A Simple Guide to *understand* and *use*

quality tools and *problem-solving methods*.

From *PDCA*, *A3*,*8D*, *5 WHY*, *FMEA* , *Control plan* and *more* . . .

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" *We learn, we grow* ".

Summary

1.Introduction

In this document we will put all the necessary information needed to use the **7 basic quality tools** (from the **theory** to **practice**).
Also we will talk about **the problem solving process** because it's an important part of the process of creating additional value and it will guide you toward the right mindset that will allow you to create the best product giving your available resources .
We will finish by speaking about the corrective and preventive actions best fit to help you avoid and to handle efficiently the problems that you will encounter.
I hope that you will enjoy reading it as much I enjoyed writing it .
Have fun !

2.Organization of the document

In general, the organization of the document will be as follows:
1. A brief history of the subject discussed in the section.
2. A clear definition of the subject discussed in the section.
3. The purpose of the subject.
4. When we use it –Conditions to use it - (as a quality tool or method).
5. How to use it – step by step - (if it's a method or a tool).
6. Comment and tips (if there is).
7. Practical examples will be made in video lectures.
8. Any other information that will be considered useful to know.

3. Purpose of this document

This document will give the reader a guide to understand and use efficiently the seven basic quality tools and to solve problems using scientific methods to reach optimal solutions., and to apply preventive method to avoid problems and to improve the quality of the work.

4.What's the meaning of the term 'Quality' ?

Before we speak about the basic quality tools we need to put a definition on the term "Quality" so we can have the same understanding of the word.
By the definition of ISO the term quality means :
"*The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs* ".
So in other words quality is the ability to give a **client** what he **want** at **the time** he wanted it with the **suitable price** with all the **expectations fulfilled.**

5.Why do we need the 7 basic quality tools ?

The 7 basic Quality Tools are tools showed there efficiency in different industry throughout more than 30 years of applications . They can help solve problems using at the best your resources and they are easy to understand and apply.

6.Problem solving process and methods.

Problems are a parts of our lives and they stay until we solve them .solving problems are more important in the professional life because it has tremendous influence in your success so the question that we need to ask ourselves is *:"How do we solve our problems in the best way ?".* We will try to answer this question in the sections 2 and 3.

7.Preventive methods

In some cases we can't wait until a problem or a failure occurs because it will be too late and with great loss, so we turn to the preventive actions to reduce the risks. We will do that by applying the preventive methods described in the section 4 .

By understanding all of the parts of this document you will acquire the tools and methods that will help you improve the quality of your work and your problems solving approach in the better way.

Section 1

The 7 basic quality tools

Simple and efficient.

Tool 1 : Check sheet

History

The check sheet has been used as far as the industrial revolution began in Europe and even before due to its simple and effective usage.

Definition

The check sheet is a document (sheet) where you collect and make a structure for the data in real time based on quantitative or qualitative category and generally it uses little lines as data ‘checks’ to keep the counting.

Why do we use it

As ***Kaoru Ishikawa*** said ,we use this tool for:

- To quantify defects by type.
- To quantify defects by location.
- To quantify defects by cause (machine, worker).
- To check the shape of the probability distribution of a process.
- To keep track of the completion of steps in a multistep procedure.

When we use it

It’s used :

- When the data are quantitative .
- When the size of the data are relatively small.
- When the data are collected repeatedly by the same person or at the same location
- When you want to collect data for a specific state (ex : shift /Day / Team,…)

How to use it

Before using it, you need first to:
1. Identify and specify the type and purpose of the data collection.
2. Identify the person responsible of this task.
3. Specify the frequency of data collection.
4. Make sure that the data sheet is appropriate and easy to use.
Document all the above in the data sheet.
And then you can fill up the data sheet.

Tips & comments

This document contains data collection and it will be used in a data analysis so you need to make sure that no one can temper with the data.

Practical examples

- See the lecture 6 : The check sheet in practice.
- The Check sheet template is available of the resource section of the lecture 6.

Tool 2 : Brainstorming

History

The brainstorming was elaborated by advertising executive Alex F. Osborn in 1939 .

Mr Alex F. Osborn in 1961

Definition

The brainstorming is a group technique designed to generate and organize creative ideas around a specific topic or domain.

Why do we use it

We use it to :
Gather ideas from a group of people to solve a problem (issue) using less amount of resources possible.

When we use it

It's used when :

- You want to find a solution and want to see the proposition of a group (it's used generally in the process of creation of a product).
- You want to collect general ideas about a topic as a starting point to your reflection.

How to use it

Before starting a brainstorming session you need to:

- Appoint a group leader (the responsible) .
- Choose a quit place .
- Choose a work group (less then 9 persons).

A brainstorming session is done as follows:

1. The group leader presents the problem in a clear way.
2. Each participant write down individually his ideas (e.g. in a note stickers)
3. The group gathers and each person presents his ideas.
4. The group choose a list of unique ideas.
5. The group discusses the ideas and rank them from the probable to the least probable.
6. The group closes the brainstorming session by selecting the best idea.

Tips & comments

- Comments ,criticism and correction are **not allowed** .
- Collect as **many** ideas as possible.
- The session should last between **30 - 45 min** .
- Always write down ideas.
- It’s recommended to take a **break** before discussing the ideas (between the step 4 and 5).

Practical examples

- See the **lecture 8** : The brainstorming in practice.
- The **brainstorming in practice** document is available on the re-source section of this lecture.

Tool 3 : Cause & effect diagram

History

Dr Kaoru ISHIKAWA

The Cause & effect diagram (Ishikawa diagram, Fishbone diagram) is a method created by the chemist Dr Kaoru Ishikawa in the early 1960's in Japan .

Definition

The cause & effect diagram is a causal diagram and a visual tool.

Why do we use it

We use it to :

- Identify the potential factors and their effects .
- See all the factors simultaneously.
- Help to direct brainstorming sessions.

When we use it

It's used when :

- You want to see the level of effect of some causes .
- You search for a root causes in a list of factors .
- You want to channel and optimize the efforts .

How to use it

Before filling out a cause & effect diagram you need to:

- Appoint a group leader (the responsible) .
- Choose a quit place .
- Choose a work group (less then 9 persons).
- Prepare the cause and effect sheet.

To fill up a cause & effect diagram you need to :

1. Write down the main problem (in the right)
2. List all the primary factors.
3. Sort out the factors by groups (6 M's).
4. Write the factor groups on the sheet.
5. Write the secondary factors on the sheet.
6. Select the most plausible factors as root causes for your problem.
7. Close the cause and effect sheet.

