POLITECNICO DI TORINO

Course of Study: Master of Science In Mechanical Engineering

Thesis: World Class Manufacturing and Its applications (Lean Manufacturing).

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ABSTRACT

Basic purpose of WCM is continuous improvement in all areas of production in order to guarantee the quality of the final product and meet customer expectations. Projects developed under the WCM methodology which rely on a high level of employee involvement target the elimination of all forms of waste and loss with the ultimate objective of achieving zero accidents, zero waste, zero breakdowns and zero inventory.

Chapter 1st describe the general Introduction on human resource development. Chapter 2nd describes the difference between traditional and lean manufacturing and different tools of lean manufacturing. (SMED, 5S, 7 Wastes, 4M, 5W1H, Root Cause Analysis, Heijunka, Kanban, Kaizen, Just In Time, Continuous flow, PDCA).

Chapter 3rd describes the Introduction of World Class Manufacturing and 7 basic tools of WCM. It describes the detail of ten technical pillars of WCM (Safety, Cost Deployment, Focused Improvement, Autonomous Activities, Professional Maintenance, Quality Control, Logistics, People Development, Early Equipment Management/Early Production Management, Environment) and its applications.

1 INTRODUCTION TO HUMAN RESOURCE DEVELOPMENT

1.1 INTRODUCTION:

Human resource development is relatively a new field in academics but when it comes to practice it is not only old but well established. The idea of human beings evolving with the passage of time in order to improve the conditions seem's almost part of human nature.

In this chapter we will briefly discuss the definition, purpose, and core beliefs of human resource development. In the second chapter we will through light on the basic concepts of World Class Manufacturing (WCM) which will lead us to our final chapter in which we will discuss the development of Human Resource within World Class manufacturing (WCM).

1.2 DEFINITION OF HUMAN RESOURCE DEVELOPMENT:

There are numerous definitions of HRD. In this phase we will discuss different definitions of HRD in order to allow ourselves an exposure to the range of thinking in the profession.

HRD is a process for developing and unleashing human expertise through organization development and personnel training and development for the purpose of improving performance.

It is important to identify that numerous definitions of HRD have been presented over the years. For example, a recent definition took an inclusive international perspective of HRD that finds HRD functioning as an agent of societal and national development, not just focused on organizations. It reads as follows: "Human Resource Development is any process or activity that, either initially or over the long term, has the potential to develop adults' work-based knowledge, expertise, productivity, and satisfaction, whether for personal or group/team gain, or for the benefit of an organization, community, nation, or, ultimately, the whole of humanity" (McLean & McLean, 2000). Figure 1.1 provides a historical summary of the HRD definitions found in the literature through 1998 (Weinberger, 1998).

Human Resource Development Definition Summary

YEAR	AUTHOR	DEFINITION

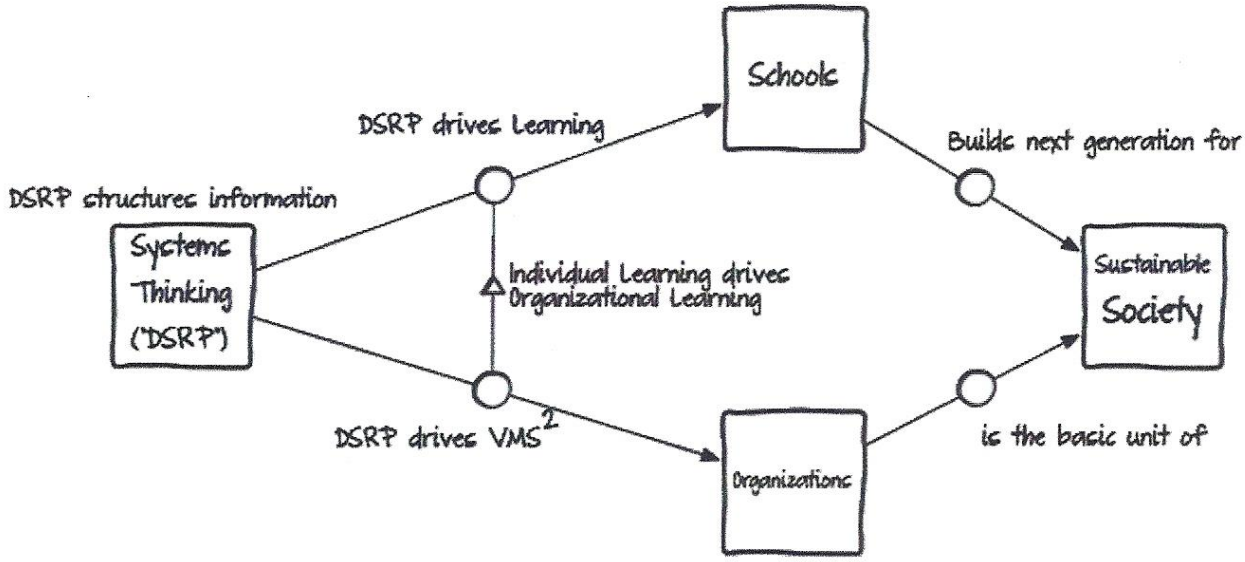
1970	NADLER	HRD is a series of organized activities adult learning conducted within a specified time and designed to produce behavioral change
1976	CRAIG	"HRD focus is on the central goal of human potential in every aspect of lifelong learning."
1981	JONES	"HRD is a systematic expansion of people's work-related abilities focused on the attainment of both organization and personal goals"
1983	MACLAGAN	"Training and development is identifying, assessing and through planned learning helping develop the key competencies which enable individuals to perform current or future jobs"
1983	CHALOFSKY & LINCOLN	Discipline of HRD is the study of how individuals and groups in organizations change through learning.
1986	NADLER & WIGGS	HRD is a comprehensive learning system for the release of the organization's learning; human potentials—a system that includes both Vicarious (classroom, mediated, simulated) learning experiences and experiential, on-the-job experiences that are keyed to the organization's reason for survival"
1989	WATKINS	"HRD is the field of study and practice responsible for the fostering of a long-term work-related learning Capacity at the individual, group and organizational level of organizations. As such, it includes—but is not limited to—training, career development and organizational development"
1990	D. SMITH	"HRD is the process of determining the optimum methods of developing improving the human resources of an organization and the systematic improvement of the performance and productivity of employees through training, education and development and leadership for the mutual attainment of organizational and personal goals"
1993	MARQUARDT	HRD skills include developing a learning climate designing training programs, transmitting information and experience, assessing results, providing career counseling, creating organizational change, and adapting learning materials.
1994	MARSICK & WATKINS	"HRD as a combination of training, career development, and organizational development offers the theoretical integration needs to envision a learning organization, but it must also

		be positioned to act strategically throughout the organization"
1995	SWANSON	"HRD is a process of developing and unleashing human expertise through organization development and personnel training and development for the improvement at purpose of improving the performance"

1.3 PURPOSE OF HUMAN RESOURSE DEVELOPMENT:

HRD is about developed human beings working in a productive system, contributing directly to the success of the organization. Idea is to pay attention on the resources that humans bring to success equation, the success of both the human and the organization. The two core issues which are addressed in HRD are as follows,

1. Individual and Organizational Learning
2. Individual and Organizational Performance



Some view learning and performance as alternatives or rivals, while most see them as partners in a formula for success. Thus, assessment of HRD successes or results can be categorized into the domains of learning and performance. In all cases the intent is improvement.

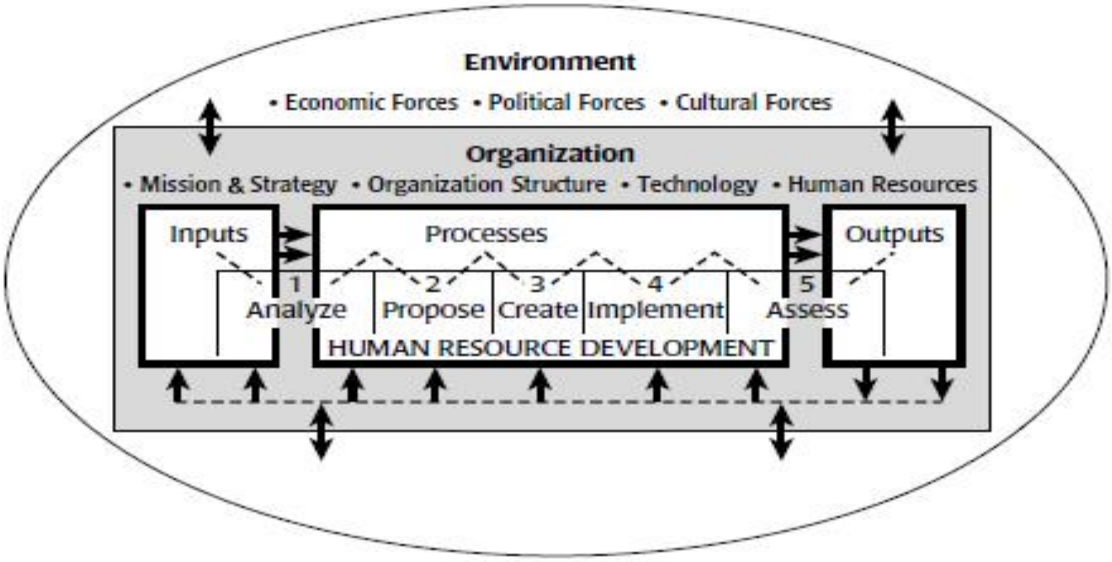
1.4 ORIGINS OF HUMAN RESOURCE DEVELOPMENT:

We can wisely connect the origins of HRD to the evolution of mankind. It was with evolution people understood that the development of Human Resource is important and necessary for the survival and advancement of society. HRD is relatively new term, training which is the most essential part of HRD can be related to the evolution of human race. It is important to recognize the massive development effort that took place in the United States during World War II as the origin of contemporary HRD. Under the name of the "Training within Industry" project (Dooley, 1945), this massive development effort gave birth to systematic (1) performance-based training, (2) improvement of work processes, and (3) the improvement of human relations in the workplace—contemporary HRD.

1.5 HRD CONTEXT:

The context in which Human Resource Development functions is always within a host organization. The organization can be a cooperation, business, industry, government agency or a nonprofit organization (charity hospitals, old houses etc). Such organizations work in a system with settled goals and missions. Organizations are always in competition and organizations which contains better developed human resources are almost always remain on top. In an international context, the host organization for HRD can be a nation. This strategic investment in HRD at the nation level can range from maintaining high-level national workforce competitiveness to fundamental elevation of a nation from poverty and disarray.

Multinational or global organizations can also be host organizations having operations in many different countries around the globe. Structure of HRD and focus of HRD work can be affected by such complex operational organizations. HRD has traditionally been sensitive to culture within an organization and between organizations. Making the transition to global issues has been relatively easy for HRD.



HRD in Context of the Organization and Environment

HRD can be thought of as a subsystem that functions within the larger host system for the purpose of advancing, supporting, harmonizing, and, at times, leading the host system. Take, for example, a company that produces and sells cars to customers. Responsible HRD would be ever vigilant to this primary focus of the company and see itself as supporting, shaping, or leading the various elements of the complex automobile organizational system in which it functions. Much more will be said about this contextual reality of HRD in the following chapters. For now, it is important to think about the great variations in how HRD fits into any one organization as well as the variation among the many types of organizations that exist in society. This complexity is compounded by the cultural differences from region to region and nation to nation in which HRD functions. It is an interesting and exciting profession!

1.6 HRD AS A DISCIPLINE AND A PROFESSIONAL FIELD OF PRACTICE

The HRD profession is widely recognized as one of very important professions. HRD can take variety of names and roles as with any applied field. Unfortunately this sometimes creates confusion to those outside the profession and even sometimes to those inside the profession. We take this position that this variation is not bad as it shows how vast HRD is as a professional field. Some of disciplines which may come under HRD are mentioned below

- Training
- Training and development
- Employee development
- Technical training
- Management development
- Executive and leadership development
- Human performance technology
- Organization development
- Organizational learning

Thus, practitioners who work in HRD may have varying titles such as manager of management development, organization development specialist, and director of technical training.

