reduce costs associated with development of products and services
- Improve team performance and employee satisfaction
- Can be used as learning material to train new employees
- Helps measure the efficiency of work processes

Process Mapping Best Practices

- Before identifying the process steps, start with identifying the start and end points of the process. This helps with setting limits
- Make your process maps as easy and simple as possible to read and understand by anyone in your company
- Keep only the necessary details on your map. Not less or more than needed to identify areas for improvements
- Make sure you use the correct process map symbols when drawing to avoid confusion
- Include all the key stakeholders when mapping the process to avoid missing out on important information or steps
- Use a business process mapping software that allows you to quickly draw as well as collaborate with your team in real-time for efficiency

Template – Student Admission Process



5 whys

Introduction

Unpredicted problems may occur in any team or process. However, problems are just symptoms of deeper issues. Fixing a problem quickly may be a convenient solution, however, it doesn't protect your work process from recurring mistakes. This is why your team needs to focus on finding the root cause and tackle it properly.

The 5 Whys technique is one of the most effective tools for root cause analysis in the Lean management arsenal. Every team faces roadblocks in its daily work. However, using the 5 Whys will help you find the root cause of any problem and protect the process from recurring mistakes and failures.

Origin of 5 Whys

The 5 Whys method is part of the Toyota Production System. Developed by Sakichi Toyoda, a Japanese inventor and industrialist, the technique became an integral part of the Lean philosophy.

*"***The basis of Toyota's scientific approach is to ask why five times whenever we find a problem … By repeating why five times, the nature of the problem as well as its solution becomes clear." TaiichiOhno**

One of the key factors for successful implementation of the technique is to take an informed decision. This means that the decision-making process should be based on an insightful understanding of what is actually happening on the work floor.

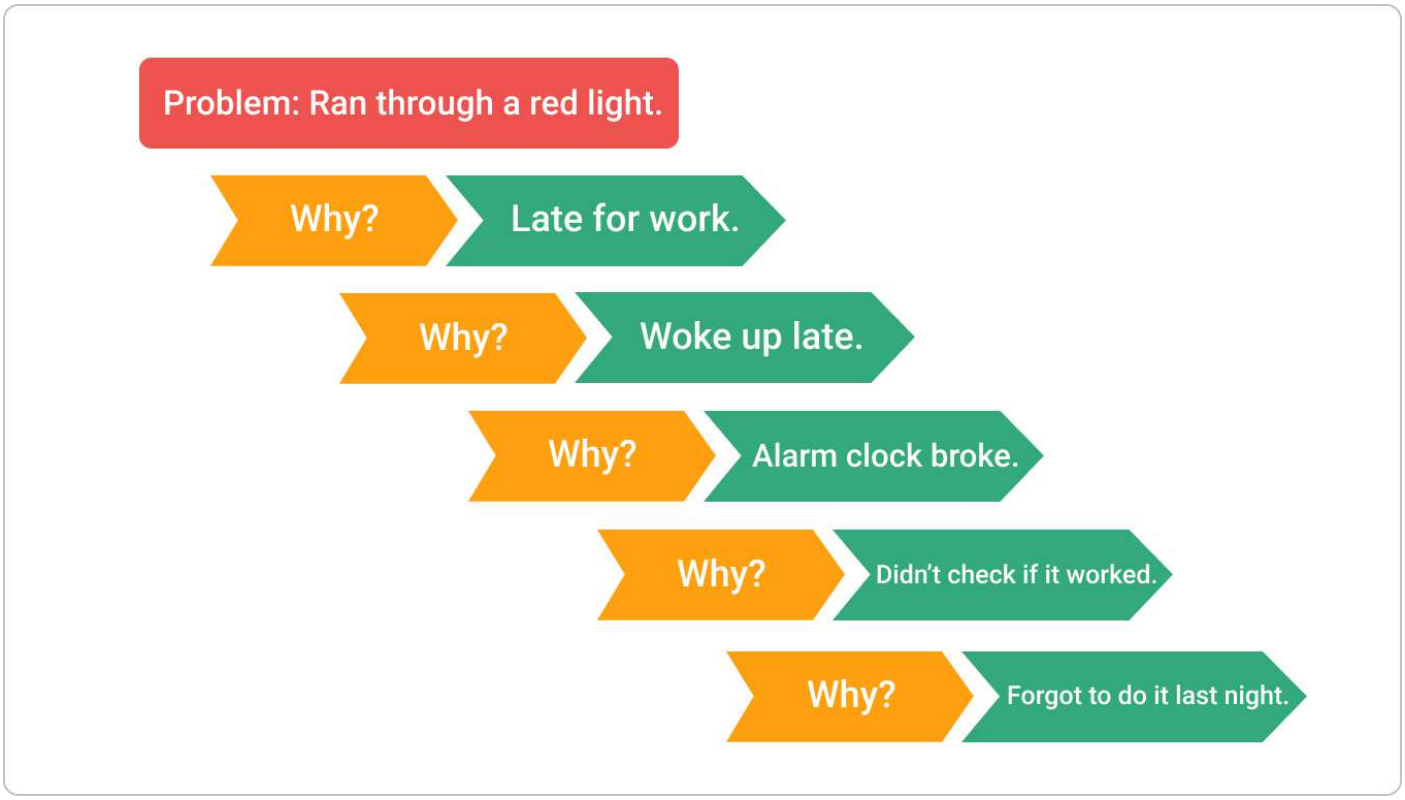
In other words, the root cause analysis process should include people with practical experience. Logically, they can give you the most valuable information regarding any problem that appears in their area of expertise.

5 Whys Analysis in Action

When applying the 5 Whys technique, you want to get to the essence of the problem and then fix it. Actually, the 5 Whys may show you that the source of the problem is quite unexpected?

Often, issues that are considered as a technical problem actually turn out to be human and process problems.

This is why finding and eliminating the root cause is crucial if you want to avoid iteration of failures.



Here is an example of applying the 5 Whys.

Problem – We didn't send the newsletter for latest software updates on time.

1. Why didn't we send the newsletter on time? Updates were not implemented until the deadline.
2. Why were the updates not implemented on time? Because the developers were still working on the new features.
3. Why were the developers still working on the new features? One of the new developers didn't know the procedures.
4. Why was the new developer unfamiliar with all procedures? He was not trained properly.
5. Why was he not trained properly? Because the CTO believes that new employees don't need thorough training and they should learn while working.

You can notice that the root cause of the initial problem turned out to be something completely different from most expectations.

Furthermore, it is obvious that it is not a technological, but a process problem. This is typical because we often focus on the product part of the problem as we neglect the human factor.

Therefore, the 5 Whys analysis has the purpose to inspect a certain problem in depth until it shows you the real cause.

Have in mind that “5” is just a number. Ask “Why” as many times as you need in order to complete the process and take appropriate actions.

How to Get Started with 5 Whys

The 5 Whys technique may help you achieve continuous improvement at any level of your organization. Here are some basics steps you need to follow.

Form a team

Try to assemble a team of people from different departments. Each representative has to be familiar with the process that is going to be investigated.

By forming a cross-functional team, you are going to receive unique points of view.

This will help you collect enough information to make an informed decision. Be aware that this is not an individual task and it needs to be executed by the team.

Define the problem

Discuss the problem with the team and make a clear problem statement. It will help you define the scope of the issue you are going to investigate.

This is important because investigating a wide scope problem may be a time-consuming exercise with blurred boundaries. Try to be as focused as possible in order to find an effective solution in the end.