Tips & comments

6 M represents :

1. **Man** : Any men involved in the process .
2. **Method** : Any method , procedure or work instruction involved in the process.
3. **Machines** : Any equipment needed to do the job .
4. **Materials** : Any raw material, parts involved in the process.
5. **Measurements** : Data generated by the process to evaluate quality.
6. **Milieu** : The environment that the process operate on (location, temperature,…).

Practical examples

- See the **lecture 10** : cause and effect in practice.
- The **Cause and effect template** is available on the resource section of this lecture.

Tool 4 : Histogram

History

Dr Karl Pearson

The term histogram was used for the first time by the statistician Karl Pearson in 1891in his lecture on 'Maps and Chartograms' but the Scottish economist William Playfair is the first one to use this diagram in his book *'Commercial and political atlas'* in 1786 .

Definition

Histogram is a bar graph plot of the data, with the bars placed adjacent to each other typically used in frequency distributions .(Ross 2010: 33, and see Triola 2010: 55, etc.),

Why do we use it

We use it to :

- Visualize graphically the distribution of the data.

When we use it

It's used when :

- The data collected are continuous (quantitative variable).

How to create it

We create a histogram as follows:

1. Collect the data.
2. Create the class intervals.
3. Calculate the frequency of each interval.
4. Draw the X axis (for the class interval) and the Y axis (for the frequency).
5. Draw the bars.

Tips & comments

- The number of class intervals is left to the user to choose but :
  - ⇒ Using a low number (less than 5) will hide the variance in the data.
  - ⇒ Using a high number (more than 30) will show too much variance and the diagram will be hard to read and to extrapolate an idea from it.
- It is advisable to have the same width for all the interval class and it's calculated using this equation:

  W = (Max x-Min x)/N. When L is not a natural number we add 1.

  * Max x: the largest number recoded of the variable x.
  * Min x : the lowest number recorded of the variable x.
  * N :the number of class interval.
- The frequency of each class interval is the sum of all the data within it.

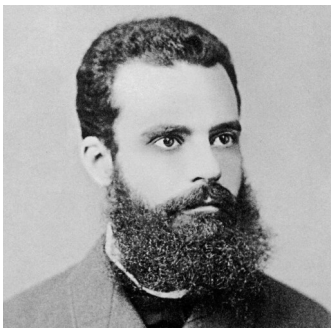
NB: The number 5 and 30 has been chosen in general .It depends on the amount of data available and the length of the interval.

Practical examples

- See the **lecture 12**: The histogram in practice.

Tool 5 : Pareto diagram

History



Vilfredo Pareto in 1870

The pareto diagram was first used by the Italian sociologist and economist Vilfredo Pareto in 1897 on his study of the distribution of wealth among the citizen of Florence (80 % of the wealth are held by 20% of the population).
It was used later on by **Walter S Shewhart** and **Joseph Juran** and introduced as a quality tool.

Definition

Pareto diagram is a bar graph plot of the data with the bars placed adjacent sorted in descending order..

Why do we use it

We use it to :

- Visualize graphically categorical data.
- Compare many categorical data .

When we use it

It's used when :

- Searching for causes that are the most impactful on the problem.
- When you have a limited resources and you want a rapid impact.

How to create it

We create a Pareto diagram as follows:

1. ***Create*** a table of 3 columns for categories (categorical variable), frequency and percentage. For the rows create N+1 row (N is the number of categories).
2. ***Fill up*** the percentage column by using the following equation:
   Percentage of X_1 = (frequency of X_1)/SoF
   Percentage of X_N = [percentage of X_{N-1} + (frequency of X_N)]/Sof
   - N : Number of categorical variable.
   - SoF: Sum of all frequencies.
   - X_i : The categorical variables (i from 1 to N).
3. Sort out categorical variables ***increasingly*** in the X axis.
4. Plot the bar chart.
5. For each categorical variable ***draw*** the corresponding point from the percentage column.
6. ***Connect*** all the dots.

Tips & comments

The categorical variables that have a sum around 80 % are the variables that we need to concentrate on. It's the pareto law of 20/80 (20 % of the causes are responsible of 80% of the problems).

Practical examples

- See the **lecture 14** : The Pareto diagram in practice.

Tool 6 –A : Control chart

History

Control chart was invented by the physicist and statistician Dr Walter A Shewhart when he was working for the Bell labs in 1920 and democratized by Dr William Deming .

Dr Walter A Shewhart

Definition

Control chart is a visualization of a process data through time.

Why do we use it

We use it to :

- See if our process is behaving normally.
- Distinguish between common and special causes of variation.

When we use it

It's used when :

- We want to analyze the stability of a process through time.
- To analyze a process before changing settings.

How to create it

We create control chart as follows:

1. We collect the studied process data.

2. We calculate:

* The mean (m) : is calculated using :

$$m = \frac{1}{N}\sum_{i=1}^{N} x_i$$

* The variance (S) is calculated using :

$$S = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - m)^2}$$

x_i : is data from a sample of N elements.

- The upper control limit (UCL) is calculated using:

  UCL = m+ 3*S.

- The lower control limit (LCL) is calculated using :

  LCL = m - 3*S.