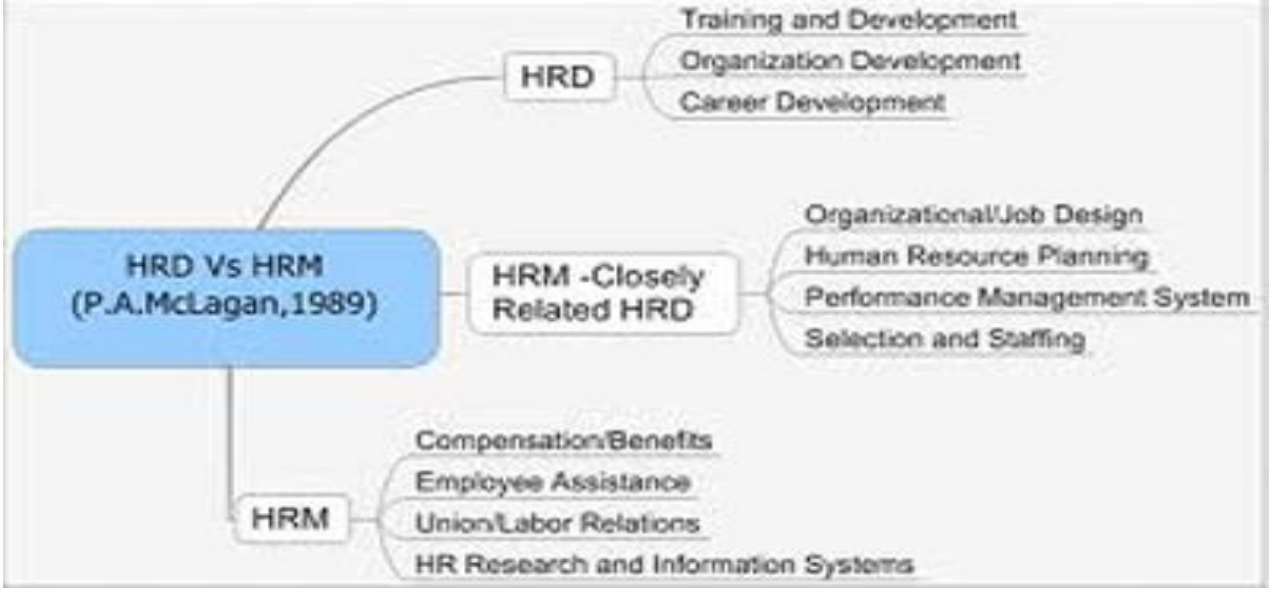
In addition, HRD roles can span the organization such as the chief learning officer, director of organizational effectiveness, or director of executive development. They can also fit within a subunit such as manager of sales training, HRD coordinator (at a particular company location), or bank teller training specialist. Furthermore, a very large contingent in organizations is doing HRD work as part of their non-HRD jobs. For these people, HRD work is part of their larger job. It is almost impossible to calculate the total organizational commitment to HRD. Reports of chief executive officers leading executive development programs and shipping clerks doing on-the-job training of new employees are commonplace. Efforts at analyzing the total financial commitment to HRD have been elusive.

Estimates in the United States have led enormous financial numbers spent annually to conceptual comparisons. For example, it is estimated that the money spent on HRD in the workplace each year exceeds all the money spent on public education—kindergarten through universities—in the same time period. By any assessment,
HRD is a huge profession with a huge annual expenditure. We also see HRD as overlapping with the theory and practice underlying other closely linked domains, including the following:

- Career development

- Organizational and process effectiveness
- Performance improvement
- Strategic organizational planning
- Human resource management
- Human resources

Probably the most apparent connection is with human resources (HR). HR can be conceived of as having two major components—HRD and HRM. As an umbrella term, HR is often confused with HRM. Thus, many HR departments are actually limited to HRM goals and activities such as hiring, compensation, and personnel compliance issues. Even when HRD and HRM are managed under the HR title, their relative foci tend to be fairly discrete.



1.7 CONCLUSION:

The practice of HRD is dominated by positive intentions for improving the expertise
and performance of individuals, work groups, work processes, and the overall organization. Most observers suggest that HRD evokes common sense thinking and actions. One consequence is the ease with which people are willing to contribute and participate in HRD processes. One bad consequence is that many of the people working in the field have little more than common sense to rely on.

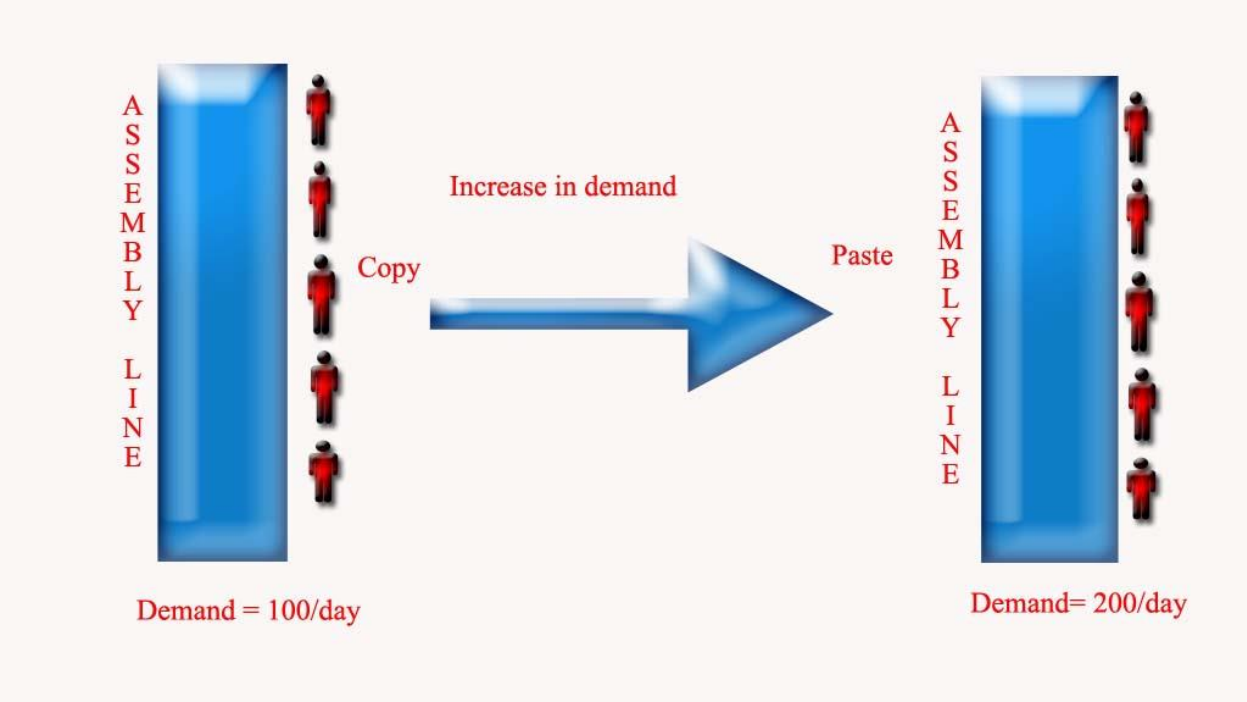
The ultimate importance of this book is to reveal the underlying thinking and supporting evidence that allow HRD professionals to accept and apply sound theories and tools confidently. Such a foundation has the potential of ridding the profession of frivolous and invalid armchair theories and faddish practices.

2 TRADITIONAL AND LEAN MANUFACTURING

2.1 TRADITIONAL MANUFACTURING:

Traditional manufacturing is the process of manufacturing where each part of the process is carried out separately and next stage of the process cannot begin until the end of previous stage. In traditional manufacturing the flow of information is only in one direction which causes many problems such as costs under prediction, time consumption etc.

The main objective of traditional manufacturing is to increase productivity regardless of costs. For example if there is firm that produces 100 pieces in one day to meet the demand of market; now if the demand increases to 200 pieces in one day the traditional manufacturing will tell us to increase investment so that a separated assembly line can be setup in order to meet the demand of the market. Productivity is increased regardless of the cost.



So in order to meet the new demand, a new assembly line is setup and labor force is increased. This is also known as over the wall engineering as each stage blindly

throws the development to the next stage over the wall. This methodology is hardly used today.

2.2 LEAN MANUFACTURING

Lean manufacturing is a production practice which aims to reduce expenditure of any resource that does not add value to the end product. It is different from traditional manufacturing where aim was to increase productivity regardless of the cost. Lean manufacturing is an enterprise wide strategy to achieve excellence. One can say that it is another approach of increasing productivity but this approach targets the reduction of non-value added activities and costs to increase the overall productivity. The core idea is to maximize **customer value** while minimizing waste. Simply, lean means creating more value for customers with fewer resources.

A lean organization understands customer value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.

To accomplish this, lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services through entire value streams that flow horizontally across technologies, assets, and departments to customers.

Eliminating waste along entire value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to

make products and services at far less costs and with much fewer defects, compared with traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Also, information management becomes much simpler and more accurate.

2.3 DIFFERENCE BETWEEN TRADITIONAL AND LEAN MANUFACTURING:

TRADITIONAL MANUFACTURING	LEAN MANUFACTURING
Production driven by (Push).	Production is driven by customer demand; items are only produced when an order is placed.
Problems are viewed as just that, problems.	Problems are viewed as opportunities for improvement often through root cause analysis.
Work in process (WIP) is viewed as a normal part of operations.	WIP is a sign that a process needs to improved and is considered a type of waste that should be reduced or eliminated (the same is true for inventory)
Improve system (disregarding all of the types of waste in the process).	Improve system by 1) Eliminating waste and 2) Improving current processes.
Management is the primary driver of change	Everyone is empowered, trained in the principles of lean and encouraged to look for ways to improve processes.
If a process is working (if it isn't broke) don't fix it.	Always look for ways to improve processes.
Standardized work (people performing the same task the same way) only exists in documents like SOPs, rarely in reality.	Everyone performs the same task the exact same way until a better way is discovered; then everyone performs the task the new and improved way.
Focuses on training and relies on people to not make mistakes.	Focuses on building processes that are error proofed (a person cannot make a mistake or it would be difficult to do so).
Systems thinking (views the organization as a whole), often ignoring	Views the organization as a series of interrelated processes that can and

or unable to see the enormous opportunities for improvement.	should be improved.

2.4 Tools of Lean Manufacturing

Lean has a very extensive collection of tools and concepts. Surveying the most important of these, understanding both what they are and how they can help is an excellent way to get started.

2.4.1 SMED

SMED stands for single minute exchange of die and it helps reduce the setup time to less than 10 minutes. It focuses on the elimination of non-essential operations and creates standardized work instructions. It is performed while the process is running. Enables manufacturing in smaller lots, reduces inventory and improves customer responsiveness.

2.4.2 Five S (5s)

5s is tool which helps organize the work area by separating, systemizing, shining, standardizing and finally sustaining. It helps in eliminating the waste that results from poorly organized work area. For example wasting time, looking for a tool etc.

Separate: Eliminate the material which is not required or which does not belong to that work place.

Systemize: Organize the remaining items and place the items at their individual places.

Shining: Clean and inspect the work area.

Standardize: Write down the standards of the above actions.

Sustain: Make sure that the standards are applied regularly and consistently.

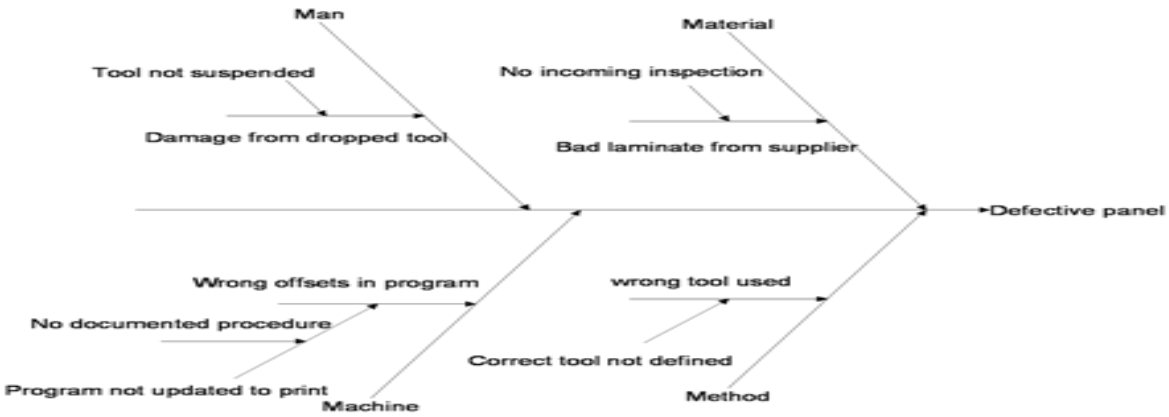
2.4.3 7 Wastes:

7 Wastes are activities identified in an organization that does not add value to final product but costs money. Usually only 5% of the time adds value to final product

and rest is waste and that waste is more or less the result of these 7 activities. These wastes include over production, Inventory, Waiting, Motion, Transportation, Rework, over processing.

2.4.4 4M:

4M is a tool used to find the rout cause of a problem. Whenever it is required to carry out a root cause analysis of any problem 4M is the tool used for that purpose. 4M stands for Manpower, Machine, Materials and Method.



Manpower:

Are operators working according to standards?

Are operators aware of problems?

Is the turnover on workplaces high?

Are operators well trained?

Is level of expertise high?

Machine:

Do machines and tools work respecting process standards?

Is capability level OK?

Is machine lubrication OK?

Is an inspection program implemented?

Are machines working properly (without breakdowns or micro-stoppages)?

Are machines producing noise?

Are tools revised according to control plans?

Materials:

Are materials available according to production requirements?

Do materials respect technical specifications?

Does stock management follow defined standards (e.g. protection from external damages by weather, manipulation, etc.)?

Are supplies made according to procedures?