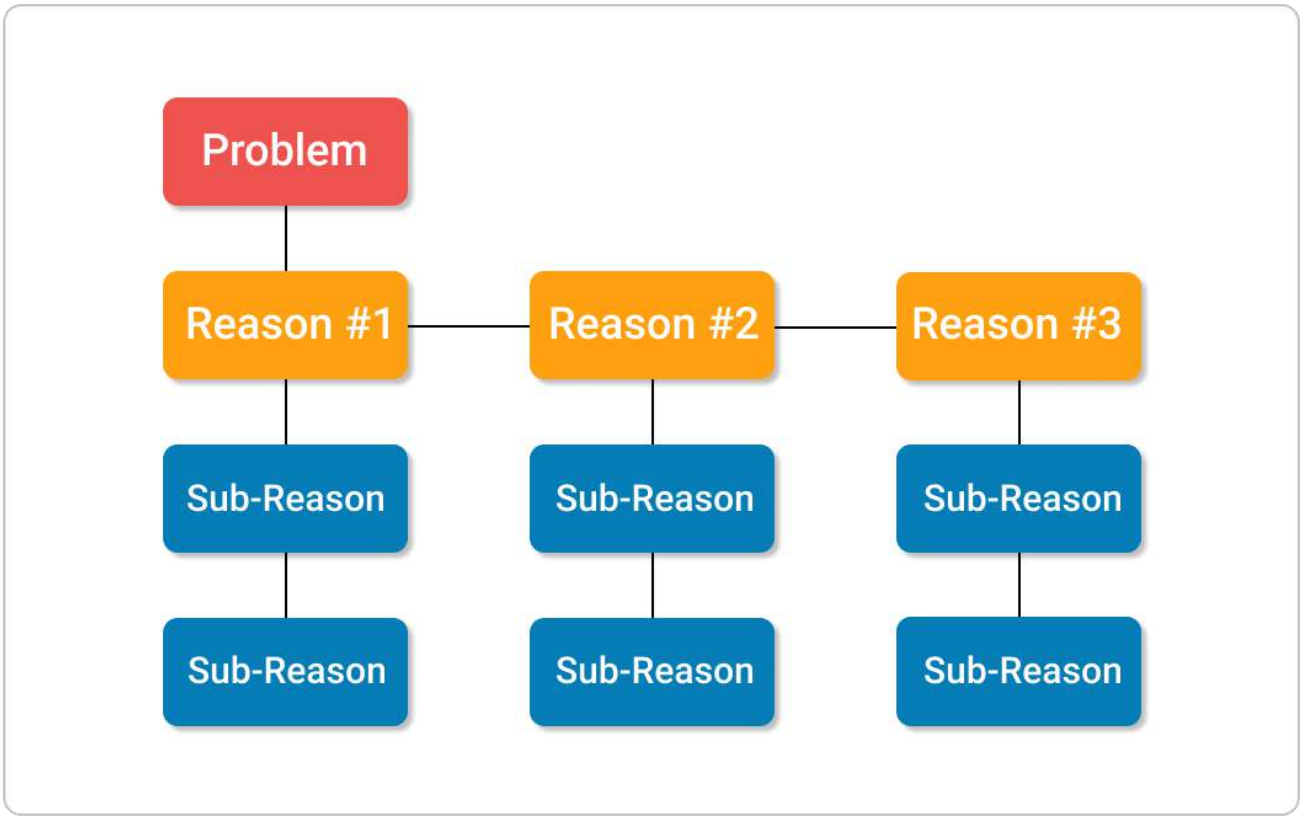
Ask Why

Empower one person to facilitate the whole process. This team leader will ask the questions and try to keep the team focused. The answers should be based on facts and real data, rather than emotional opinions.

The facilitator should ask “Why” as many times as needed until the team is able to identify the root cause of the initial problem.

Advice 1. Don’t ask too many Whys. If you keep going, you may end up receiving tons of unreasonable suggestions and complaints, which is not the purpose. Focus on finding the root cause.

Advice 2. Sometimes there could be more than one root cause. In these cases, the 5 Whys analysis will look more like a matrix with different branches. This may even help you detect and eliminate organizational issues that have permanent negative effects on the overall performance.



Take Action

After the team detects the root cause(s), it is time to take corrective actions. All members should be involved in a discussion in order to find and apply the best solution that will protect your process from recurring problems.

When the decision is made, one of the team members should be responsible for applying the right actions and observing the whole process.

After a certain period of time, the team needs to meet again and check if their actions actually had a positive impact. If not, the process should be repeated.

In the end, the case should be documented and sent across the organization. Sharing this information will give an insightful overview of different kinds of problems a team may face and how those problems can be eliminated.

Kaizen

"Kaizen" refers to a Japanese word which means "improvement" or "change for the better". **Kaizen is defined as a continuous effort by each and every employee (from the CEO to field staff) to ensure improvement of all processes and systems of a particular organization**. Work for a Japanese company and you would soon realize how much importance they give to the process of Kaizen. The process of Kaizen helps Japanese companies to outshine all other

competitors by adhering to certain set policies and rules to eliminate defects and ensure long term superior quality and eventually customer satisfaction.

Kaizen works on the following basic principle.

"*Change is for good*".

Kaizen means "continuous improvement of processes and functions of an organization through change". In a layman's language, Kaizen brings continuous small improvements in the overall processes and eventually aims towards organization's success. Japanese feel that many small continuous changes in the systems and policies bring effective results than few major changes.

Kaizen process aims at continuous improvement of processes not only in manufacturing sector but all other departments as well. Implementing Kaizen tools is not the responsibility of a single individual but involves every member who is directly associated with the organization. Every individual, irrespective of his/her designation or level in the hierarchy needs to contribute by incorporating small improvements and changes in the system.

Following are the main elements of Six Sigma:

- Teamwork
- Personal Discipline
- Improved Morale
- Quality Circles
- Suggestions for Improvement

Kaizen aims for improvements in productivity, effectiveness, safety, and waste reduction, and those who follow the approach often find a whole lot more in return:

- **Less waste** – inventory is used more efficiently as are employee skills.
- **People are more satisfied** – they have a direct impact on the way things are done.
- **Improved commitment** – team members have more of a stake in their job and are more inclined to commit to doing a good job.
- **Improved retention** – satisfied and engaged people are more likely to stay.

- **Improved competitiveness** – increases in efficiency tend to contribute to lower costs and higher quality products.
- **Improved consumer satisfaction** – coming from higher quality products with fewer faults.
- **Improved problem solving** – looking at processes from a solutions perspective allows employees to solve problems continuously.
- **Improved teams** – working together to solve problems helps build and strengthen existing teams.

The kaizen philosophy was developed to improve manufacturing processes, and it is one of the elements which led to the success of Japanese manufacturing through high quality and low costs. However, you can gain the benefits of the kaizen approach in many other working environments too, and at both a personal level or for your whole team or organization.

Much of the focus in kaizen is on reducing "waste" and this waste takes several forms:

- **Movement** – moving materials around before further value can be added to them.
- **Time** – spent waiting (no value is being added during this time).
- **Defects** – which require re-work or have to be thrown away.
- **Over-processing** – doing more to the product than is necessary to give the "customer" maximum value for money.
- **Variations** – producing bespoke solutions where a standard one will work just as well.

Five S of Kaizen

“Five S” of Kaizen is a systematic approach which leads to foolproof systems, standard policies, rules and regulations to give rise to a healthy work culture at the organization. You would hardly find an individual representing a Japanese company unhappy or dissatisfied. Japanese employees never speak ill about their organization. Yes, the process of Kaizen plays an important role in employee satisfaction and customer satisfaction through small continuous changes and eliminating defects. Kaizen tools give rise to a well-organized workplace which results in better productivity and yield better results. It also leads to employees who strongly feel attached towards the organization.