3. Draw the line of m (mean also called the central limit) , UCL and LCL.

4. Plot the x_i point on the chart.

5. Connect all the dots.

Tips & comments

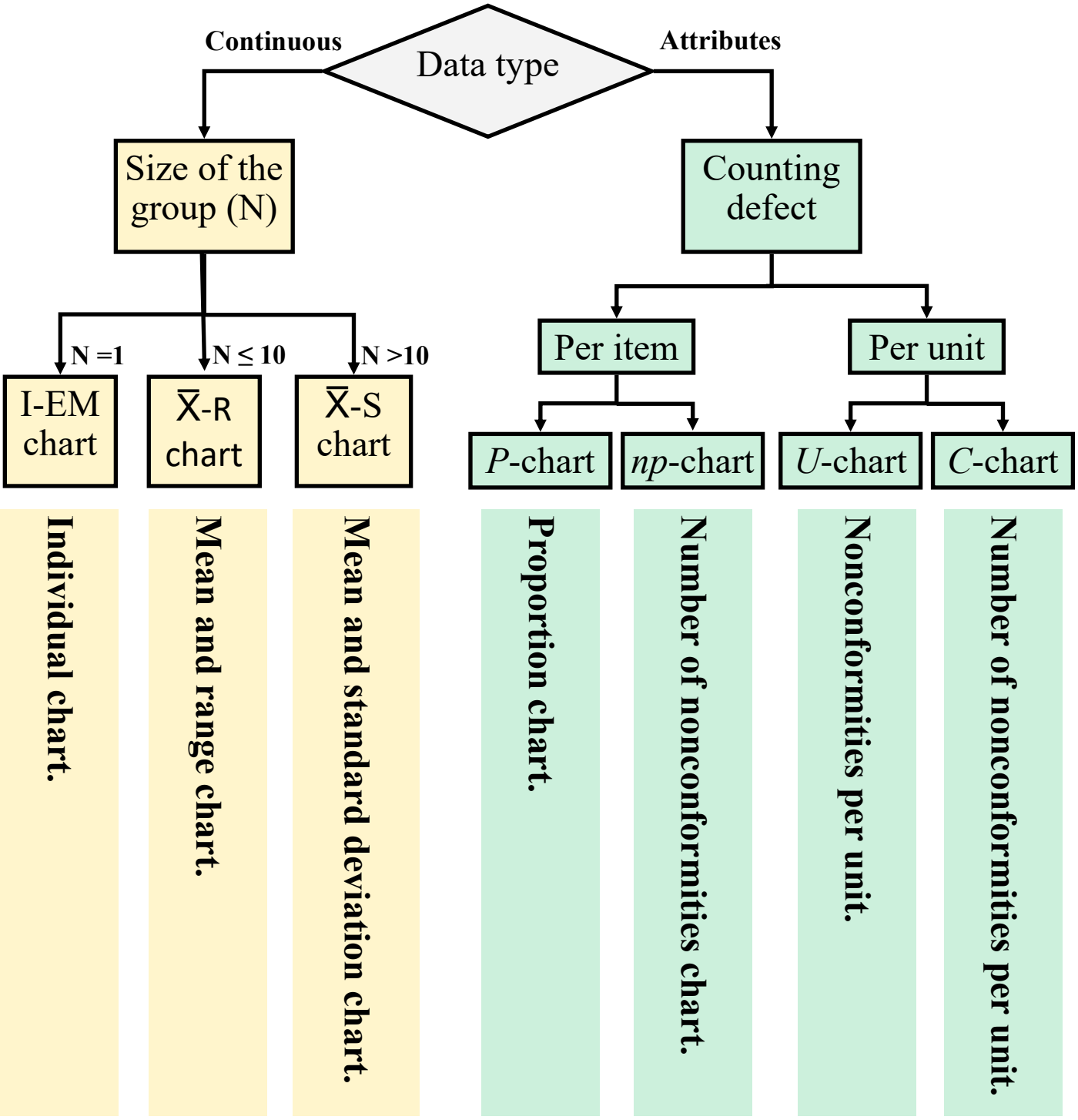
You need to have a basic comprehension of certain statistical concepts to fully grasp the control chart

Practical examples

- See the **lecture 16** : The control chart in practice part 1.
- See the **lecture 16** : The control chart in practice part 2.

Tool 6 –A : Control chart

Types of control charts



Per item means that the product have two states pass/fail conform/not conform.
Per unit means that a single product can have many defects at the same time.

Summary of the typical causes of a special variation.

According to his works, Dr Deming summarized **typical causes** for **special variation** in **8 points** listed below as following :

N	Typical cause
1	1 or more points are greater than 3 standard deviation form the central line.
2	7 points in a row in one side on the central line.
3	6 points in a row all increasing or decreasing.
4	14 points alternating up and down.
5	2 points out of three are greater than 2 standard deviation from the central line (on the same side).
6	4 points out of 5 are greater than 1 standard deviation from the central line (on the same side).
7	15 points in a row within 1 standard deviation from the center line (same side).
8	8 points in a row within 1 standard deviation from the center line (same side).

Tips & comments

You need to have a basic comprehension of some statistical concepts to fully grasp the control chart

Practical examples

- The **8 points summary of typical causes and the types of control chart** documents are available on the resource of **section 15.**

Tool 6 – B : Scatter plot

History

Scatter plot was made in 1833 by the English scientist John Frederick W. Herschel for a study on the orbits of double stars .

John F W. Herschel

Definition

A scatter plot in a representation in a cartesian coordinate of two variables.

Why do we use it

We use it to :

- See visually the relation between two variables.
- See trends between two variables.

When we use it

It’s used when :

- We have two continuous variables and we want to see if there is a relation between them.

How to create it

We create control chart as follows:
1. Collect the data (two continuous variables).
2. Choose an axis for each variable.
3. Plot a point for each coordinate from the data.

Tips & comments

In general we use an orthonormal basis .

Practical examples

- See the **lecture 19** : The scatter plot in practice .

Tool 7: Flowchart/Process mapping

History

In 1921, industrial engineers Frank and Lillian Gilbreth introduced the “Flow Process Chart” to the American Society of Mechanical Engineers (ASME).

Frank and Lillian Gilbreth

Definition

A Flowchart is a visual description of different steps of a process.

Why do we use it

We use it to :

- Clarify each step in a process.
- Standardize the work .
- Essential to some certification (ISO 9001,IATF 16949,…).

When we use it

It’s used when :

- You want to optimize the work.
- You want to analyze the process for an improvement.
- Follow the best practices set out in ISO 9001 Standards.

How to create it

We create control chart as follows :

- Appoint a group leader (the responsible) for this task.
- Create a group of subject matter experts of the analyzed process.
- Discuss and identify each step of the analyzed process .
- Follow the guide of flowchart to map your process.

Tips & comments

- Subject matter expert : is the best knowledgeable person about a certain matter .
- There are many types of flowcharts.

Practical examples

- See the **lecture 21** : Flowchart / process mapping in practice.
- The **Workflow and the process mapping example** documents are available on the resource section of the **lecture 21**.

The problem solving and the continuous improvement processes

Solving problems is a very important task to do in order to improve quality , that’s why in the next section we will talk about the problem solving process and methods .

Section 2

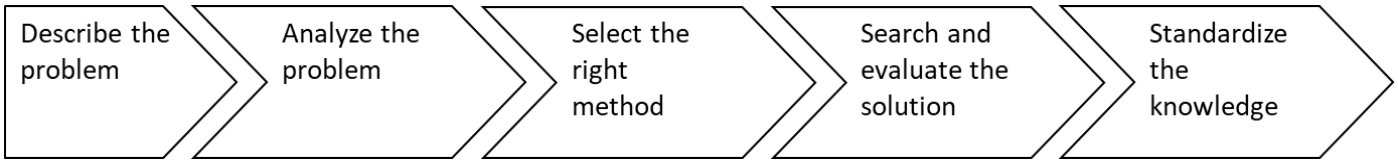
Problem solving process

The next step toward ***excellence*** *.*

In order to resolve problems efficiently, we need to create a standard process to do it.