Are materials properly put near workplaces?

May materials be properly identified in terms of code and status (e.g. scraps)?

Are suppliers working according to supply standards?

Method:

Are working instructions clear, understandable, complete and currently updated?

Are ergonomic conditions OK?

Do exist “error proofing” methods (Poke Yoke)? Do environmental conditions (temperature, lighting, cleanness, safety) allow operators working in a proper way?

2.4.5 5W1H:

This is actually the description of the problem. This tool wants to answer one simple question i.e. which is the actual situation? There are different tools to answer this question like histogram, control charts etc. But the most common and most powerful tool is 5Ws plus 1H.

What: What is the product/object effected by the problem? Description of the phenomenon product, machine material; affected by the problem

When: When did the problem occur? Time period of the problem occurrence in the process flow: startup, normal operations, setup, shutdown.

Where: Where did you detect the problem? Part of the product/production line where the problem was detected.

Who: Who is the problem affected by human factor.

Which: The trend of the problem, repetitive, irregular etc.

How: Current conditions vs ideal status.

2.4.6 Root Cause Analysis (5Whys):

A problem solving methodology that focuses on resolving the underlying problems instead of quick fixes that only treats the immediate symptoms of the problem. A common approach is to ask why five times, each time moving a step closer to discovering the true underlying problem.

It helps to ensure that a problem is truly eliminated by applying corrective action to the root cause of the problem.

2.4.7 HEIJUNKA:

A form of production scheduling that purposefully manufactures in much smaller batches by sequencing product variants within the same process. Reduces lead time since each variant is manufactured more frequently and it also reduces the inventory since batches are smaller.

2.4.8 KANBAN:

It is a method of regulating the flow of goods both within the factory and outside with suppliers and customers. Based on automatic replenishment through signal cards that indicate when more material is needed.

Eliminates wastes from inventory and overproduction and can eliminate the need of physical inventory instead relying on signal cards to indicate when more goods are required.

2.4.9 KAIZAN:

It is a strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing processes. It combines the collective talents of company to create an engine that eliminates waste from manufacturing processes.

2.4.10 JUST IN TIME:

Pull parts through production based on customer demand instead of pushing parts through production based on projected demand. It relies on many lean tools such as heijunka, continuous flow, Kanban etc.

Highly effective in reducing inventory levels and improves cash flow. Also reduces space requirement.

2.4.11 CONTINOUS FLOW:

Manufacturing where work in process smoothly flows with minimal or no buffers between the steps of the manufacturing process. This tool helps eliminate many kinds of wastes such as inventory, waiting and transportation.

2.4.12 PDCA (Plan, Do, Check, Act):

It is an interactive methodology for implementing improvements.

PLAN: Establish plan and expected results

DO: Implement plan

Check: Verify expected results achieved

ACT: Review and assess; do it again.

2.5 SUCCESS STORIES:

Boride Engineered Abrasives

For nearly forty years Boride Engineered Abrasives, located in Traverse City, has developed and manufactured abrasive products for industrial and consumer applications. BEA products include mold polishing supplies and polishing equipment. In an effort to move forward with their motto, "Everything is accomplished with a process", BEA began their lean manufacturing journey. They contacted the MMTC Northwest regional office for assistance. BEA wanted to reduce lead-times, increase on-time delivery and reduce Work-in-Progress inventory in its facility. Applying lean principles to production, order handling, development projects, elimination of waste, improvements in customer Service, quality, productivity, safety, BEA achieved great success. MMTC Northwest partnered with the Northern Michigan College (NMC) Training and Research staff to conduct a needs analysis based on the Human Performance Technology model. Once the analysis was complete and summarized, MMTC and NMC recommended appropriate services to address the identified gaps in performance.

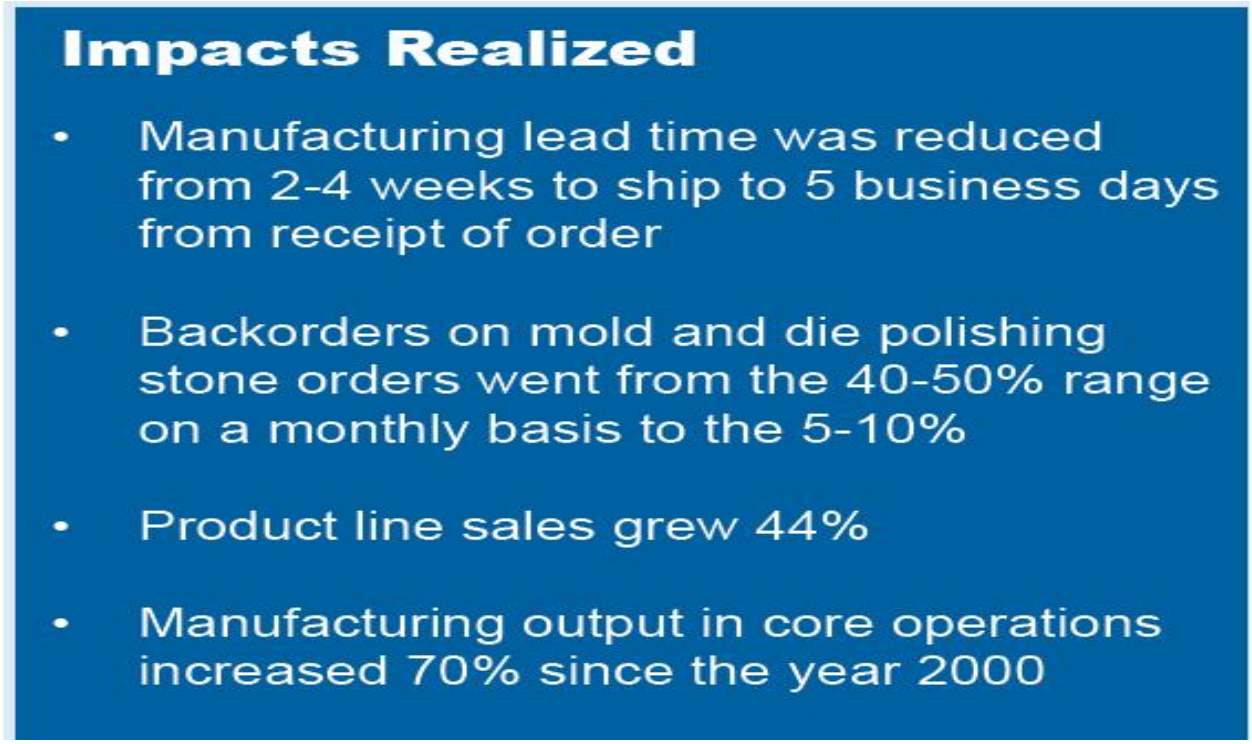
Training was provided in the following areas by NMC staff:

- Lean Manufacturing Overview with simulation
- Value Stream Mapping
- Cellular Flow
- 5S – Workplace Organization
- Setup Reduction

NMC Training and Research staff facilitated project teams in order to:

- create current and future state maps of complete
- production flow
- identify first horizon Kaizen activities in the Mark and Pack process
- apply cellular flow in Mark and Pack process
- apply 5S to press area
- conduct Set-up Reduction in Hydro-met press area

The lead time to manufacture a mold and die polishing stone was significantly reduced. BEA customers are told every order received before 3PM will be shipped the next day complete. Backorders on mold and die polishing stone orders went from the 40-50% range on a monthly basis to the 5-10% range. Floor space was increased over 1000 sq feet which was used initially for manufacturing a new product line. The 5S application has been dramatic. BEA's facility is cleaner, brighter and more organized. Walls have been painted. Unused materials and equipment have been removed and tagged. Tools have their proper places and are being kept there. Machines in the wheel area were all painted, repaired and their hydraulic leaks fixed.



3 WORLD CLASS MANUFACTURING(WCM)

3.1 INTRODUCTION:

What does it mean to be world class competitor? It means being successful in your chosen market against any competition regardless of size, country of origin or resources. It means matching or exceeding any competitor on lead time, flexibility, cost/price, customer service and innovation.

WCM was born with joint venture of Fiat and the best European and Japanese experts with goal to increase the production standards to recognized world standards.

Fiat first started implementing WCM in 2005 in order to overcome the crisis. FIAT started implementation of WCM model as FAPS (Fiat Auto Production System), initially starting with two pilot plants Tychy (PO) and Melfi (IT) and in 2006 extending to other plants of Fiat Group of Automobiles. Now WCM is extended to Suppliers in order to create a proper flow system and same production from beginning to end.

WCM is a structured and integrated system of manufacturing which encircles almost all possible aspects of production, from safety to environment, from maintenance to logistics and quality. The first and foremost aim of this system is to continuously improve production and progressively eliminate waste making sure the quality and maximum flexibility in response to the needs of the customers by involving and motivating people working in the plants. WCM principles apply to all aspects of plant organization from the Quality system to Maintenance, from Cost control to Logistics, in a perspective of Continuous Improvement.

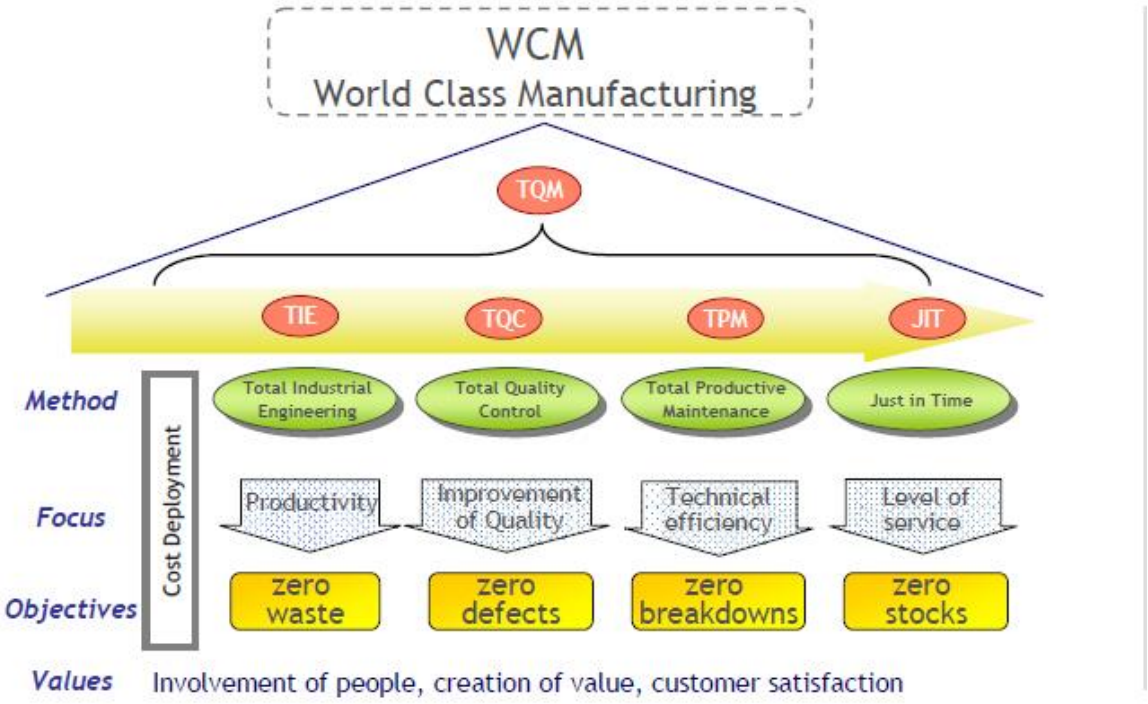
People involvement is one of the cornerstones of WCM and in 2010 50% of blue and white-collar workers at Group plants in Italy participated in the program and over 1 million employee suggestions were received worldwide. Application of World Class Manufacturing methodologies and guidelines has also been extended beyond the manufacturing area. Similar initiatives have, in fact, also been

developed for logistics and administrative processes with the aim of achieving an integrated approach across the various areas of activity.

At the end of 2010, 130 sites were involved in the program, accounting for over 95% of the manufacturing cost base for Fiat Group pre demerger. Of those sites, 18 achieved bronze level and 9 silver level. Achievement of each performance level (bronze, silver, gold or world class) is certified through external audits conducted by teams overseen by representatives of the WCM Association. This audit system enables continuous internal benchmarking between Group entities and facilitates a constructive exchange of experience and applied solutions between members of the WCM Association.

3.2 FRAMEWORK OF WCM:

World Class Manufacturing is cost driven, all the activities are coming from the cost deployment pillar except Safety activities as Safety is first and health don't have price. World Class Manufacturing focuses on the Workplace, Quality of the product and process, Maintenance of the capital and the Logistic system of the company.



WCM uses Total Industrial Engineering, Total Quality control, Total Productive maintenance and Just In Time methods and standard to solve the problem in the above mentioned areas. The focus of these activities is to increase the productivity, improving quality, maximizing technical efficiency and providing efficient service level to the customers.