Let us understand the five S in Detail:

1. **SEIRI -** SEIRI stands for Sort Out. According to Seiri, employees should sort out and organize things well. Label the items as “Necessary”, ”Critical”, ”Most Important”, “Not needed now”, “Useless and so on. Throw what all is useless. Keep aside what all is not needed at the moment. Items which are critical and most important should be kept at a safe place.
2. **SEITION -** Seition means to organize. Research says that employees waste half of their precious time searching for items and important documents. Every item should have its own space and must be kept at its place only.

3. **SEISO -** The word "SEISO" means shine the workplace. The workplace ought to be kept clean. De-clutter your workstation. Necessary documents should be kept in proper folders and files. Use cabinets and drawers to store your items.
4. **SEIKETSU-SEIKETSU** refers to Standardization. Every organization needs to have certain standard rules and set policies to ensure superior quality.
5. **SHITSUKE or Self Discipline -** Employees need to respect organization's policies and adhere to rules and regulations. Self-discipline is essential. Do not attend office in casuals. Follow work procedures and do not forget to carry your identity cards to work. It gives you a sense of pride and respect for the organization.

Kaizen focuses on continuous small improvements and thus gives immediate results.

Just-in-time manufacturing was a concept introduced to the United States by the Ford motor company. It works on a demand-pull basis, contrary to hitherto used techniques, which worked on a production-push basis.

To elaborate further, under just-in-time manufacturing (colloquially referred to as JIT production systems), actual orders dictate what should be manufactured, so that the exact quantity is produced at the exact time that is required.

Just-in-time manufacturing goes hand in hand with concepts such as Kanban, continuous improvement and total quality management (TQM).

Just-in-time production requires intricate planning in terms of procurement policies and the manufacturing process if its implementation is to be a success.

Highly advanced technological support systems provide the necessary back-up that Just-in-time manufacturing demands with production scheduling software and electronic data interchange being the most sought after.

Advantages Just-In-Time Systems

Following are the advantages of Adopting Just-In-Time Manufacturing Systems

- Just-in-time manufacturing keeps stock holding costs to a bare minimum. The release of storage space results in better utilization of space and thereby bears a favorable impact on the rent paid and on any insurance premiums that would otherwise need to be made.
- Just-in-time manufacturing eliminates waste, as out-of-date or expired products; do not enter into this equation at all.
- As under this technique, only essential stocks are obtained, less working capital is required to finance procurement. Here, a minimum re-order level is set, and only once that mark is reached, fresh stocks are ordered making this a boon to inventory management too.
- Due to the aforementioned low level of stocks held, the organizations return on investment (referred to as ROI, in management parlance) would generally be high.

- As just-in-time production works on a demand-pull basis, all goods made would be sold, and thus it incorporates changes in demand with surprising ease. This makes it especially appealing today, where the market demand is volatile and somewhat unpredictable.
- Just-in-time manufacturing encourages the 'right first time' concept, so that inspection costs and cost of rework is minimized.
- High quality products and greater efficiency can be derived from following a just-in-time production system.
- Close relationships are fostered along the production chain under a just-in-time manufacturing system.
- Constant communication with the customer results in high customer satisfaction.
- Overproduction is eliminated when just-in-time manufacturing is adopted.

Disadvantages

Following are the disadvantages of Adopting Just-In-Time Manufacturing Systems

- Just-in-time manufacturing provides zero tolerance for mistakes, as it makes re-working very difficult in practice, as inventory is kept to a bare minimum.
- There is a high reliance on suppliers, whose performance is generally outside the purview of the manufacturer.
- Due to there being no buffers for delays, production downtime and line idling can occur which would bear a detrimental effect on finances and on the equilibrium of the production process.
- The organization would not be able to meet an unexpected increase in orders due to the fact that there are no excess finish goods.
- Transaction costs would be relatively high as frequent transactions would be made.
- Just-in-time manufacturing may have certain detrimental effects on the environment due to the frequent deliveries that would result in increased use of transportation, which in turn would consume more fossil fuels.

Precautions

Following are the things to Remember When Implementing a Just-In-Time Manufacturing System

- Management buy-in and support at all levels of the organization are required; if a just-in-time manufacturing system is to be successfully adopted.
- Adequate resources should be allocated, so as to obtain technologically advanced software that is generally required if a just-in-time system is to be a success.
- Building a close, trusting relationship with reputed and time-tested suppliers will minimize unexpected delays in the receipt of inventory.
- Just-in-time manufacturing cannot be adopted overnight. It requires commitment in terms of time and adjustments to corporate culture would be required, as it is starkly different to traditional production processes.
- The design flow process needs to be redesigned and layouts need to be re-formatted, so as to incorporate just-in-time manufacturing.

- Lot sizes need to be minimized.
- Workstation capacity should be balanced whenever possible.
- Preventive maintenance should be carried out, so as to minimize machine breakdowns.
- Set-up times should be reduced wherever possible.
- Quality enhancement programs should be adopted, so that total quality control practices can be adopted.
- Reduction in lead times and frequent deliveries should be incorporated.
- Motion waste should be minimized, so the incorporation of conveyor belts might prove to be a good idea when implementing a just-in-time manufacturing system.

Conclusion

Just-in-time manufacturing is a philosophy that has been successfully implemented in many manufacturing organizations.

It is an optimal system that reduces inventory whilst being increasingly responsive to customer needs, this is not to say that it is not without its pitfalls.

However, these disadvantages can be overcome with a little forethought and a lot of commitment at all levels of the organization.

Meaning of Quality Circles:

Conceptually Quality Circles can be described as a small group of employees of the same work area, doing similar work that meets voluntarily and regularly to identify, analyse and resolve work related problems.

This small group with every member of the circle participating to the full carries on the activities, utilizing problem solving techniques to achieve control or improvement in the work area and also help self and mutual development in the process.

The concept of the Quality Circle is based on “respect for the human individual” as against the traditional assumption based on suspicion and mistrust between management and its employees.

Quality circles built mutual trust and create greater understanding between the management and the workers. Cooperation and not confrontation is the key element in its operation. Quality Circles aims at building people, developing them, arousing genuine interest and dedication to their work to improve quality, productivity, cost reduction etc.

Thus we can say that a quality circle is a group of 5 to 8 employees performing similar work, who volunteer themselves to meet regularly, to identify the cause of their on-the-job problems, employ advanced problem-solving techniques to reach solutions and implement them.

The concept is based on the premise that the people who do a job everyday know more about it than anyone else and hence their voluntary involvement is the best way to solve their work related problems.

The Quality Circle concept provides an opportunity to the circle members to use their wisdom, creativity and experience in bringing about improvements in the work they are engaged in by converting the challenging problems into opportunities and it contributes to the development of the employees and in turn benefits the organization as well. The concept encourages the sense of belongingness in circle members and they feel that they have an important role to play in the organization.

Characteristics of Effective Quality Circles:

1. The atmosphere should be informal, comfortable and relaxed. The members should feel involved and interested.

2. Everyone should participate.

3. The objectives should be clear to the members.

4. The members should listen to each other.

5. The group should feel comfortable even when there are disagreements.

6. The decisions should generally be taken by a kind of consensus and voting should be minimum.

7. When an action is required to be taken, clear assignments should be made and accepted by all the members.

8. The leader should not dominate the group. The main idea should not be as to who controls but how to get the job done.

9. Until a final solution is found and results are attained feedback is necessary.

Objectives of Quality Circles:

Some of the broad objectives of the Quality Circle are:

(i) To improve quality, productivity, safety and cost reduction.