The problem solving process

We will explain the different steps that will have to follow in order to solve a problem efficiently. To do so we will describe those steps as a workflow and explain each step.



Next we will explain each step of the problem solving process by underlining the objectives and the tasks needed in each step.

This table is a summary of the objectives needed to be achieved and the tasks needed to be performed in order to pass to the next step. Achieving those objectives and performing those tasks are very important to solve a problem efficiently.

Practical examples

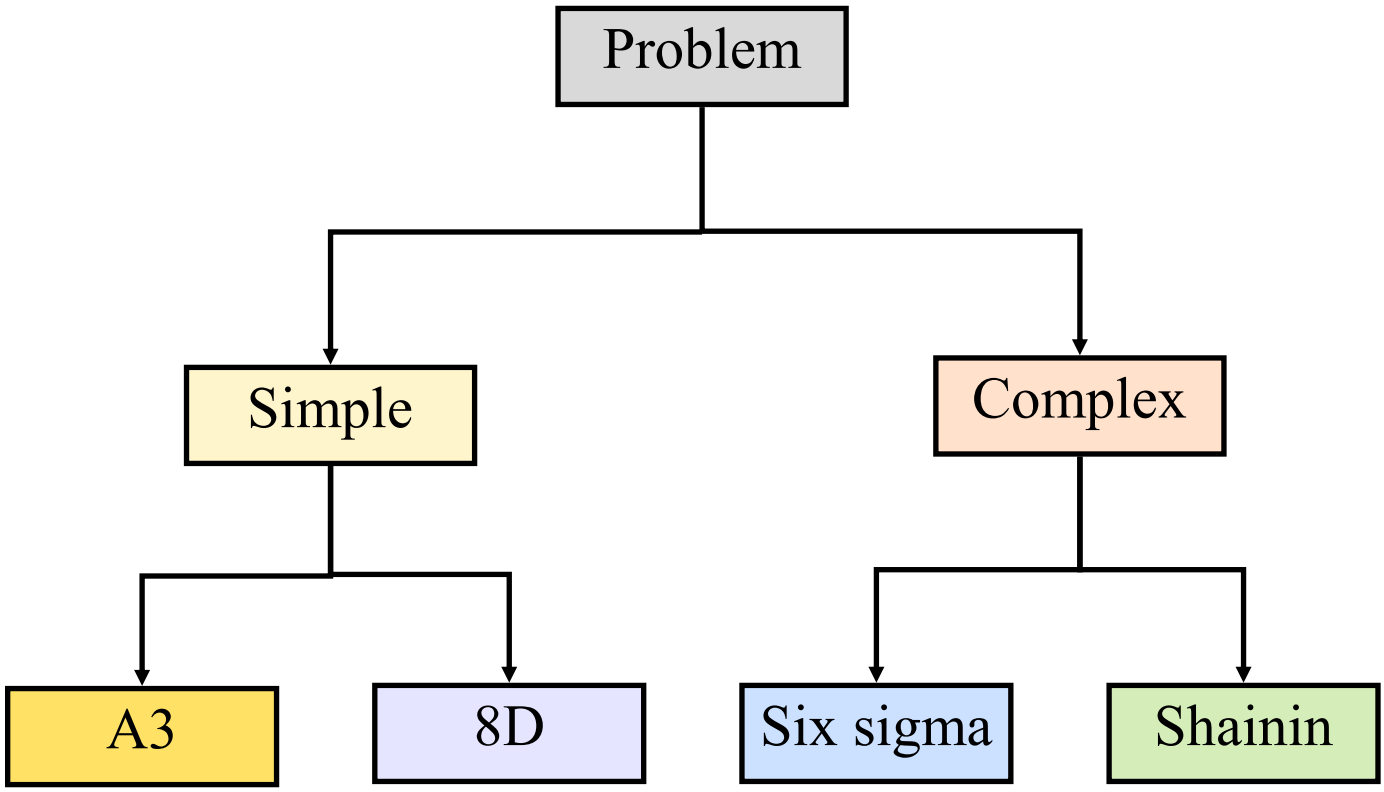
- See the **lecture 24** : The PSP in detail.

Steps	Objectives	Tasks
1.Describe the problem	To describe the problem in the clearest way we need to answer those questions: • What's the problem? • What's not a problem? • Why it's a problem? • A description needs to be based on data and facts not assumptions and opinions.	1. Collect data and facts. 2. Describe the current status (problem description). 3. Define the desired status.
2.Analyze the problem	Once a common understanding is achieved we will analyze the problem by searching for the influences and the causes of it.	1. Search for possible influences and causes. 2. Select significant influences and causes. 3. Confirm the chosen influences and causes .
3.Select the right method	Selecting the right method will be based on the chosen influences and causes .Choosing the right method will optimize the use of the resources to solve the problem.	1. Take the chosen influences and causes. 2. Classify the problem. 3. Select the right method .
4.Search and evaluate solutions	Based on the chosen method , potential solutions will be proposed , the best fitted solution will be applied.	1. Use the chosen method. 2. Select a list of potential solutions. 3. Apply these solution of the field. 4. Track and evaluate the efficiency of the solutions.
5.Standardize the knowledge	For the last step ,we need to add the best solutions in our database of knowledge as a standardized solution to preserve and improve the quality of the work.	1. Choose the best solution. 2. Standardize the solution. 3. Add the solution in the knowledge company database and archive it.

The types of problems

We will categorize the problems in two types : simple and complex.

- ***Simple problem :*** is characterized by it's **simple** causes and by it's **low** resources needs to solve it.
- ***Complex problem*** : is characterized by the complexity of its causes and by the large resources needed to solve it.



Internal : problem involving internal parties .
External : problem involving external parties (clients, supplier).
Process : problem related to the processes.
Product: problem related to the product (service) itself.

In the next section we will discuss about the problem solving methods mentioned above :

- A3.
- 8D .
- Six sigma.
- Shainin.
- Plus PDCA .

For the Six Sigma and Shainin methodology , it will be an overview (because they require a complete and long training to master them).

Section 3

Problem solving methods

*The **right tool** to find the **best solution**.*

Method 1 : A3

History

The A3 problem solving method was created *Toyota industries* and it's one of their Toyota production System tools.The name is a reference of the size of the paper needed to print the sheet of this method.