The targets of World Class Manufacturing are to achieve the following zeros;

1. Zero Waste
2. Zero Defects
3. Zero Breakdowns
4. Zero Inventory

The Values of World Class Manufacturing is the Involvement of people as for any improvement the involvement of the people on the floor is very important and by involving people creating Value and the most important Customer satisfaction.

3.3 7 BASIC TOOLS OF WCM:

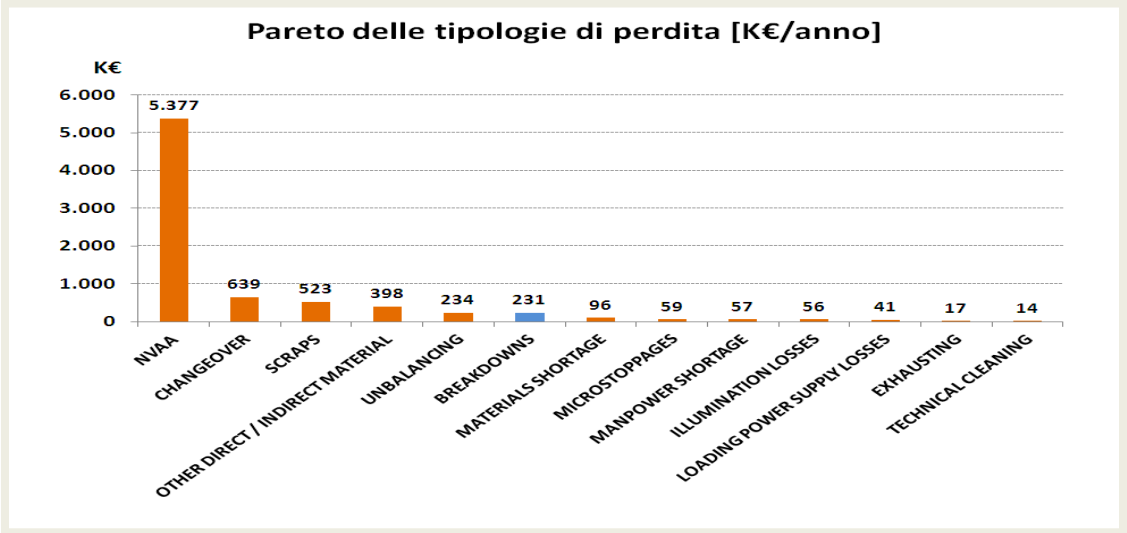
There are seven basic tools which are used by WCM in building of improvements that are made. These tools are used by all pillars as it gives a structured approach in solving problems and continuously improve. These seven tools are as follows

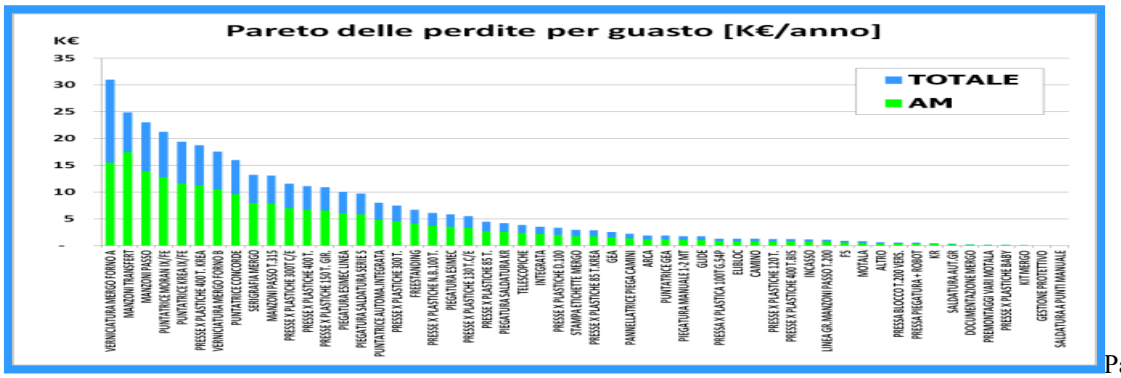
1. Prioritization
2. Deployment of objectives
3. Problem description with sketches
4. Problem description
5. Root cause analysis
6. Phenomen description
7. TWTTP

3.3.1 PRIORITIZATION

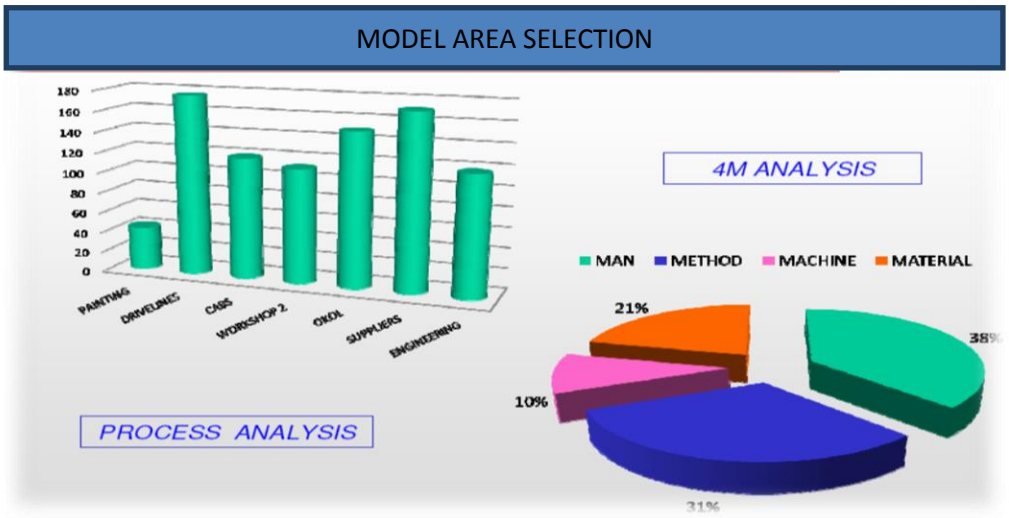
Prioritization is one of the fundamental tools used in WCM. All the pillars in WCM work on a model area prioritized based on the amount of loses generated. A detailed study is conducted to find out loses generated in different processes and special teams are made with the know how to minimize or eliminate loses on priority bases. The prioritization allows us to find most important problems and following are the most common tools used to achieve this goal

1. Cost deployment
2. ABC classification
3. Pareto diagram
4. Stratification
5. QA matrix
6. Machine breakdown map
7. Safety matrix
8. Value stream Map





Pareto Diagram



QA Matrix Analysis

3.3.2 DEPLOYMENT OF OBJECTIVES:

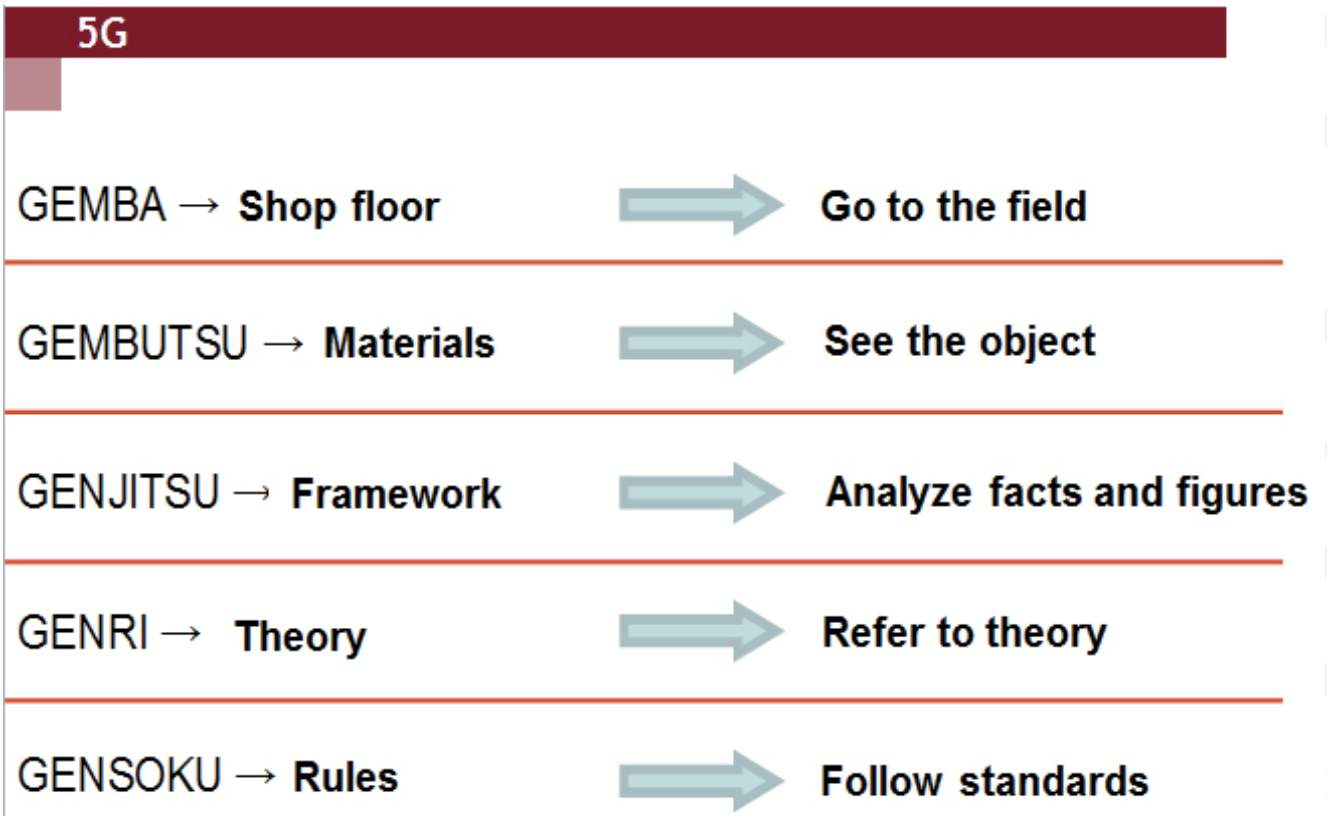
It is a systematic, logical and detailed deployment of objectives into right means and right solutions, and measurement of the results against the objectives and targets that helps in identifying where the problem lies. It is important not to mix objectives with means.

3.3.3 PROBLEM DESCRIPTION WITH SKETCHES:

Problem description with sketches is another basic philosophy based on the fact that it is easier for humans to understand when explained visually rather than theoretically. Drawing sketches and pictures helps better understand the problem and therefore it is suggested in WCM to explain the problems with use of sketches and pictures.

3.3.4 5W1H WITH 5G PRINCIPLES:

This tool is used to gather the description of the problem in a complete and detailed way keeping a proper relation between theory and practice. It follows a logical flow during the process. This is an approach used to manage a loss phenomenon like defect, breakdown, abnormality etc.



3.3.5 ROOT CAUSE ANALYSIS:

Root cause analysis uses 5 why and 4M tools to identify the real cause of the problem. In lean manufacturing it is important find the root cause of the problem as it helps to completely eliminate the problem. We have already discussed these tools in chapter 2 and needs no further explanation.

3.3.6 PHENOMENA DESCRIPTION:

This tool helps to describe phenomena by carefully observing what is happening behind the problem. OPL (One Point Lesson) and SOP (Standard Operating Procedure) are major tools used to visually explain the phenomena.