(ii) To give chance to the employees to use their wisdom and creativity.

(iii) To encourage team spirit, cohesive culture among different levels and sections of the employees.

(iv) To promote self and mutual development including leadership quality,

(v) To fulfill the self-esteem and motivational needs of employees.

(vi) To improve the quality of work-life of employees.

Implementation of Quality Circles in an Organization:

For the success of Quality Circle programme, following actions are necessary in the Organization:

(a) Few managers representing production, quality control, design, process planning form the Quality Circle (Q.C.) steering committee. This acts as a policy making body and will monitor the Q.C. in the Organization.

(b) Top management must attend the orientation courses designed for them.

(c) A committed top and middle management is necessary.

(d) A facilitator must be appointed, who serves as a link between top management, Q.C., steering committee, middle management circle leaders and circle members. Facilitator will coordinate training courses; get the support from all concerned including top management Q.C., steering committee, circle leader and circle members to help the circle leader in conducting the meetings, and to provide necessary resources.

Organization and Working of Quality Circles*:*

Q.C. was conceived in Japan in 1962 as a forum for training its work force for improving the quality of products. Q.C. is a voluntary one. Employees are free to join or not to join. In it, 8 to 10 employees including the Supervisor from same workshop doing similar work join together as a group. The Supervisor can become leader of the group, if the members of Q.C. so desire.

It is a part time activity; members of Q.C. are allowed to meet for an hour every week. During the various meetings, these groups progressively identify, select, analyse and solve the problems. Later they offer their proposed solutions to management for consideration, approval and implementation.

Additionally a senior officer from same workshop is nominated as facilitator who guides the activities of the group.

A Management Committee at senior level is also formed, which overview the progress of Quality Circles.

Training of members, leaders and facilitators is very important for the success of programme.

Rules for Quality Circles:

(a) Each member can contribute an idea on his turn in rotation.

(b) Each member offers only one idea per turn regardless of how many he or she has in mind.

(c) Not everyone has an idea during each rotation, when this occurs just say “Pass”.

(d) No criticism or comments should be passed on the ideas being contributed by the member whatever old it may look to be, welcome their ideas.

(e) During brain-storming, no evaluation of suggested idea should occur. This applies equally to leader, phrases such as “We have tried it before”, “Impractical”, “Well” “May be it would work”. “Doubtful”, “Very good” etc. should not be uttered.

(f) Members can vote by raising their hands.

(g) Only supporting votes are taken. Votes against the ideas are not allowed.

(h) The time allotted for brain-storming session should be variable. The length of time that can be spent profitably will vary widely with nature of problem and the group itself. As a general practice, one hour is probably the minimum.

(i) While members give their ideas, they are recorded by the Recorder on a large sheet.

(j) It is often helpful to set a goal originally, i.e. Let us start for 30 ideas.

(k) When all members say “pass” then the first phase of brain-storming session is over. This means all ideas have been exhausted.

(l) Now all the ideas recorded on the sheet are displayed.

(m) These massive number of ideas are then narrowed down by the process of voting. The voting technique works because the members are experts in their areas. Members vote on each idea. The leader records each vote next to the idea.

(n) Members can vote for as many ideas as they feel have value. Only supporting votes are taken.

(o) Leader draws a circle around those ideas that receive the most votes. The members thus find that many of the top ideas will be so identified.

(p) Now the members can focus on a few important ideas instead of being somewhat confused by a large number of them. These few important ideas are voted on to give ranking to the circle ideas. Leader writes the ranking number beside each idea that has been circled.

(q) A member can ask for voting on any idea and argue for or against it. Others can join, if they wish. Only when the discussion has finished then the voting take place.

Idea ranked in the session can then be taken up for analysis or solution later on.

Duties of Circle Leader:

For the success of Quality Circles, circle leader must have following duties:

(i) He must assume the responsibility of guiding the members.

(ii) He must make his members sure about what is going on.

(iii) He must channelize the discussions.

(iv) Every member is allowed equal opportunity.

(v) Specific task be assigned to each member.

(vi) He must work in coordination with facilitator.

Steps for Setting up Quality Circles:

For starting Quality Circles in an organization, following steps should be taken:

(i) First of all Managers, Supervisors and Foremen must be made to understand the concepts and activities of Q.C.

(ii) Management's total support and commitment should be made known to everyone in the organization.

(iii) Steering committee is formed with the top management personnel to give direction to Quality Circle activities.

(iv) A facilitator (or sometimes known as promoter) is selected from the senior management level, who will serve as coordinator and advisor to the circle.

(v) Supervisor and foreman are then trained to act as Q.C. leaders.

(vi) Members of each circle must be selected from the persons who are doing similar type of work or belong to the same department or section.

(vii) Membership to the circle is voluntary.

(viii) First few meetings of the circle are held with a view to train them.

(ix) To start with, only one to two circles should be formed in an organization, and then increase the number gradually as more and more experience is gained.

(x) Meetings must be held regularly, may be once in a week initially and once in a month on completion of basic training of members.

(xi) Everyone's suggestion or problem matching with the circle's objectives is discussed.

(xii) Total participation of team members must be encouraged.

(xiii) Recommendations of the circle must be considered and decisions should be taken without delay.

Benefits of Quality Circles (Q.C.):

1. Through the forum of Q.C. the chronic problems-of organizations which really create hurdles in work get resolved by the grass root employees of organization, whose knowledge and experience otherwise is not fully utilized.

2. With such a capable work force, any organization can easily undertake more difficult and challenging assignments for its growth and profit.

3. As the employees gain experience they take more challenging projects, in due course they undertake projects on cost reduction, material handling, quality improvement, preventing wastage, improving delivery schedule, improving customer service, improving inspection and test methods, preventing accidents improving design and process etc.

4. Cost reduction.

5. Increased productivity.

6. Improved quality.

7. Better communication.

8. Better house-keeping.

9. Increased team work.

10. Smooth working.

11. Better mutual trust.

12. Greater sense of belongingness.

13. Increased safety.

14. Better human relations.

Launching of Quality Circle Programme*:*

The typical steps for launching programme are as under:

(i) Orientation Programme for Senior Management Personnel.

(ii) Orientation Programme for Managers and Executives.

(iii) Orientation Programme for Selected Supervisors.

(iv) Orientation Programme for Workers (selected area).

(v) Formation of Circles (Minimum 2 and Maximum 4).

(vi) Training of Facilitators.

(vii) Training of Leaders.