Definition

The A3 is a combination of methods and concept to solve a problem. This method is one of the simplest and the commonly used and it's very effective for the resolution of simple problem.
As mentioned earlier this method is generally used when there is an internal problem .

How to use it

The use of this method is split up in 8 steps as follows:

1. **Initiate the problem:** write the problem as clear as possible so that everybody can understand the issue on the same way.
2. **Clarify the problem:** The first step is a summary, here you can add information that can help to understand more the problem.
3. **point out the problem appearance :** quick actions made to decrease or put under control the effect of the problem (temporarily).
4. **Apply countermeasures :** quick actions made to decrease or put under control the effect of the problem (temporarily).
5. **Use the cause & effect diagram:** classify the potential causes of the problem.
6. **Investigate the causes:** search for the main causes using the 5 why to find the root cause.
7. **Validate the measures:** evaluate the effectiveness of the measures applied to eradicate the root causes .
8. **Further activities :** talk about all the good practices that laid to solve the problem.

Practical examples

- See the **lecture 28** : The A3 sheet.
- See the **lecture 33** : The A3 in practice.
- The **A3 problem solving sheet** template is available on the resource section of the **lecture 33**.

Method 2 : 8D

History

The 8D problem solving method was created by the Ford Motor Company in the 1980s as a part of her problem solving methodology knows as Team Oriented Problem Solving (TOPS) .

Definition

The 8D stand for 8 disciplines (points) needed to be discussed in order to find a solution. This method is widely used in the case of external problems (problems with suppliers or with customers) and it's an effective means of resolving complaints.

How to use it

The 8 discipline are:

1. **Use a team approach:** by assembling a multidisciplinary team of subject matter experts.
2. **Describe the problem:** communicate the problem with more details to give the team a starting point.
3. **Interim Countermeasure:** quick actions made to decrease or put under control the effect of the problem (temporarily).
4. **Define the root causes:** the core of the 8D method. Investigate the root causes among potential ones.
5. **Develop solutions:** based on the root causes select the best actions that will lead to a robust and cost-effective resolution.
6. **implement the solution:** the best solutions will be implemented using an action plan document.
7. **Prevent recurrence:** the team must ensure the solutions work and validate them to ensure that the problem is solved definitely.
8. **Remarks:** add any relative remarks of information.

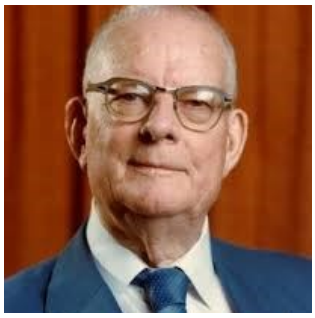
All team members deserve to be congratulated.

Practical examples

- See the **lecture 28** : The 8D sheet.
- See the **lecture 34** : The 8D in practice.
- The **8D** template is available on the resource section of the **lecture 34**.

Method 3-A : PDCA

History



Dr William E Deming

The PDCA (**P**lan **D**o **C**heck **A**ct) also known as "Deming Cycle" was developed by **Dr Walter S Shewhart** and popularized by **Dr William E Deming** in the 1950s .

Definition

The PDCA cycle is an iterative method who is composed of 4 steps (Plan Do Check Act) .It's an important method for continuous improvement .

How to use it

The actions that needed to be done in each step are:

1. **Plan :** identify and analyze the problem and point out it's root **causes**
1. **Do :** implement the potential solutions.
2. **Check** : evaluate and track the efficiency of the implemented solutions.
3. **Act :** add the successful solutions into the standards of work.

Practical examples

- The practical example of the PDCA is included on the **lecture 33** and **lecture 34**.

Method 3-B : 5Why

History

The 5 why techniques was invented by Mr **Sakichi Toyoda** the founder of Toyota industries in the 1930s. Toyota still uses it to solve problems today.

Mr Sakichi Toyoda

Definition

The 5 why is a method based on consecutive questioning that will lead to the root cause.
This method is used for simple problems, and it's an effective tool for problem solving and quality improvement.

How to use it

We use this method as fellow:
1. Assemble a team.
2. Choose a leader.
3. Ask the "Why "5 times.
4. Identify the root cause.
5. Discuss potential solutions.
6. Monitor and track the implementation of the solutions.

NB: Always document what you did .

Practical examples

- The example of a 5 why is included on **lecture 33**.

Method 4 : Six sigma

History

The six sigma methodology was created by Motorola company in 1987 but was widely known by General Electric in the 1990s .

Definition

The six sigma method is data driven and uses statistical methods to reduce the variation of processes.

How to use it

The six sigma methodology is based on the DMAIC approach.
DMAIC means **D**efine -**M**easure -**A**nalyze -**I**mprove and **C**ontrol.

- **Define :** identify the core processes and define the customer requirements.
- **Measure :** measure the current performances objectively.
- **Analyze:** analyze and find the root causes to improve the process.
- **Improve :** implement the actions to eliminate the root causes and to improve the process.
- **Control :** track and evaluate the efficiency of the implemented action and add the effective ones to the work standard.

Tips & comments

- The six sigma methodology uses many statistical concepts (confidence intervals , plan of experiments, test hypothesis, ANOVA ,…).
- The six sigma methodology is a complex methodology ,it has many level of knowledge (white belt, yellow belt ,green belt ,black belt and master black belt).
- The six sigma methodology is generally used to improve processes and to gain financial return of investment.
- A six sigma project lasts at least 6 months with a return of investment more than 10000 $.

- There is another methodology called lean six sigma, it’s a combination of the lean and the six sigma methodology. The main differences between them is the second one integrates the JIT concept (Just in Time) and the optimization of the logistic flux chain.

Practical examples

- You will find an more about six sigma in the **lecture 36**.
- The **Six sigma methodology** document is available on the resource section of **the lecture 36**.

Method 5 : Shainin methodology

History

Dorian Shainin

The Shainin methodology was introduced by the American quality engineer and consultant Dorian Shainin in 1988 .

Definition

A set of tools used to identify and eliminate the root causes then improve the process. The focal point in this methodology is the Red X ® (called also the dominant cause).

How to use it

To use Shainin methodology you need to follow :

1. **Focus** : create a project for the improvement.
2. **Approach :** identify the problem , develop an investigation strategy and verify if the measurement system is reliable.
3. **Converge :** Converging on Red X® ,test best and worse scenarios and identify the Red X ® candidate.
4. **Test : confirm** Red X ® by trial /DOE (design of experiment) and assess the risks.
5. **Understand :**understand the interaction between the cause and the effects and establish the appropriate tolerance limits.
6. **Apply :** implement the correction actions and update the procedure.
7. **Leverage :** document the lessons learned the calculate the benefits.