3.3.7 THE WAY TO TEACH PEOPLE (TWTTP)

This tool helps to find hidden issues behind the problem mainly linked with human errors. Human errors takes place WHERE:

- Operations are irregular and discountinous
- In case of two mens operation, work responsibilities between them is not clear
- It is not easy to stop operation in case problem occurs
- There are many similar pieces of equipement installed which are difficult to distinguish one from another

BECAUSE OF:

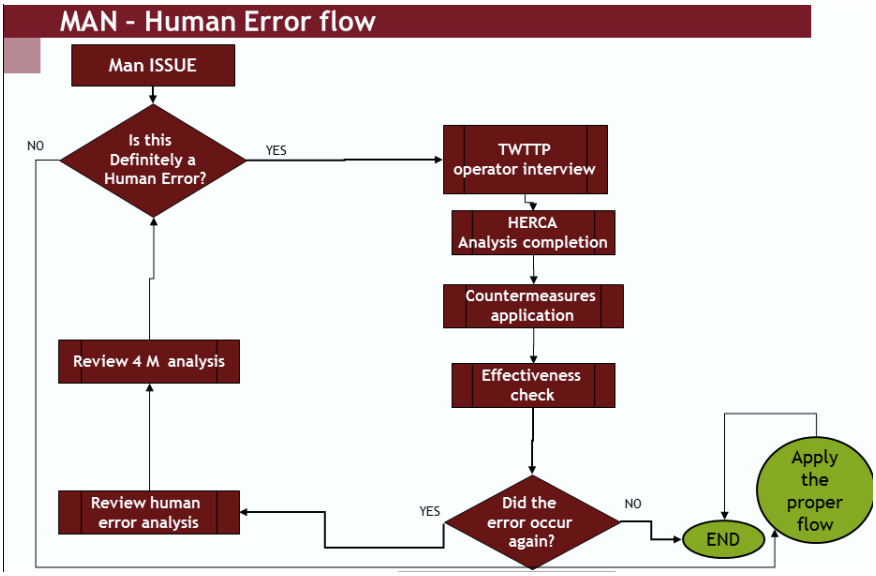
- Wrong judgement of visual information
- Time delay between action taken and receving information
- Forgetfullness
- Wrong measurement and/or preparations
- Carelessness and/or rough operation

Reasons of theses human errors can be categorized

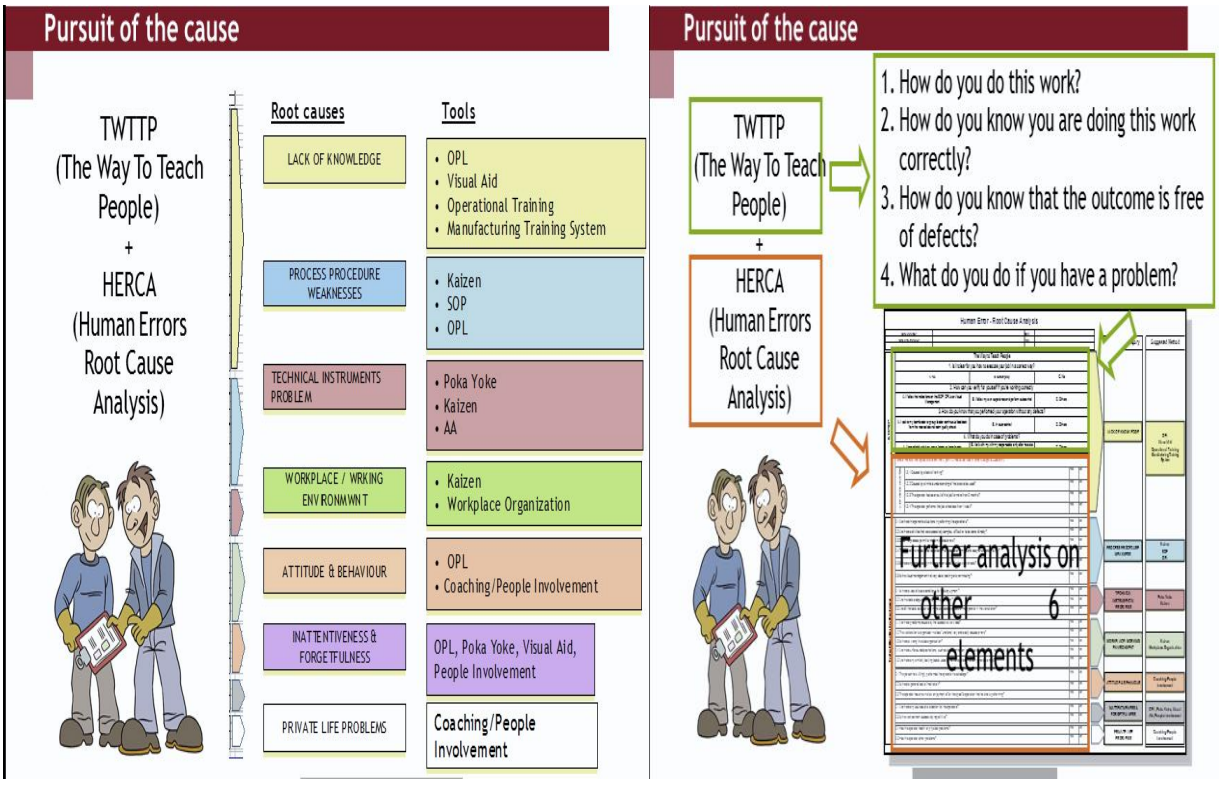
- Knowledge
- Skill
- Bad habbits due to past experience
- Attention (Health problems)
- Misunderstanding, misjudgement, misoperation

In order to eliminate human errors, it is important to work parallel on two different sides

1. Pursuing the causes of human errors and taking countermeasures against them
2. Introduce visual control to avoid human errors everywhere there is a risk of creating human errror.



(HUMAN ERROR FLOW)



TWTTP+HERCA

(THE WAY TO TEACH PEOPLE AND HERCA

3.4 PILLERS OF WORLD CLASS MANUFACTURING

The WCM system consists of ten technical and ten managerial pillars, each with incremental levels of improvement, and results that are clearly identified and measurable. An increased focus on energy saving and efficiency has also been incorporated into WCM, with development of an Energy sub-pillar forming part of the Environment pillar, to improve the ability to identify and implement measures to reduce waste and achieve more efficient energy use.

Technical Pillar:

The pillars of technology or activities are structured improvement processes that must be present together with various tools. The pillars are;

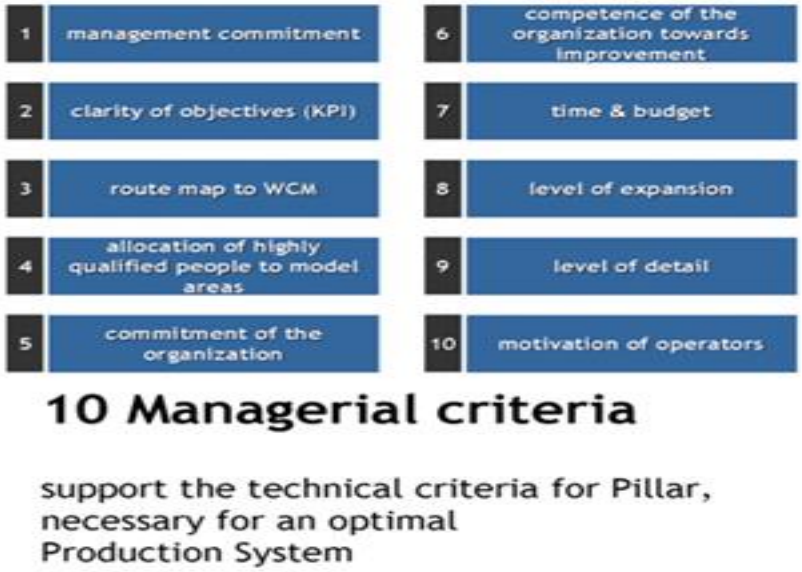
1. Safety (SAF)
2. Cost Deployment (CD)
3. Focused Improvement (FI)
4. Autonomous Activities
    a. Autonomus Maintanance (AM)
    b. Workplace Organization (WO)
5. Professional Maintanance (PM)
6. Quality Control (QC)
7. Logistics and Customer service (LOG)
8. Early Equipment/Product Management (EEM/EPM)
9. People Development (PD)
10. Environemnt

Managerial Pillars:

The pillars managerial or management, are vice versa actions that must be played by the central coordinator of Team WCM (WCM leader or plant manager). They are aimed at promoting the commitment and responsibilities of the various managers assigned to specific pillars of activity to carry out plans and projects through the dissemination of know-how. The pillars are;

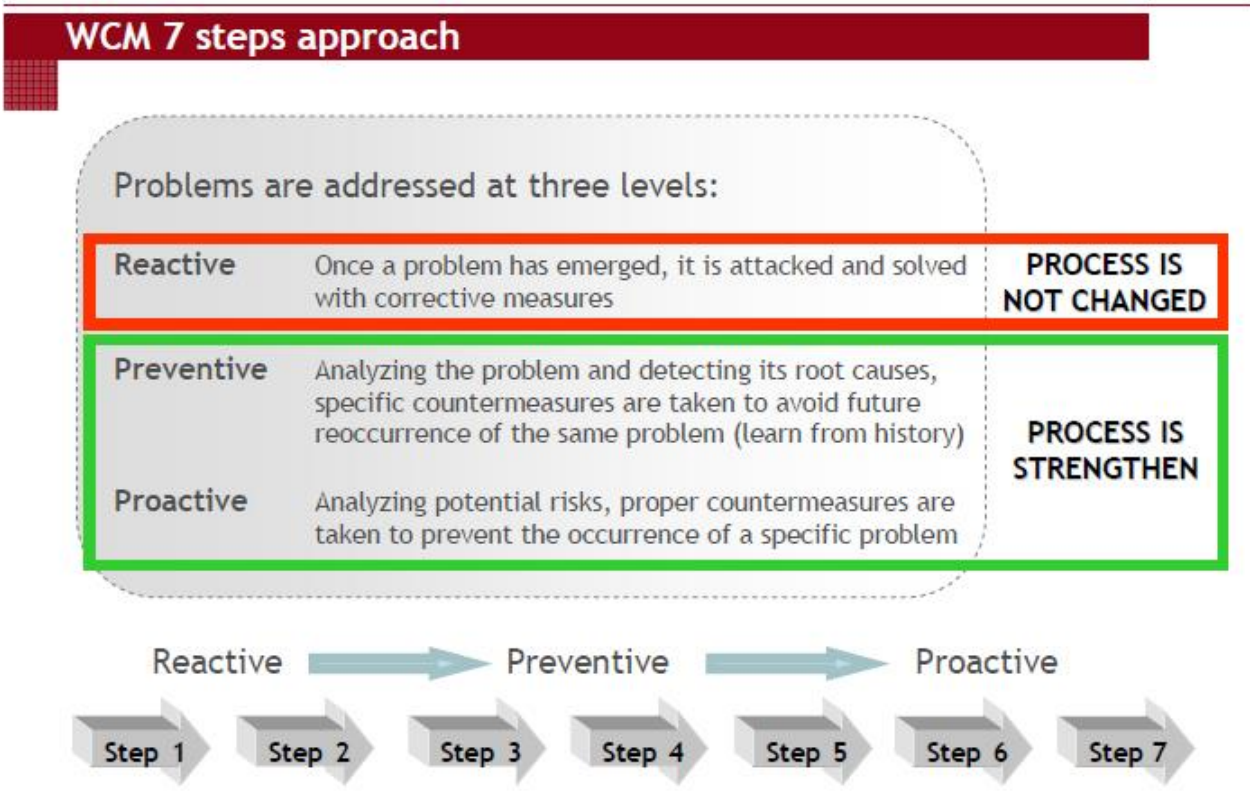
1. Management Commitment
2. Clarity of Objectives
3. Route Map to WCM
4. Allocation of high qualified people to Model Area

5. Commitment of the Organization
6. Competence of the Organization towards Improvement
7. Time and Budget
8. Level of Detail
9. Level of Expansion
10. Motivation of Operators



Each pillar has seven steps that must be covered and certified to implement this methodology, in the bond that you can't go to the next step if you have not completed and certified the previous step. These columns address the business functions in their daily work and require an analysis of the benefit/cost which is the discriminating factor for the feasibility of that is about to undertake. Each project must be implemented to have a competent team, a cost analysis, actions to improve the benefit / cost ratio, and constant monitoring over time. The concepts of depth and breadth of the WCM are further innovations in the sense that this methodology requires that individuals holding a limited area on which we begin to do yard, and only when the team gave the expected results, and followed strictly the steps provided by the pillar you can think of the extension of the methodology, which consists of identifying other sites, which are areas

identified as critical analysis of the preliminary costs. In practice, if this proves to be strict in a limited scope, it is unthinkable to go further and extend the process. The score that comes from formal audit establishes a competition between plants leading to a further push to the improvement.



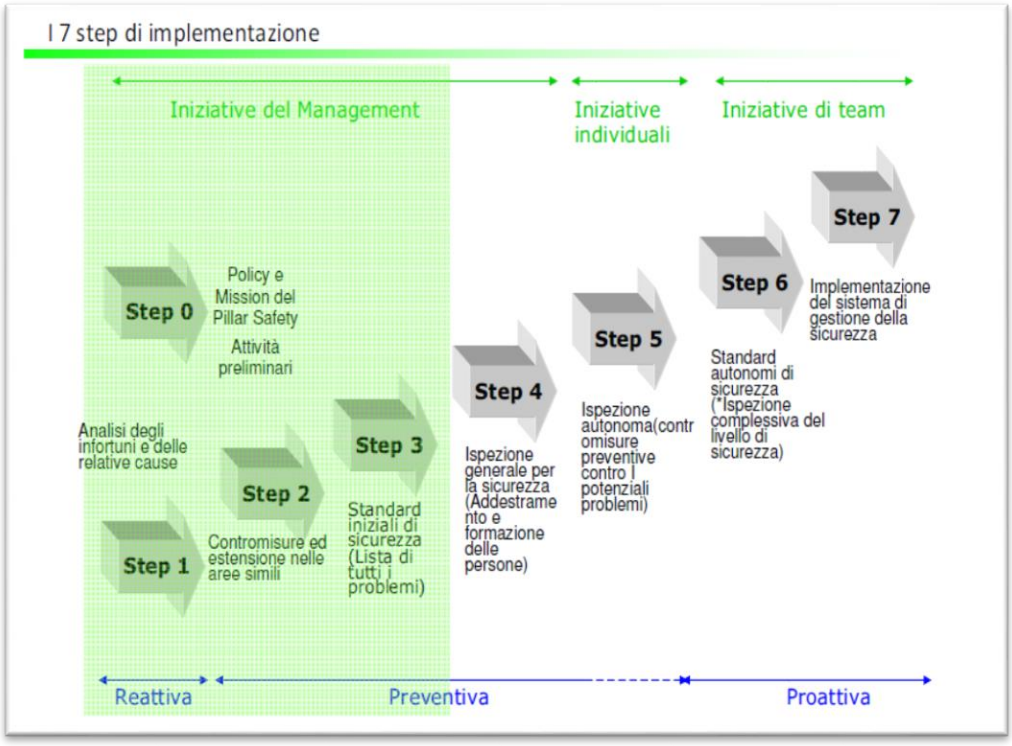
3.4.1 SAFETY (Safety First)

Safety pillar proposes continous improvement of work enviroment and elimination of any condition that may cause any accident or injury. The objective of this pillar is to achieve zero injury level. This target can only be achieved by spreading the culture of safety at levels of organization.