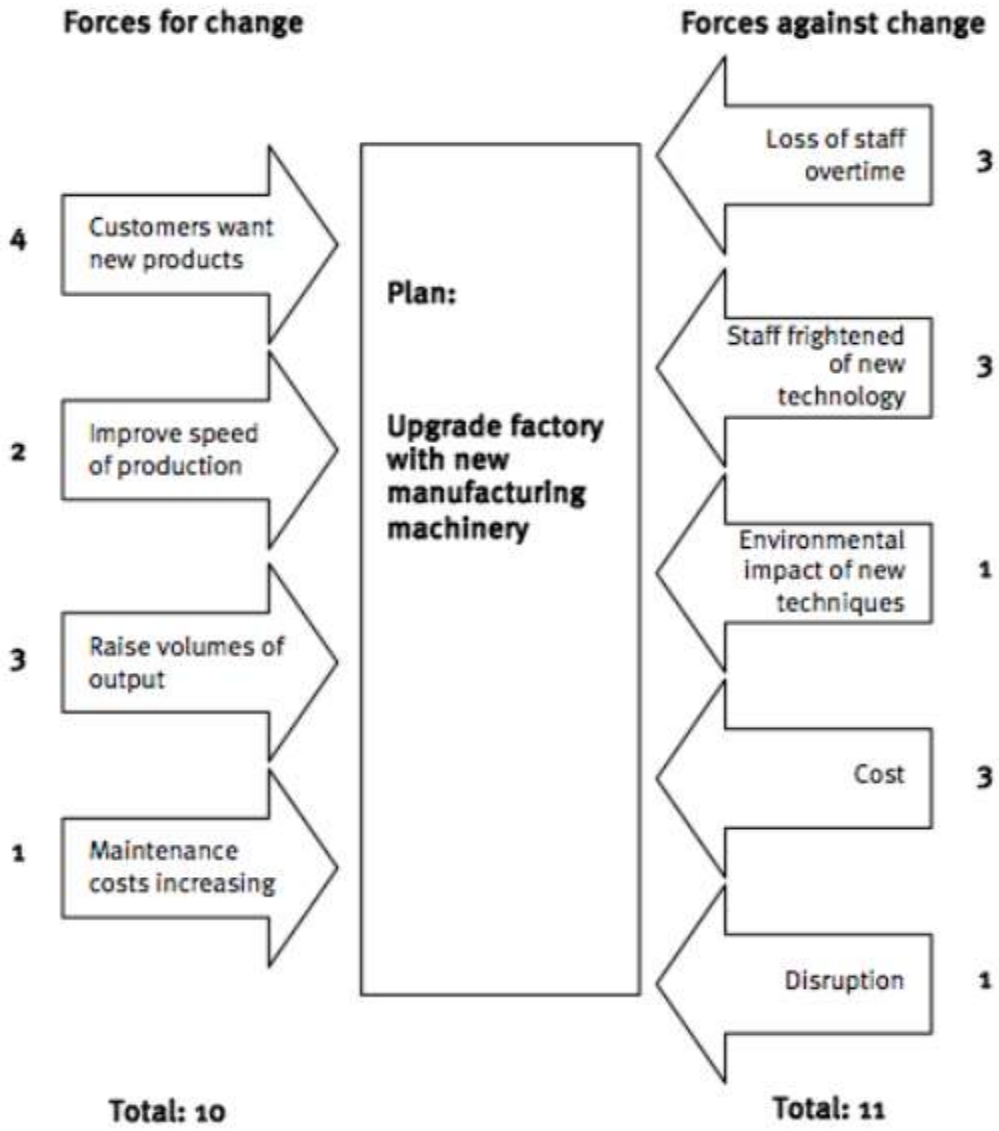
(viii) Q.C. meetings for projects.

Force field Analysis

Force Field Analysis was developed by Kurt Lewin (1951) and is widely used to inform decision making, particularly in planning and implementing change management programmes in organizations.

It is a powerful method of gaining a comprehensive overview of the different forces acting on a potential organizational change issue, and for assessing their source and strength.

Force field analysis is best carried out in small group of about six to eight people using flipchart paper or overhead transparencies so that everyone can see what is going on. The first step is to agree the area of change to be discussed. This might be written as a desired policy goal or objective. All the forces in support of the change are then listed in a column to the left (driving the change forward), whereas all forces working against the change are listed in a column to the right (holding it back). The driving and restraining forces should be sorted around common themes and then be scored according to their 'magnitude', ranging from one (weak) to five (strong). The score may well not balance on either side. The resulting table might look like the example above.



Throughout the process, rich discussion, debate and dialogue should emerge. This is an important part of the exercise and key issues should be allowed time. Findings and ideas may well come up to do with concerns, problems, symptoms and solutions. It is useful to record these and review where there is consensus on an action or a way forward. In policy influencing, the aim is to find ways to reduce the restraining forces and to capitalize on the driving forces.

In force field analysis change, is characterized as a state of imbalance between driving forces (e.g. new personnel, changing markets, new technology) and restraining forces (e.g. individuals' fear of failure, organizational inertia). To achieve change towards a goal or vision three steps are required:

- First, an organization has to unfreeze the driving and restraining forces that hold it in a state of quasi-equilibrium.
- Second, an imbalance is introduced to the forces to enable the change to take place. This can be achieved by increasing the drivers, reducing the restraints or both.
- Third, once the change is complete the forces are brought back into quasi-equilibrium and re-frozen.

Advantages of Force Field Analysis

1. On A Force Field Analysis provides a visual summary of various forces for and against a particular change, with all the information that has been collected regarding a potential decision into a single graph.

2. Force Field Analysis help us identify obstacles that lie ahead so that we can make a plan to strengthen the forces supporting the decision and take actions to reduce or avoid the forces preventing it.

3. A Force Field Analysis Diagram can be used as a visual aid, and it will help simplify communication among the staff and to break down communication barriers.

4. A Force Field Analysis diagram can assist the group to develop a common understanding of the subject, and all the group's members will have a clear concept of the opinions and the options related to the situation.

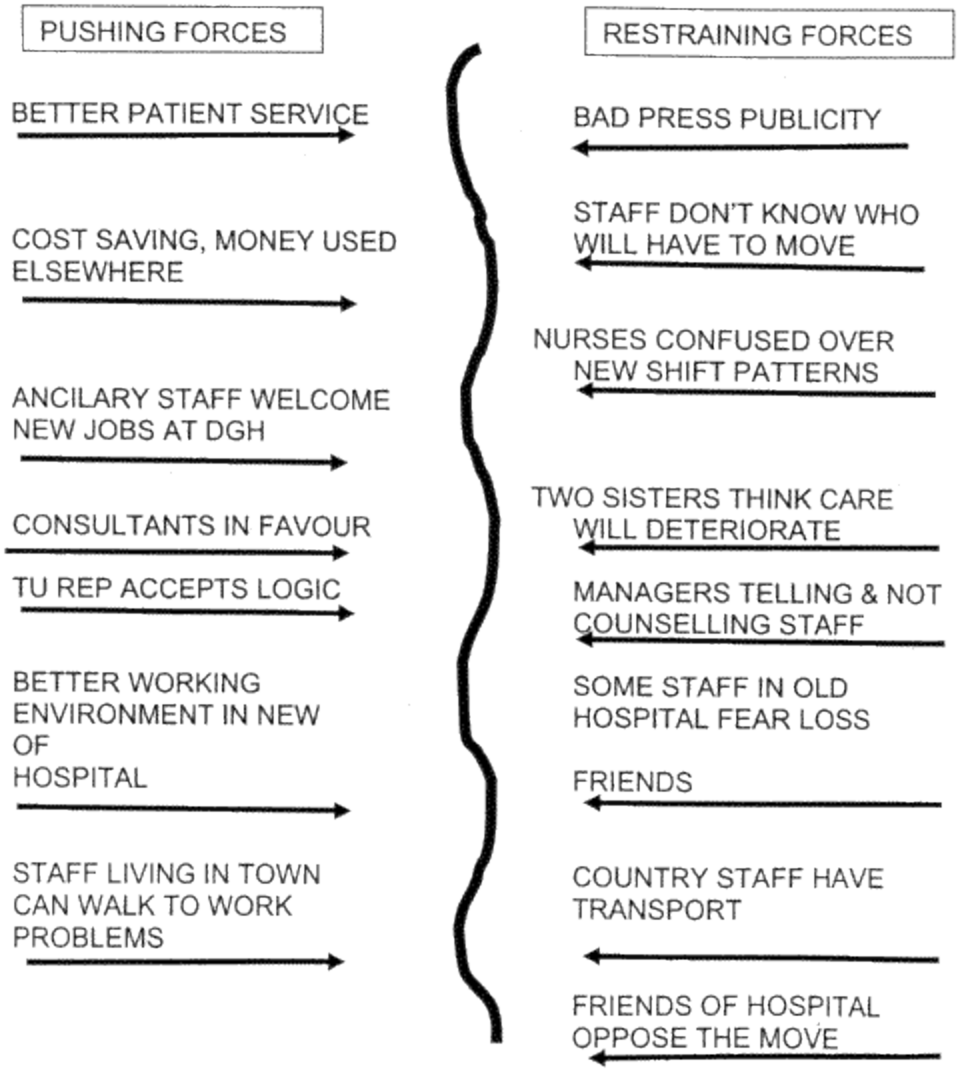
Disadvantages of Force Field Analysis

1. Force field analysis requires every group member to participate so that they can have all the information needed for a better analysis, which can be difficult to achieve.