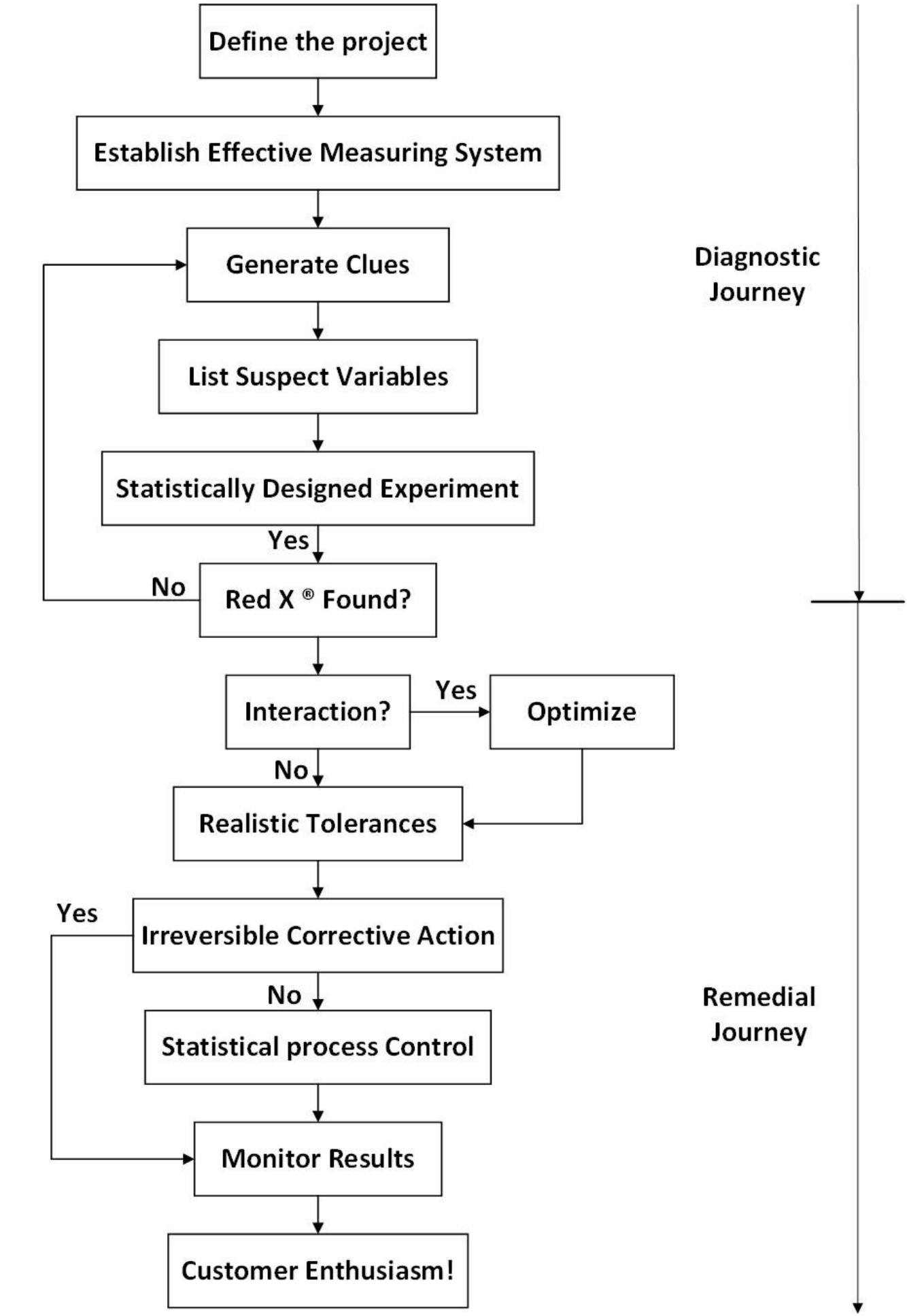
We generally use the acronym FACTUAL to memorize the Shainin methodology steps.

Tips & comments

- **Diagnostic journey:** aims to find the Red X ® .
- **Remedial Journey:** aims to eliminate the Red X ® .

We can't have examples because the Shainin system is a ***trademark***.

The Shainin system™ diagram



In the next section, we will speak about the following preventive Methods:

- FMEA (**F**ailure **M**ode and **E**ffects **A**nalysis).
- Control Plan.

Practical examples

- You will find an more about Shainin system (TM) in the **lecture 37**
- The **Shainin system** document is available on the resource section of **the lecture 37**.

Section 4

Preventive tools.

***Prevention** is **better** than cure.*

Tool 1 : FMEA

History

The Failure Mode and Effect Analysis (FMEA) is a method introduced first by the American army for its missile program (in 1949) with the creation of the document "*MIL-P 1629: procedure for performing a failure mode effect and critical analysis*", but also for the space missions as part of its space program to ensure the safety of astronauts.

In 1970, the FMEA entered the automotive industry through the American manufacturer FORD after the Pinto affair .

Definition

The FMEA is a method for classifying faults according to their impact on the operation of the system or product studied, the aim of which is to eliminate or reduce them.

Standards related to the FMEA

- ***SAE*[1] *J 1739,*** Potential failure mode and effects analysis design.
- ***AIAG*[2]** Potential FMEA reference manual.
- ***MIL-STD-1629*** A Procedure for performing an FMEA.
- ***SAE ARP 5580*** Recommended FMEA practices for non-automotive applications.
- ***IEC*[3] *60812*** Analysis technics for system reliability procedure for FMEA.
- **VDA**[4]**4** - General, risk analysis ,method , process models - product and process FMEA .

- You will find an more about the **FMEA in practice** in the **lecture 43** beside the document FMEA sheet available on the resource section.
- You can use the FMEA process as **a kick off meeting** support.

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[1] ***SAE*** : **S**ociety of **A**utomotive **E**ngineer .
[2] ***AIAG*** :**A**utomotive **I**ndustry **A**ction **G**roup .
[3] ***IEC*** : **I**nternational **E**lectrotechnical **C**ommission.
[4] ***VDA*** : **V**erband **d**er **A**utomobilindustrie : German Association of the Automotive Industry .