Safety pillar plays the role and reduces many unseen losses and helps better the moral of the labour force. Efficiency that can be achieved in an injury free environment is hard to achieve in not so safe envirnoment. Safety is important because

- It helps increase the moral
- Legal reasons
- Economic reasons

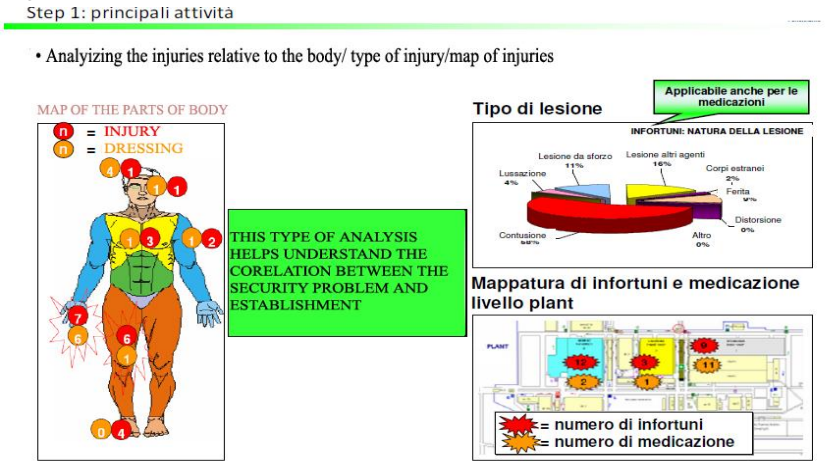
- Human error reduction
- Management system efficiency



STEP 1: ANALYSIS OF INJURIES AND RELATIVE CAUSES

PRINCIPAL ACTIVITIES

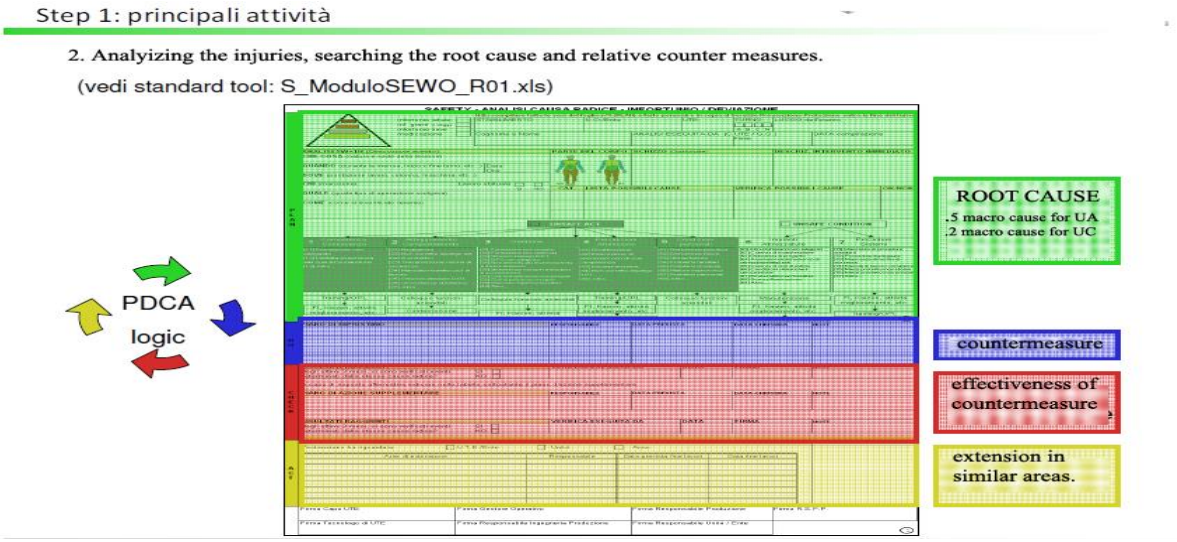
1. Analyzing the injuries relative to the body/ type of injury/map of injuries



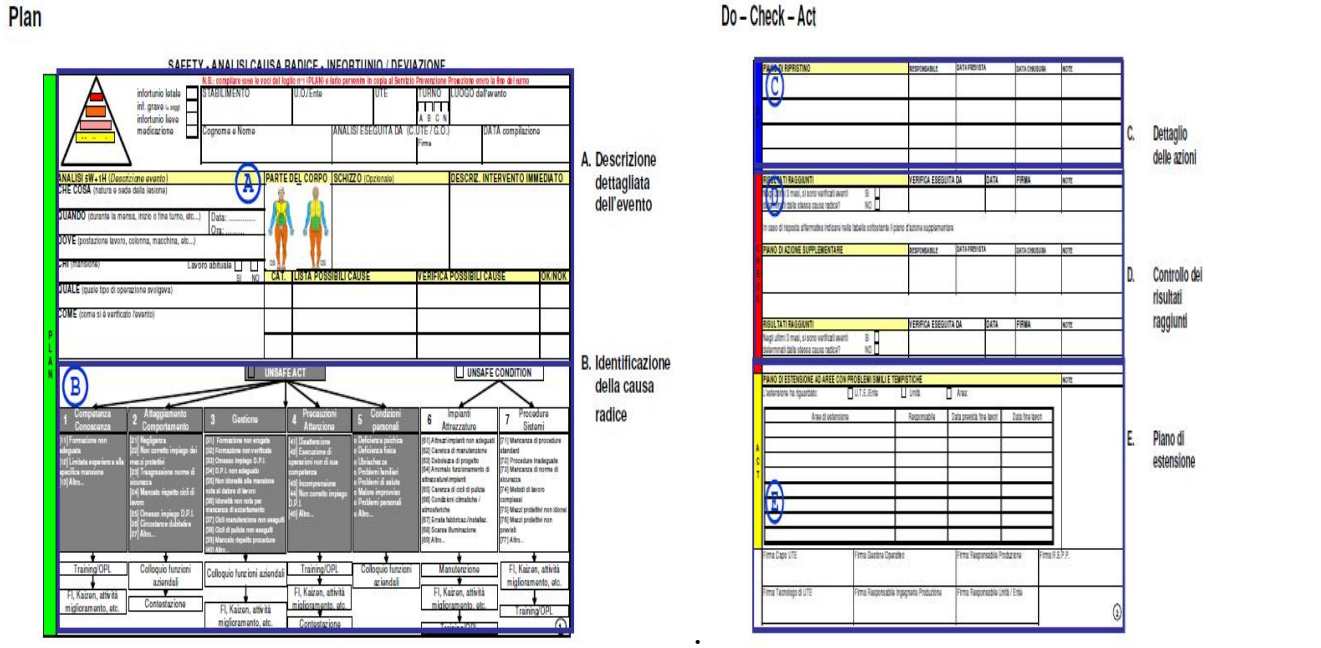
This kind of analysis helps understand the correlation and commonalities between the security problem and establishment. This is the step that also helps in prioritizing that helps in choosing the model area for intervention.

2. Analyizing the injuries, searching the root cause and relative counter measures.

For analyzing the injures and find out the root causes of all the injuries, a specific tool is used SEWO. This tool uses the PDCA activity to first find the root cause and then eliminating before extending the project to different similar cases.

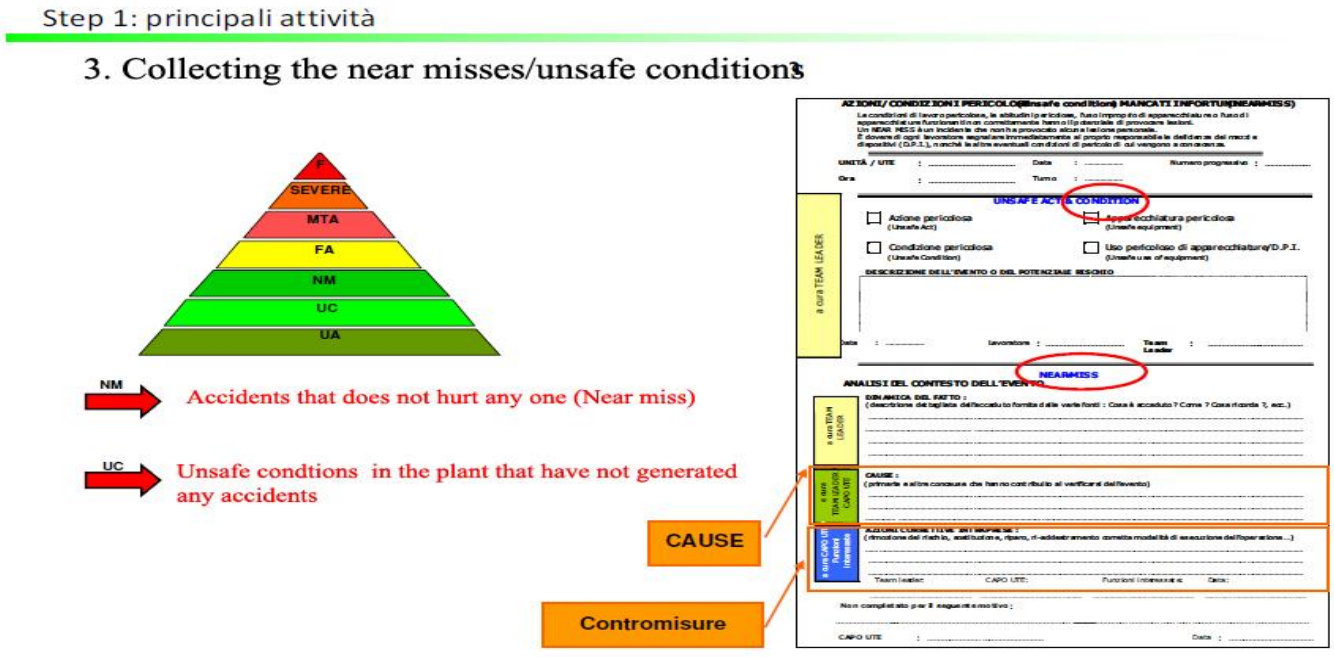


In the plan phase we find the root cause of the injuries according to two different parameters i.e. unsafe act and unsafe conditions. In the second part all the countermeasures are applied in the model areas which are then observed to check the effectiveness of the countermeasures. In the final part the countermeasures are extended to different areas of the plant with similar problems.



3. Collecting the near misses/unsafe conditions

All WCM pillars start from a reactive phase but in safety reactive phase does not exist, therefore all the record of unsafe condition and unsafe acts is collected and such conditions are prioritized for intervention. This is key performance indicator for the safety pillar.



4. Basic norms of safety for padestrians, control of vehicals and basic working condition

Earlier in my thesis we studied the 7 basic tools of WCM and one of those 7 tools were the use of sketches and photos to explain different things to labor. Here all the basic norms of safety are applied and then preached further using sketches and photos.

Image above shows how we can maintain the basic safety conditions by just using different sketches with instructions for the appropriate user.

5. Plan of evacuation and organization for sudden accidents or explosions etc.

An organization must have a plan for sudden evacuation in case of an emergency. It must also be equipped with emergency first aid service. Any organization is bound to carry out evacuation exercises to prepare the staff for an emergency condition.