2. Unlike other methods, when full participation isn't possible, it would be difficult to provide a complete picture of the driving forces and restraining forces.

3. Another potential problem is that Force Field Analysis may have a bad influence on team work. Because a force field analysis may lead to a division in the group between those who support the change and those who are against the change.

EXAMPLE: Closure of a small cottage hospital and transfer of patients and staff to the new District General Hospital



Actions

- Invite the editor of the local paper to visit both facilities
- Run a "training workshop" for all the first line managers, spell out the need for them to talk over the problems of moving with each member of their staff. Provide information pack for these managers. Include skills training on positive listening and later collect feedback from them in order to plan general response.
- Provide access to a more expert neutral counsellor, once a week, so that individuals can work through their individual problems arising from the move.
- Clinical nurse manager to work with the two reluctant sisters to identify their concerns and plan to resolve them.
- Establish a small working party (DNS, DPO, Clinical Nurse Manager, and Sister, Staff Nurse) to examine options for nursing shift systems and report back, in first instance to UMG.
- Use managers to identify transport problems of any individual, spell out policy on temporary payments.

A Gantt chart, commonly used in project management, is one of the most popular and useful ways of showing activities (tasks or events) displayed against time. On the left of the chart is a list of the activities and along the top is a suitable time scale. Each activity is represented by a bar; the position and length of the bar reflects the start date, duration and end date of the activity. This allows you to see at a glance:

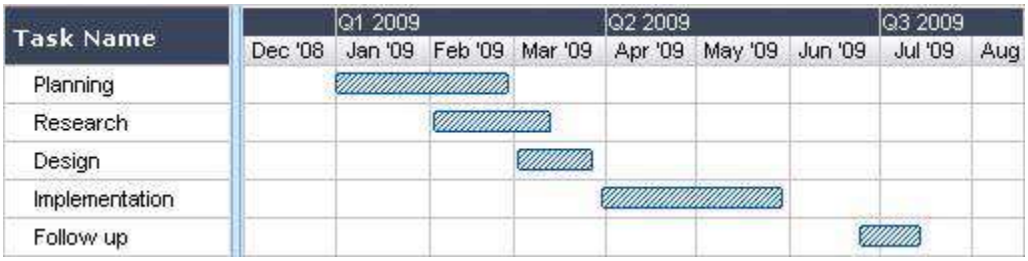
- What the various activities are
- When each activity begins and ends
- How long each activity is scheduled to last
- Where activities overlap with other activities, and by how much
- The start and end date of the whole project

Gantt charts provide a way to track and manage project timelines, progress, and deliverables. Vertical lines or bars are used to visualize each task, and each Gantt chart includes resources, milestones, tasks, and dependencies.

- **Resources:** Project managers must have insight into what resources are needed for tasks outlined in a Gantt chart, in order for each to be completed on time.
- **Milestones:** Along your timeline, there will likely be milestones, both small and large, that must be hit in order to keep your project on track. A milestone for a blog launch might be, **"Blog post draft due on 5/30."**
- **Tasks:** There are specific things that need to be completed along the way of your project. In our blog post example, a task might be, **"Edit blog post."**
- **Dependencies:** Tasks on your Gantt chart will be related to each other, for example, the editor won't be able to complete her task of editing the blog post until the writer has met their milestone and submitted their draft on 5/30. These are dependencies and should be noted in your chart.

The main goal of a Gantt chart is to track the timeline and completion of a project. It's especially helpful for project managers who need to keep team momentum going on campaigns with many moving parts, like product launches or marketing events.

To summarize, a Gantt chart shows you what has to be done (the activities) and when (the schedule).



A simple Gantt chart

Gantt chart History

The first Gantt chart was devised in the mid-1890s by Karol Adamiecki, a Polish engineer who ran a steelworks in southern Poland and had become interested in management ideas and techniques.

Some 15 years after Adamiecki, Henry Gantt, an American engineer and project management consultant, devised his own version of the chart and it was this that became widely known and popular in western countries. Consequently, it was Henry Gantt whose name was to become associated with charts of this type.

Originally Gantt charts were prepared laboriously by hand; each time a project changed it was necessary to amend or redraw the chart and this limited their usefulness, continual change being a feature of most projects. Nowadays, however, with the advent of computers and project management software, Gantt charts can be created, updated and printed easily.

Today, Gantt charts are most commonly used for tracking project schedules. For this it is useful to be able to show additional information about the various tasks or phases of the project, for example how the tasks relate to each other, how far each task has progressed, what resources are being used for each task and so on.

Activity Network Diagram

The **Activity Network Diagram** is a tool used by Project Managers to indicate the project activities and sequential relationships. The purpose is to identify the boundaries for the best case, worst case, and most likely project finish time (critical path). Moreover, to identify the critical path activities that have the most bearing on project completion.

Some tasks can occur simultaneously (in parallel) and others must take place only when other(s) are completed first (in series). Some activities may need to be only partially completed to allow another one to begin.

Example

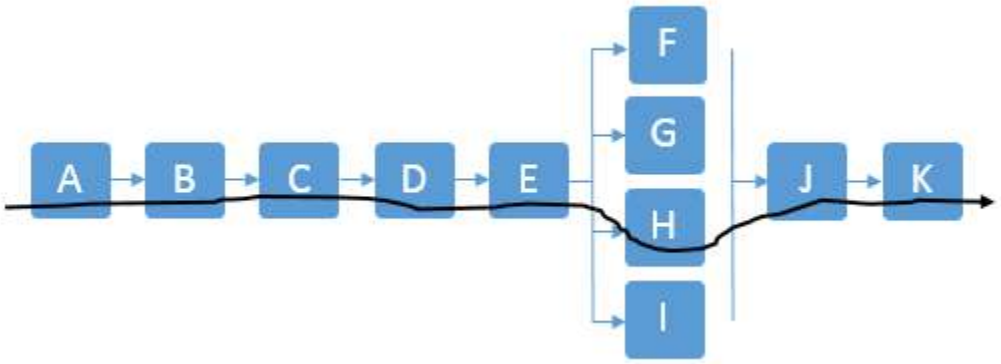
A newer company is in the process of qualifying new direct material suppliers. There is some historical data available but some of the estimated timing is based on assumptions.

The Six Sigma Black Belt is tasked with creating the activity network diagram, and developing the best-case, most-likely, and worst-case lead times to approve new suppliers.

The company wants to implement a new target of establishing new suppliers with a mean <30 days and never to exceed 60 days. The general steps and data are shown below with the performance based on history, sample trials, or judgment.