Types of FMEA

There are several types of FMEA, including:

- ***FMEA of a system:*** This is a high level analysis for a system made up of several subsystems. We focus in this case on the faults related to the subsystems including safety issues, and also on the interactions of its subsystems with each other and with others.
- ***FMEA of a design:*** This method aims to improve the design of the product, and for that we touch all the subsystems of the product ensuring that the final result can be mass-produced, and that the parts can be reproduced in series.
- ***FMEA of a process:*** This method focuses on the manufacturing or assembly process at the level of subsystems or parts of a product, but also on how to assemble the product under standards with the safest method , with the minimum of defect and within a very short time. Therefore, this analysis can include logistics, quality and maintenance.

Success factors of an FMEA

We can summarize the main factors of success of an FMEA versus consistency of results in any company. These factors are:
1. Understanding of the fundamental principles and procedures of an FMEA including concepts and definitions.
2. Selection of good FMEA projects.
3. Complete preparation of the steps of an FMEA before each project.
4. Apply background knowledge and ensure that quality goals are met.
5. Provide excellent facilitation.
6. Implementation of an FMEA project throughout the company
Implementing these factors helps ensure that an FMEA is applied in a safe, reliable and economical manner.

Tips & comments

- You will find an more about the **FMEA process** in the **lecture 42.**
- The **FMEA process, RPN ranking norms** and **the FMEA request sheet** document are available on the resource section of **the lecture 42**.

How to use it

These steps are defined by the VDA 4 standard and they are detailed further in the following:

1. System Analysis (Mapping)
- Record all the important elements in the studied system
- Creation of a clear structure.
- Clarify the interface with all other processes.

2. Function analysis (Mapping)
- Assign the functions of each element of the system.
- Use the mapping functions (show the relationships).

3. Failure (defect) analysis (Mapping)
- Define and assign failure modes.
- Link the fault modes with a mapping.

4. Measures (actions) analysis (Checklist)
- Evaluate the risks (effects) of the fault modes.
- See corrective and preventive actions (measures).

5. Optimization (Checklist)
- Evaluate the processes again after the implementation of the measures.
- Add other measures if necessary to reduce the risks.

Responsibilities and management

In the most companies, FMEA projects fall under the responsibility of the quality management department, as a result has the responsibility to:

1. Demonstrate the need of this project and provide all the means necessary to do so.
2. Choose the appropriate member of the FMEA team.
3. Set the goals and define responsibilities of each member.
4. Document the project initialization stage (for tracking and archiving)

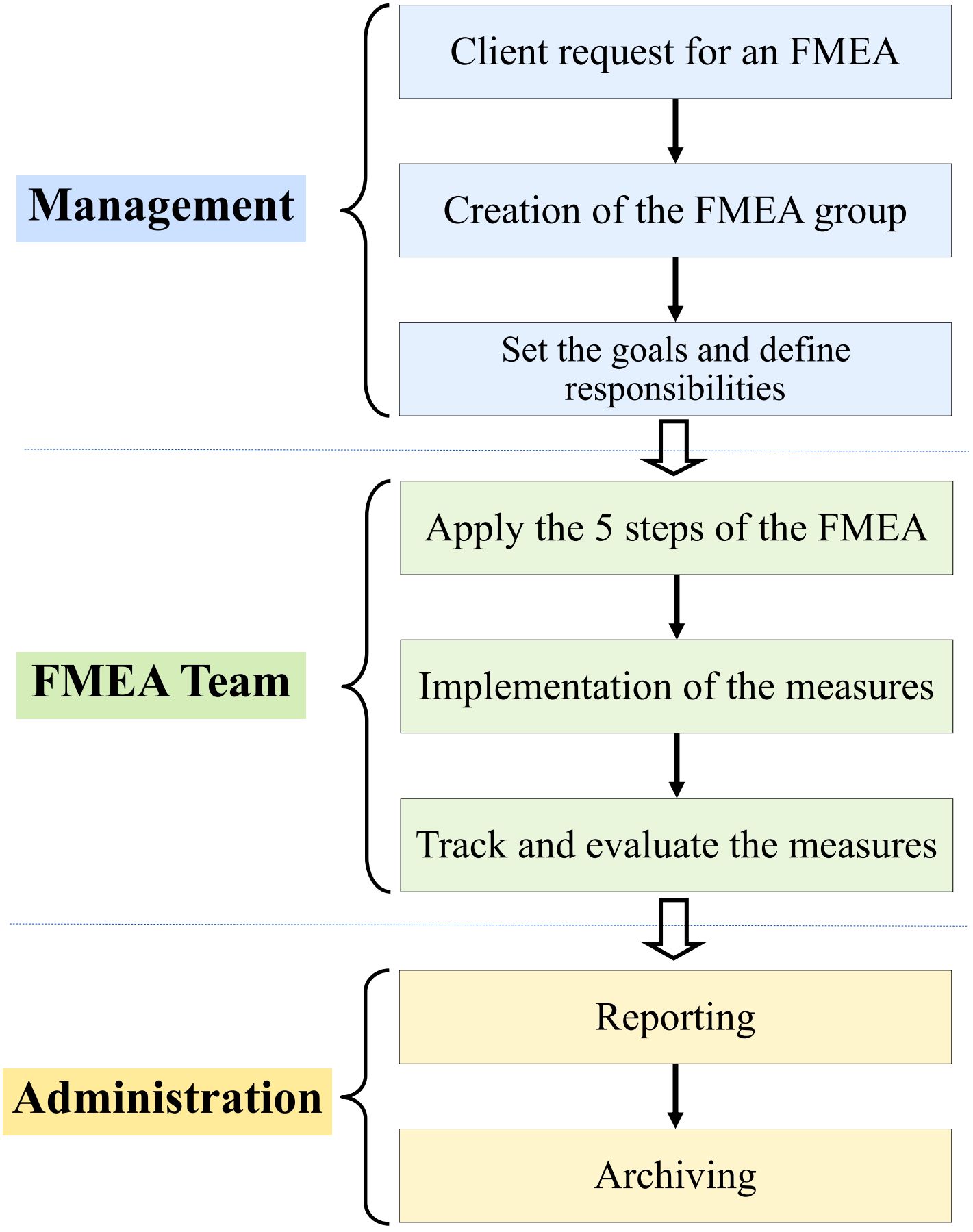
The FMEA coordinator: this person must be appointed by the management or selected by the group as soon as possible and his tasks are:

- Organize and facilitate meetings.
- Ensure the availability of all the resources necessary for the success of the project.
- Make sure that the work is progressing in the right direction.

The moderator is here to manage and facilitate the work and not to make the decisions alone.