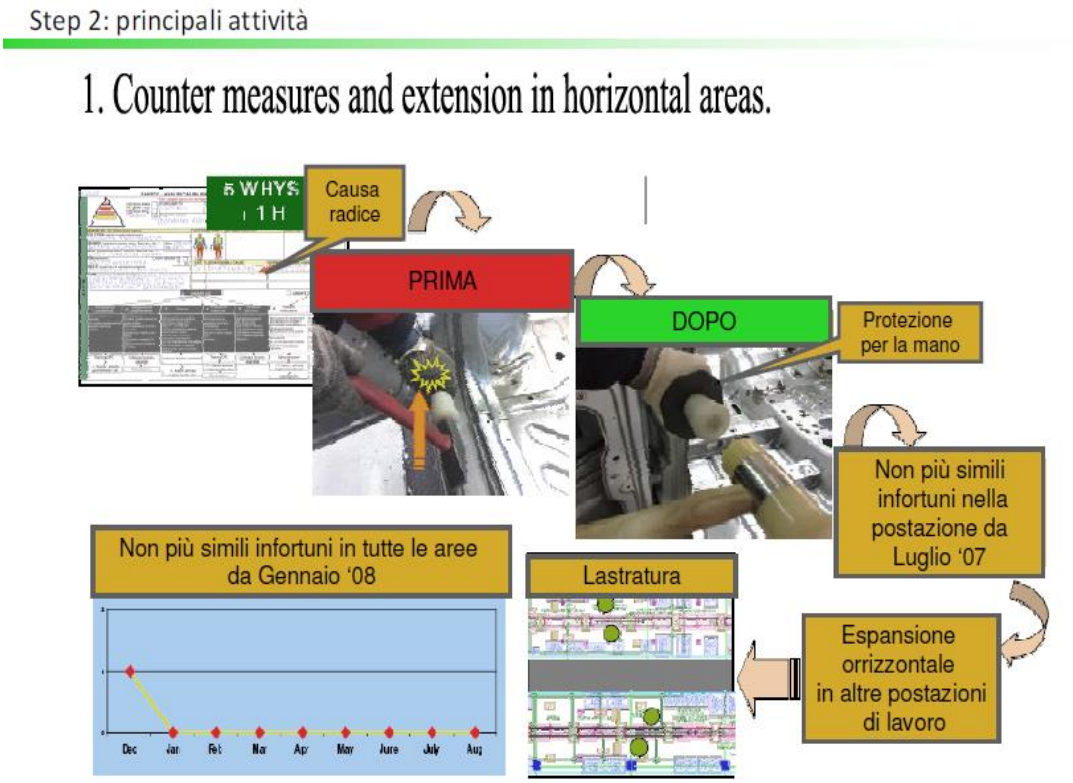
STEP 2: COUNTERMEASURES AND EXTENSION IN SIMILAR AREA

In this step horizontal extension of results obtained in step one is carried out in similar areas. Such activities are settled which help in improving the safety. System is setup to communicate the level of safety to everyone and responsibility matrix is made for safety. At this stage an analysis is carried out to find the gap between actual and standard safety.

At the end of this stage one can see the correct number of interventions extended to the same risk areas which will also give a specific number about workers trained during the process.

PRINCIPAL ACTIVITIES:

1. Counter measures and extension in horizontal areas.

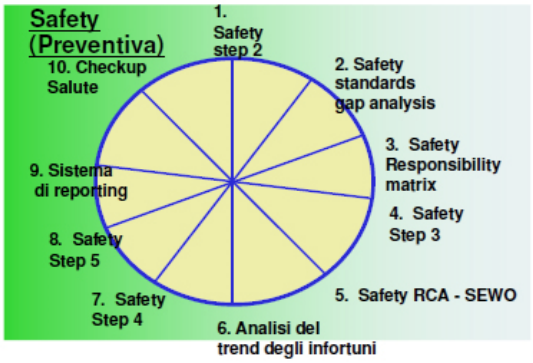


2. Safety communication system

3. Analysis of the gap between actual and standard safety

Step 2: principali attività

3. Analysis of the gap between actual and standard safety



2.3 Matrice delle responsabilità di sicurezza

INITIAL STANDARDS:

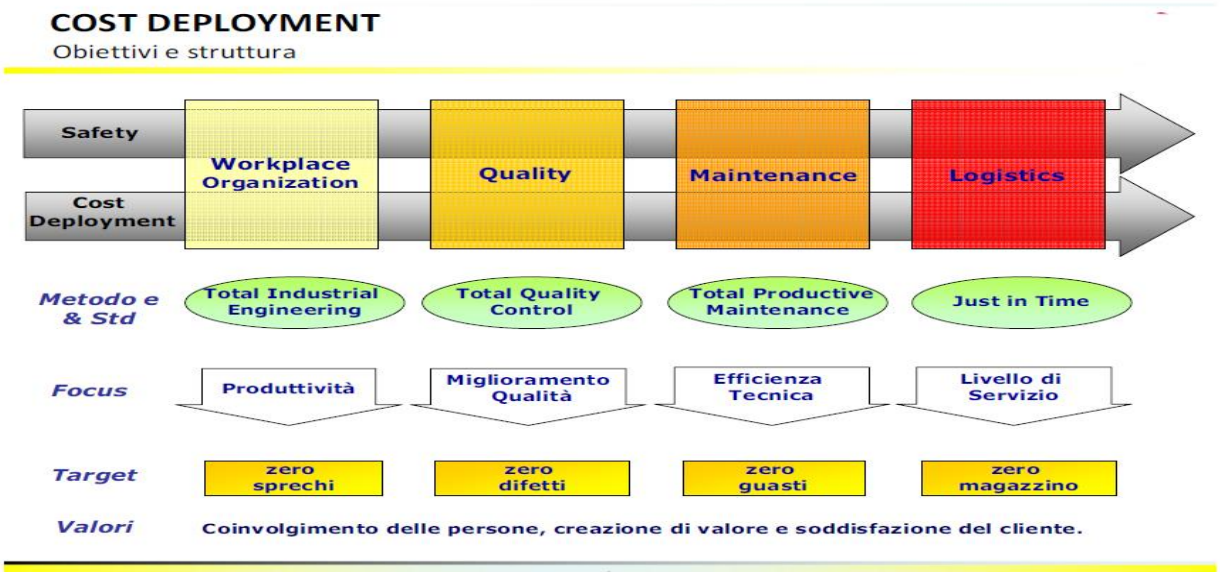
At this level an organization will be able to set up initial standards based on the operations that have been carried out in the previous stage. Apart from setting up initial standards, risk analysis is carried out; a study of the trend of injuries is also studied.

PRINCIPAL ACTIVITIES:

1. Analysis of the trend of injuries
2. Risk analysis
3. Mapping the risk
4. Erogonomics risk
5. Procedure lock off lock out
6. Instructions of working and opl
7. Standard of visual factory

3.4.2 COST DEPLOYMENT:

Cost deployment is a methodology that defines a scientific and system cost reduction program based on cooperation of production resources and finance. As we studied earlier that in World Class Manufacturing all activities come from cost deployment except safety because cost deployment gives us the prioritization of interventions.



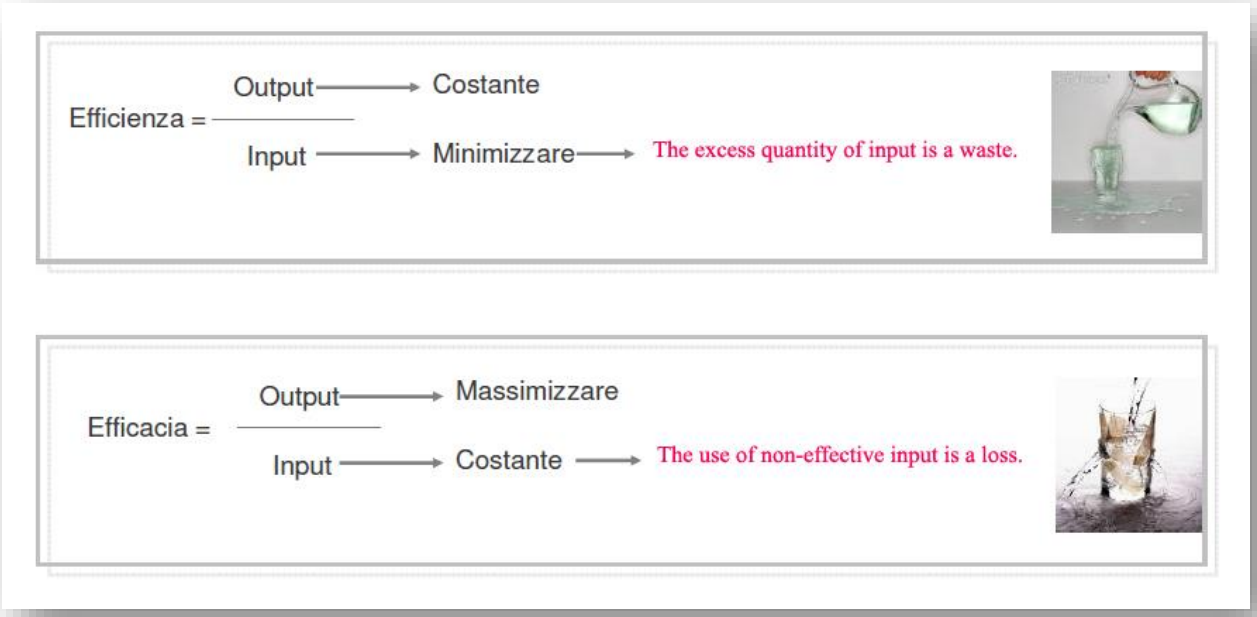
One of the principal inconveniences in TPM, TCQ, FIT and TIE is the lack of connection between their activities and their benefits in terms of reduced cost.

The cost deployment pillar allows identifying the relation between cost factors, processes that generates cost and various types of loses and wastes. It also looks for a relation between loss and waste and try to reduce it and it is also responsible to clarify whether the know-how is available or not for the reduction of losses and wastes. Cost deployment pillar also classify the projects based on the cost/benefit analysis.

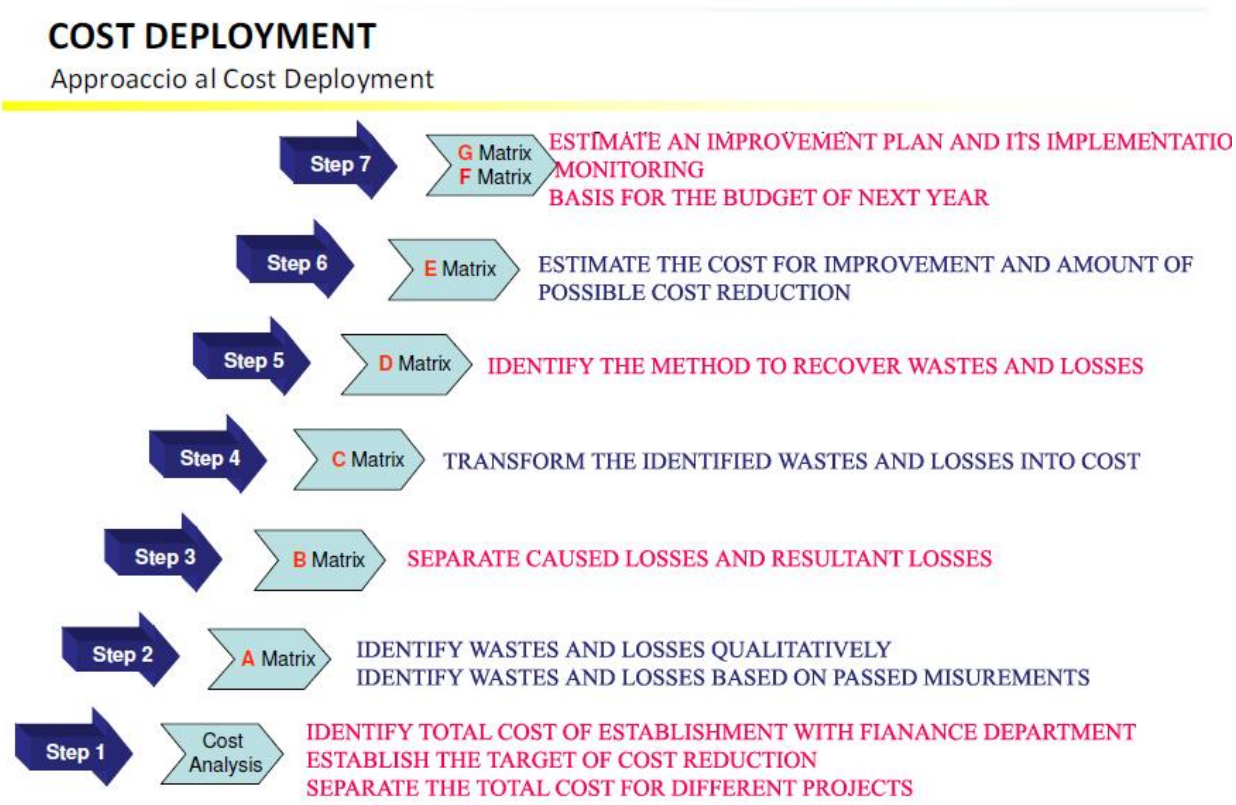
Benefits of cost deployment are as follows

1. Focus, allows to identify the areas that can gurantee greatest savings (Prioritization).
2. Value correctly losses and wastes
3. Show savings

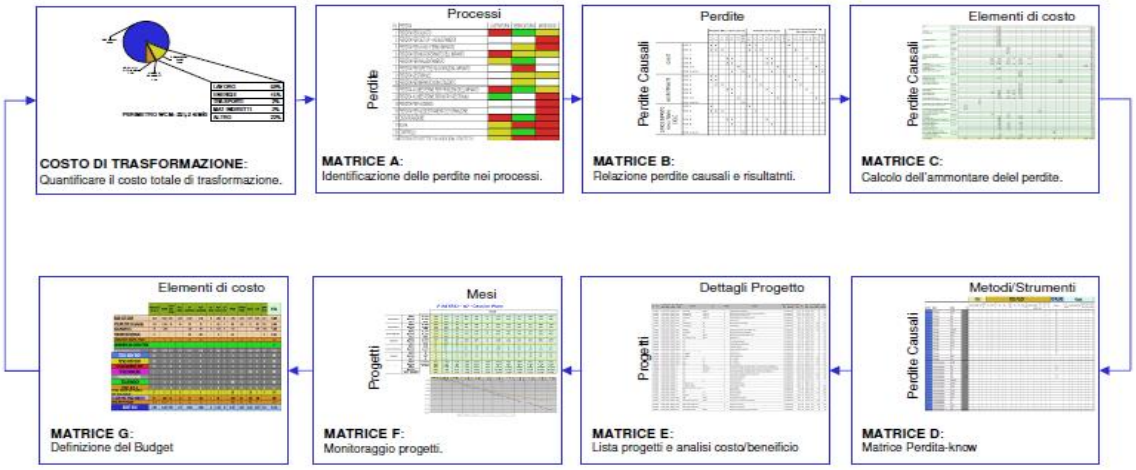
The key element of a good cost deployment application is measurement. Only the date can lead to identify the right areas and then find out whether the countermeasures are effect or not.