Establishing a New Direct Material Supplier

	Step Description
A	Requestor emails Supplier Creation Form to Supplier
B	Supplier Completes their Portion (Part A) and returns form
C	Supply Chain review of the form and schedules visit if accepted to this point
D	Supply Chain preliminary review, visit, and review with Operations
E	Supply Chain rejects/approves of Supplier for next phase of approvals.
F	If Supply Chain approves, attaches certification, tax forms, etc to e-form.
G	Finance reviews Supplier and completes Part C. Rejects or Approves supplier, signs e-form.
H	Quality reviews and on-site audit and completes Part B. Rejects or Approves supplier, signs e-form.
I	Engineering reviews and completes Part D. Rejects or Approves supplier, signs e-form.
J	If all approved, SC assigns Supplier Code and Type to e-form
K	Admin establishes supplier in ERP system and attaches e-form, certs, other notes
L	Admin notifies requestor, SC, Finance, Quality, and possibly others



Data based on "days"

	Mean	Median	Min	Max	Type	Notes
A	0	0	0	0	Series	*No data but estimated to take 5 minutes- no issues*
B	6.54	2.5	1	15	Series	
C	2.64	3	2	4	Series	
D	14.4	6.8	3	24	Series	
E	2.3	1	1	8	Series	
F	0.25	0.25	0.25	0.25	Parallel	
G	7	12.2	3	27	Parallel	*Needed more info on 30% of submissions creating rework loop*
H	13.1	12	8	21	Parallel	*Needed more info on 15% of submissions creating rework loop*
I	8.1	8	6	14	Parallel	*Needed more info on 5% of submissions creating rework loop*
J	4	4	4	4	Series	*Trials showed mean of 4 minutes about the same every time*
K	1.3	1.6	0.15	3	Series	
L	1	1	1	1	Series	*Clicks box on e-form which automatically notifies all*
SUM	**60.63**	**52.35**	**20.15**	**86.00**		

Notice that steps F, G, H, I can occur simultaneously but only after steps A, B, C, D, and E are complete in series (or sequential order). Then, once the four parallel steps are complete, Step J can begin. Then the last two steps are K and L in that order.

Radar Charts are a way of comparing multiple quantitative variables. This makes them useful for seeing which variables have similar values or if there are any outliers amongst each variable. Radar Charts are also useful for seeing which variables are scoring high or low within a dataset, making them ideal for displaying performance.

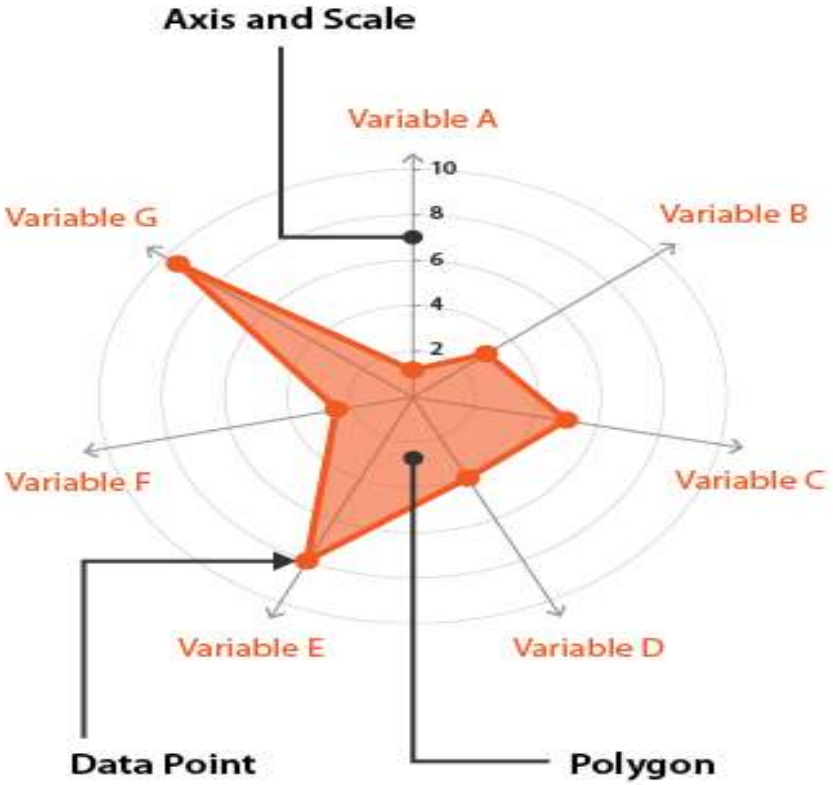
Each variable is provided with an axis that starts from the center. All axes are arranged radially, with equal distances between each other, while maintaining the same scale between all axes. Grid lines that connect from axis-to-axis are often used as a guide. Each variable value is plotted along its individual axis and all the variables in a dataset and connected together to form a polygon.

However, there are some major flaws with Radar Charts:

Having multiple polygons in one Radar Chart makes it hard to read, confusing and too cluttered. Especially if the polygons are filled in, as the top polygon covers all the other polygons underneath it.

Having too many variables creates too many axes and can also make the chart hard to read and complicated. So it's good practice to keep Radar Charts simple and limit the number of variables used.

Another flaw with Radar Charts is that they’re not so good for comparing values across each variable. Even with the aid of the spider web-like grid guide. Comparing values all on a single straight axis is much easier.



A radar chart is often a good choice if you need to plot a series of observations or cases with multivariate data. Each observation or case is represented by a polygon; and if they are shaded opaquely it is easy to see how they overlap and in which direction.

A radar chart is especially useful if:

- You want to compare the general shape, reach and symmetry of the distribution of variables rather than specific quantities among observations,
- You are working with a large number of variables,
- You want a quick visual way of viewing quality data.

The PDCA Cycle

The PDCA (Plan-Do-Check-Act) model first introduced by Walter Shewhart in 1929 and popularized by W. Edwards Deming in the 1950s as "a flow diagram for learning, and for improvement of a product and a process". Deming advocated the use of PDCA as a continuous feedback loop to analyze, measure, and identify sources of variations from customer requirements and take corrective action.

The application of PDCA as a tool to implement Total Quality Management and Six Sigma has made PDCA fundamental to the tenet of quality management. PDCA is one approach toward Total Quality Management, and the basis on which Six Sigma's DMAIC model rests. The PDCA cycle provides a feedback mechanism for continual quality improvement.

PDCA for quality management entails ensuing consistency across consecutive business activities.

PLAN

The "Plan" phase of PDCA for quality management covers:

- defining the problem or issue that requires redress
- defining the ideal or desired state
- data collection to determine the problem in terms of deviance from the ideal state
- ascertaining the root cause for the problem or issue
- evaluating the various possible interventions to solve the problem and their possible outcomes
- selecting the best possible intervention
- scheduling the corrective process by planning for resources, determining people responsible for the corrective action
- mapping the corrective process through flowcharts, control charts, and other tools

DO

The "Do" phase of PDCA concerns implementation of the selected solution to reduce the deviation or solve the issue. The implementation of the selected solution is initially on a small scale to check its effectiveness. Successful implementation results in across-the-board implementation.

This phase also covers training the employees for the adopted quality intervention.

CHECK

In traditional quality management schemes, the "Check" of PDCA became synonymous with quality inspection. The methodology entails defining workmanship standards such as upper specification limit (USL) and lower specification limit (LSL) and then comparing the product specifications against such standards. The inspection would weed out unacceptable products.

Deming replaced the "Check" stage with "Study" stage that entails use of statistical tools to understanding the nature of variation in the process output in terms of what worked, what did not work, and the lessons learned from the experience.

ACT

The "Act" phase in PDCA for quality management entails:

- standardization of the successful solution and adopting the same for wholesale process improvement
  involving other stakeholders such as other departments, suppliers and customers in the changed process

creating safeguards to check relapse into the previous stage
explore opportunities for further improvements

Different Approaches towards PDCA for Quality Management

Although the basic structure of PDCA remains constant, the application of PDCA to improve quality takes various approaches. The two major approaches are Edwards Deming's Statistical Control Approach and Genichi Taguchi's Robust Engineering Approach.