:

The process of FMEA



Tool 2 : Control plan

History

The control plan was introduced by the AIAG in there manual as a part of the PPAP (**P**roduction **P**art **A**pproval **P**rocess) in 1994.

Definition

The Control Plan is a document that describes the actions (measurements, inspections, quality checks or monitoring of process parameters) required at each phase of a process to assure the process outputs will conform to pre-determined requirements.

Types of control plan

There are 3 control plan for three distinct phases :

1. **Phase 1 Prototype:** a description of the dimensional measurements, material and performance tests that will occur during building of the prototype. The organization shall have a prototype control plan, if required by the customer.
2. **Phase 2 Pre-launch:** a description of the dimensional measurements, material and performance test that occur after prototype and before series production. Pre-launch is defined as a production phase in the process of product realization which may be required after prototype build.
3. **Phase 3 – Production:** documentation of product / process characteristics, process controls, test and measurements system that occur during series production.

How to use it

The plan needs the FMEA as an input or a process mapping ,so we have to assume that we have an FMEA analysis in our disposal to proceed.

To create a control plan document, you need to:

1. Assign a responsible for this task.
2. Gather a group (preferably the FMEA group).
3. Fill out the control plan sheet.

Tips & comments

- The control plan is also a living document. It needs to be frequently updated to be useful (at least 2 times per year).
- Any update in the FMEA will lead to an update in the control plan if necessary.
- The FMEA and control plan sheets are very important for the certification ISO 9001 and others related to the quality management.

Practical examples

In the next page we will see a template of an PDCA sheet .
In the video of the lecture we will show how to fill up a 8D sheet.

Section 5

Conclusion

*It's only the **beginning**.*

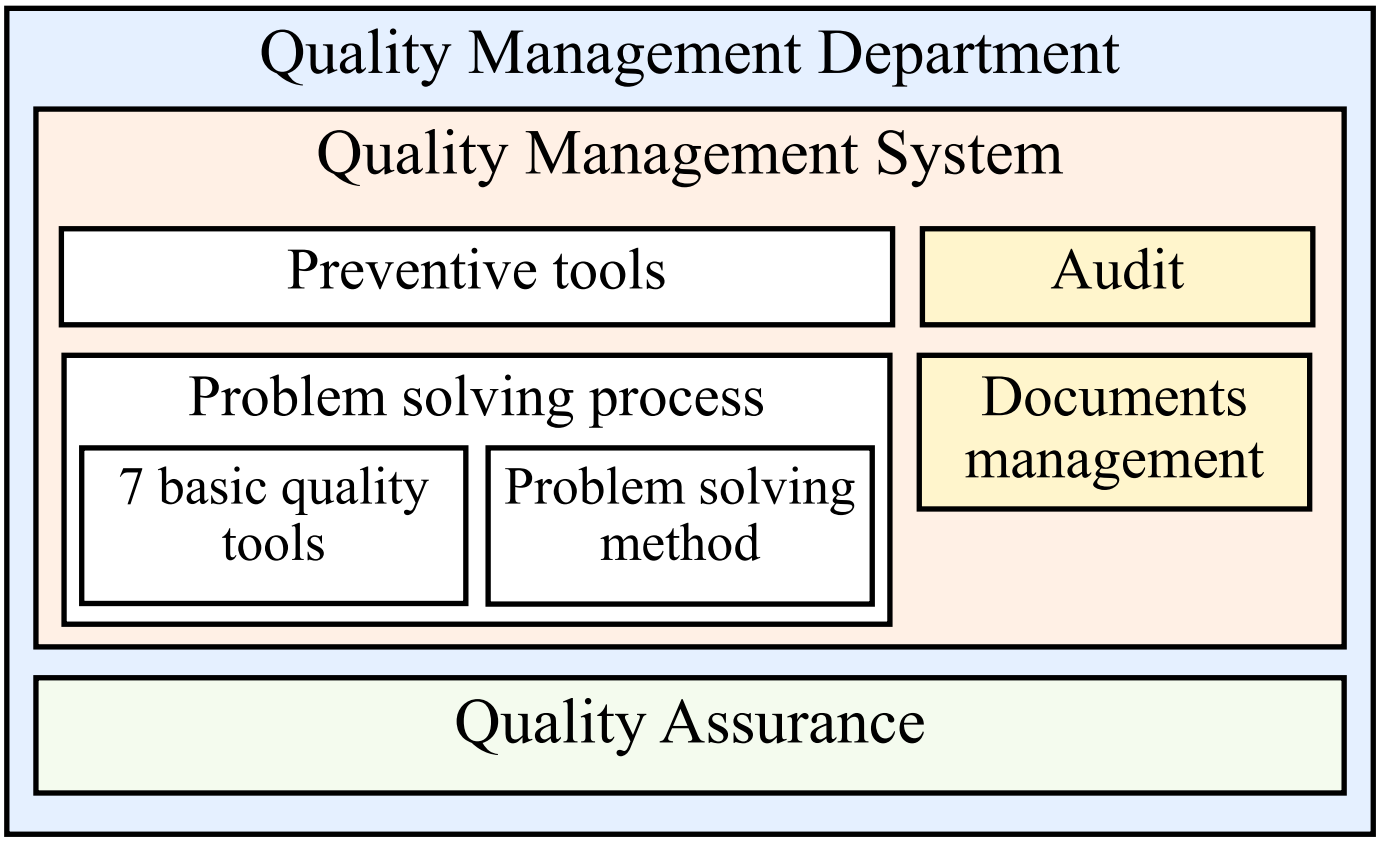
Relation between all sections

In this scheme you can see the relations between the all of the sections content.

The 7 basic quality tools are used as a tool of a problem resolution campaign, this campaign will follow the problem solving process, and by that it will choose a method. But for the quality in a company there are preventive methods that we will have to apply to improve or sustain a high level of quality. All these efforts are made to reach the level of an ISO 9001 certification or higher and to be more competitive in the market.

Conclusion

The tools and methods discussed in this document are a part of a system who has the purpose to achieve and sustain high level of quality. This system is called Quality management system (QMS) which the best known standard is ISO 9001 .
This document is the beginning of our journey in the world of quality management and I hope it will help you to achieve your goal.



Summary diagram of the relation of all the sections with QMS.

Thanks

I would like to thank all of you because you gave me the chance and the opportunity to grow by sharing with you my knowledge and thank you for this experience . I would like to close this document with a simple advice : “*Nothing is more **powerful** than **knowledge** and there is nothing **more dangerous** than **bad applications** of it*.”
Thanks.

" We learn, we grow ".

Thank you.