Edward Deming applied PDCA to reduce excessive variability in processes and products by using statistical tools. Taguchi tried to avoid variability by targeting it in the planning phase using robust engineering solutions to achieve performance on target.

Whatever the approach, the PDCA model helps in quality management on a day-to-day basis. It keeps the process under control, prevents non-conformance, and encourages development of innovative and breakthrough changes to ensure quality and performance improvement.

The PDCA approach toward Quality Management is a continuous approach. Increased quality leads to increased customer expectations, which in turn drives further product and process improvement.

Plan-Do-Check-Act Example

The Pearl River, NY School District, a 2001 recipient of the Malcolm Baldrige National Quality Award, used the PDCA cycle as a model for defining most of their work processes, from the boardroom to the classroom.

The PDCA model was the basic structure for the districts:

- Overall strategic planning
- Needs analysis
- Curriculum design and delivery
- Staff goal-setting and evaluation
- Provision of student services and support services
- Classroom instruction

Figure 2 shows their "A+ Approach to Classroom Success." This is a continuous cycle of designing curriculum and delivering classroom instruction. Improvement is not a separate activity—it is built into the work process.

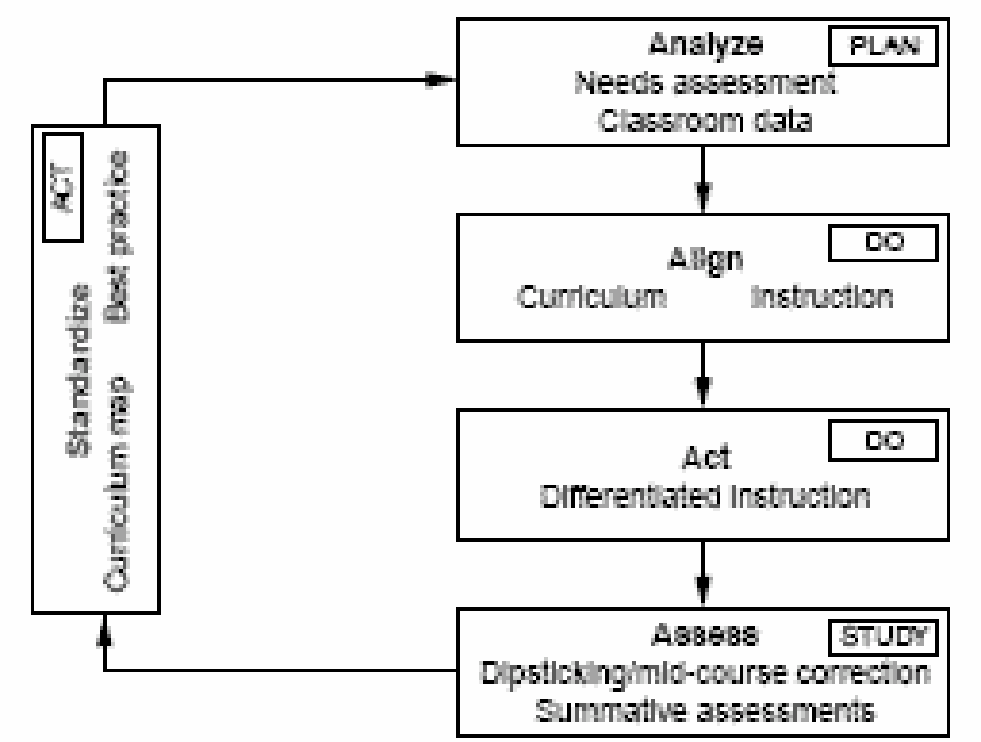


Figure 2: Plan-do-check-act example

Plan

The A+ Approach begins with a "plan" step, which the school district calls "analyze." In this step, students' needs are analyzed by examining a range of data available in Pearl River's electronic data "warehouse." The data reviewed includes everything from grades to performance on standardized tests. Data can be analyzed for individual students or stratified by grade, gender, or any other subgroup. Because PDCA does not specify how to analyze data, a separate data analysis process (Figure 3) is used here as well as in other processes throughout the organization.

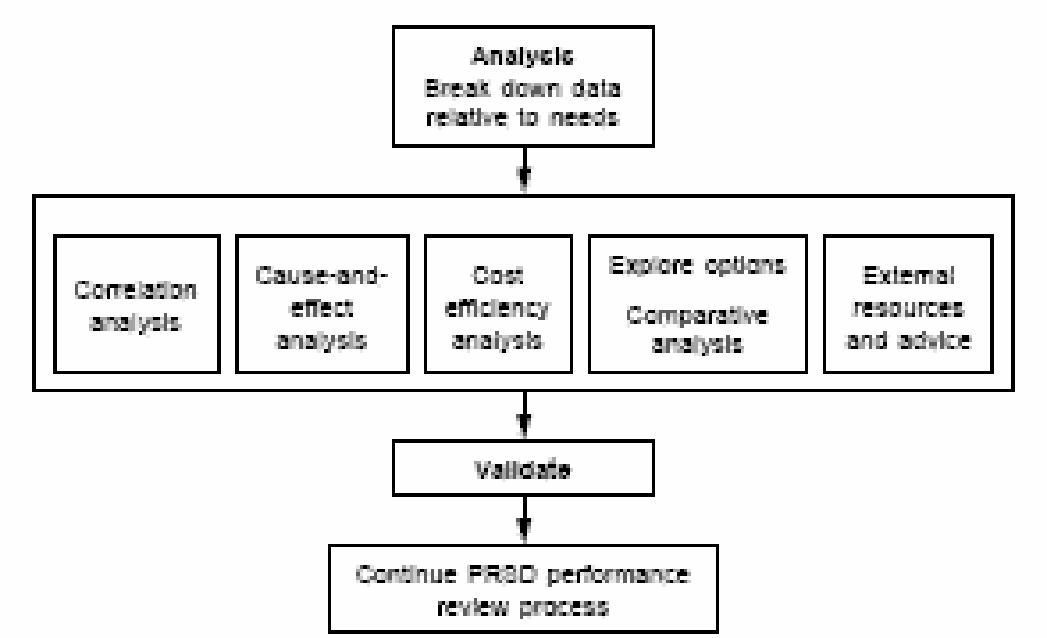


Figure 3: Pearl River Analysis Process

Do

The A+ Approach continues with two "do" steps:

1. The "align" step asks what the national and state standards require and how they will be assessed. Teaching staff also plans curricula by looking at what is taught at earlier and later grade levels and in other disciplines to ensure a clear continuity of instruction throughout the student's schooling. Teachers develop individual goals to improve their instruction where the "analyze" step showed any gaps.
2. The "act" step is where instruction is provided, following the curriculum and teaching goals. Within set parameters, teachers vary the delivery of instruction based on each student's learning rates and styles.

Check

Formal and informal assessments take place continually, from daily teacher assessments to six-week progress reports to annual standardized tests. Teachers also can access comparative data on the electronic database to identify trends. High-need students are monitored by a special child study team.

Throughout the school year, if assessments show students are not learning as expected, mid-course corrections are made (such as re-instruction, changing teaching methods, and more direct teacher mentoring). Assessment data become input for the next step in the cycle.

Act

In this example, the "act" step is "standardization." When goals are met, the curriculum design and teaching methods are considered standardized. Teachers share best practices in formal and informal settings. Results from this cycle become input for the "analyze" phase of the next A+ Approach cycle.