7 STEP APPROACH OF COST DEPLOYMENT:



This is the structured approach for the pillar of cost deployment. Every step is based on the results of the previous step therefore it is important to do almost every step with utmost attention and care.



Matrices are files often made on excel in which all the record is saved and analyzed for prioritization of intervention. Following activities are handled by matrices of cost deployment

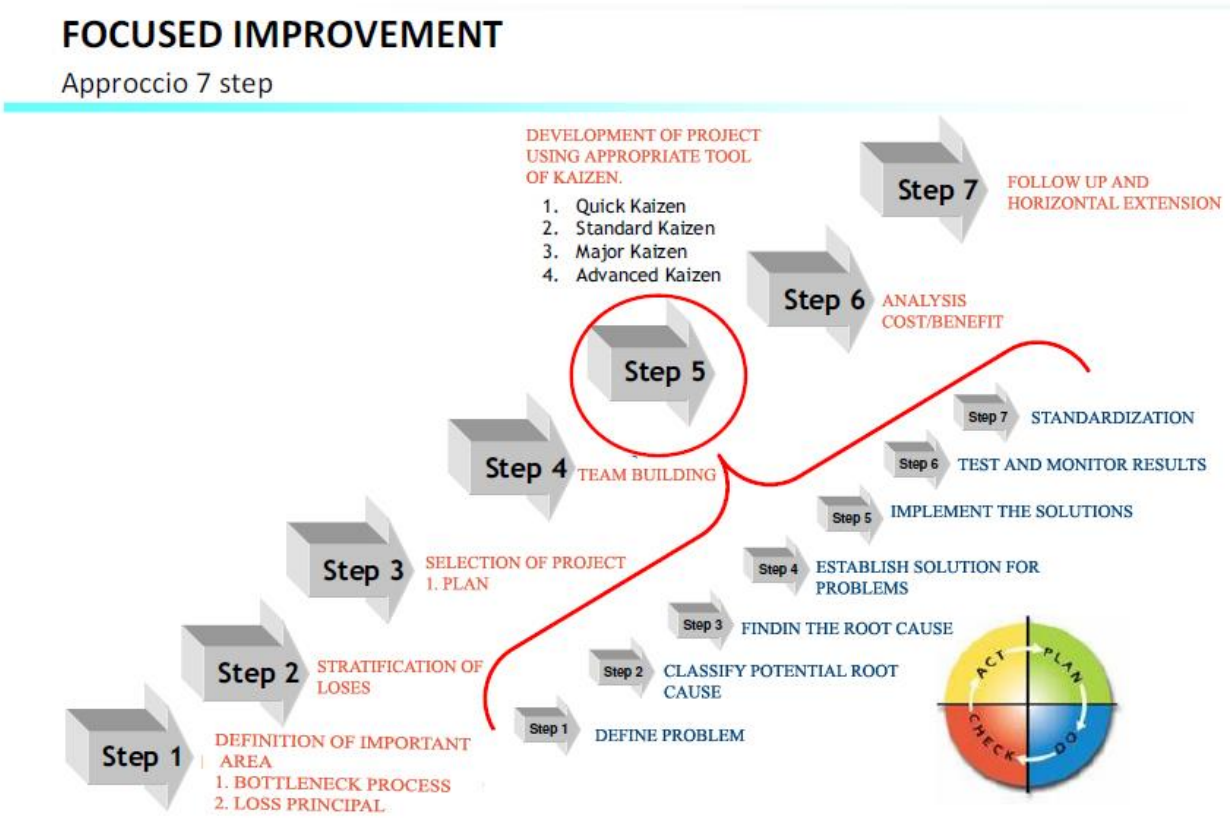
1. Identify the losses
2. Relation between caused losses and resultant losses
3. Costify the losses
4. Chosing the best methodology
5. List of projects
6. Monitoring of projects and budget

3.4.3 FOCUSED IMPROVEMENT:

It is a focused approach to solution of specific and uniquely identifiable issues which aim to achieve a result in short term with benefits in terms of cost reduction due to wastes and losses. Focused improvement pillar helps conduct different projects and provide the know-how of conducting projects.

The principal activity of focused improvement pillar is to apply techniques, tools and methods for the solution of the problems of increased difficulty in relation with the complexity of the causes of wastage and losses to be removed. Based on the prioritization given by different tools of WCM, FI team attack the areas with most losses and wastages, conduct operations and gain profits in terms of cost reduction.

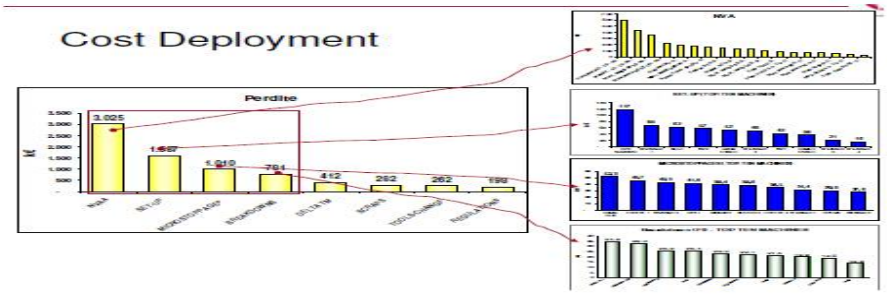
The target of the cost deployment pillar is to eliminate large losses that impact on budget and key performance indicators of the establishment. The pillar is further required to restore operating standards or innovate.



STEPS OF FI PILLAR:

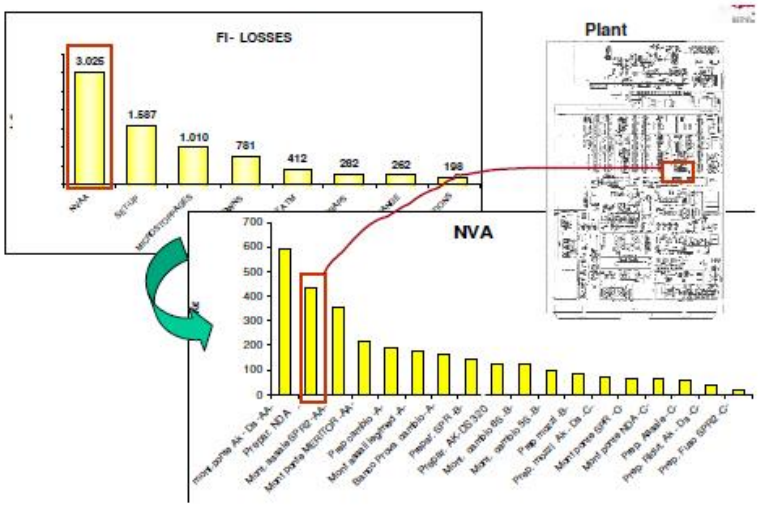
1. STEP 1: DEFINITION OF IMPORTANT AREA

In the first step of focused improvement pillar the FI team has to recognize different types of losses and then define prioritization. They identify different areas for intervention with the help of Cost deployment pillar.



2. STEP 2: STRATIFICATION OF LOSSES:

After identifying important areas for intervention in the first step they have to stratify losses and define the main areas of loss. The FI team has to repeat the stratification process in order to identify the cause of the problem and then associate a kaizen process necessary to solve the problem.



3. STEP 3: CHOOSE THE ISSUE:

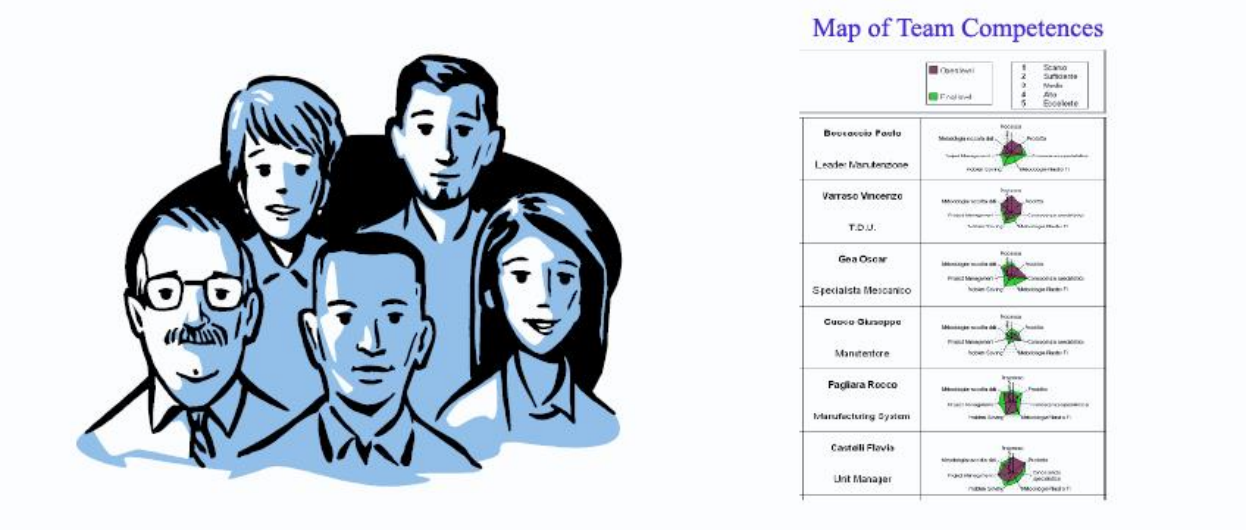
At this stage after defining the problem area and then stratifying the losses FI team will do the following activities

- Decide the theme of improvment
- Promote the theme
- Plan the correlated activities
- Prepare the activities

Each project of FI most certainly requires investment in terms of work, time and money.

4. STEP 4: CHOOSE THE TEAM:

At this stage team is defined with competences needed to address problems related to process or product. A team leader is also selected with best competences to guide the rest of the team; other organizational support is also defined at this stage. This team is selected on the basis of priority given on basis of losses and this team is responsible to eliminate/minimize the losses defined in the first three stages.

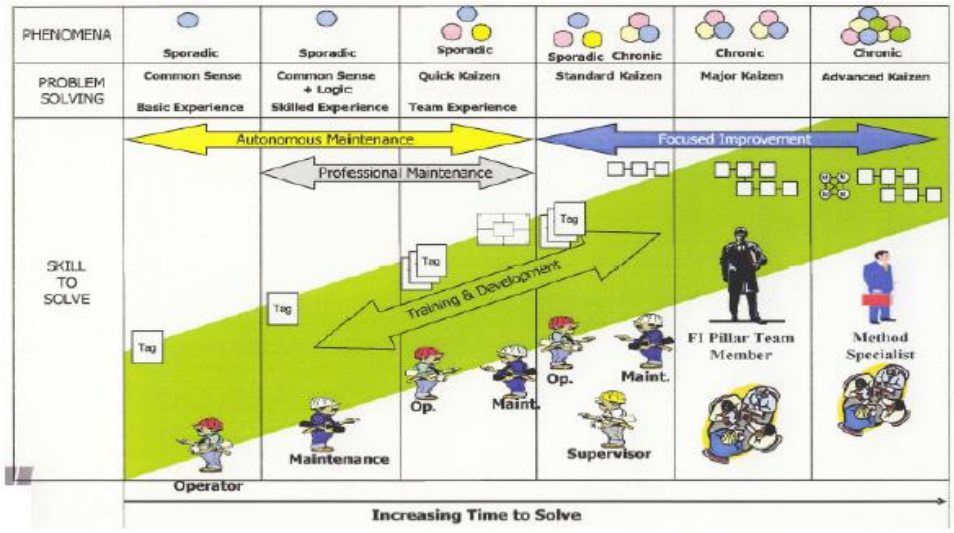


Map of Team Competences

This map guides the FI pillar to choose the best possible team suited to solve the problems. This map is made by the People Development pillar which gives us the connection of FI with PD.

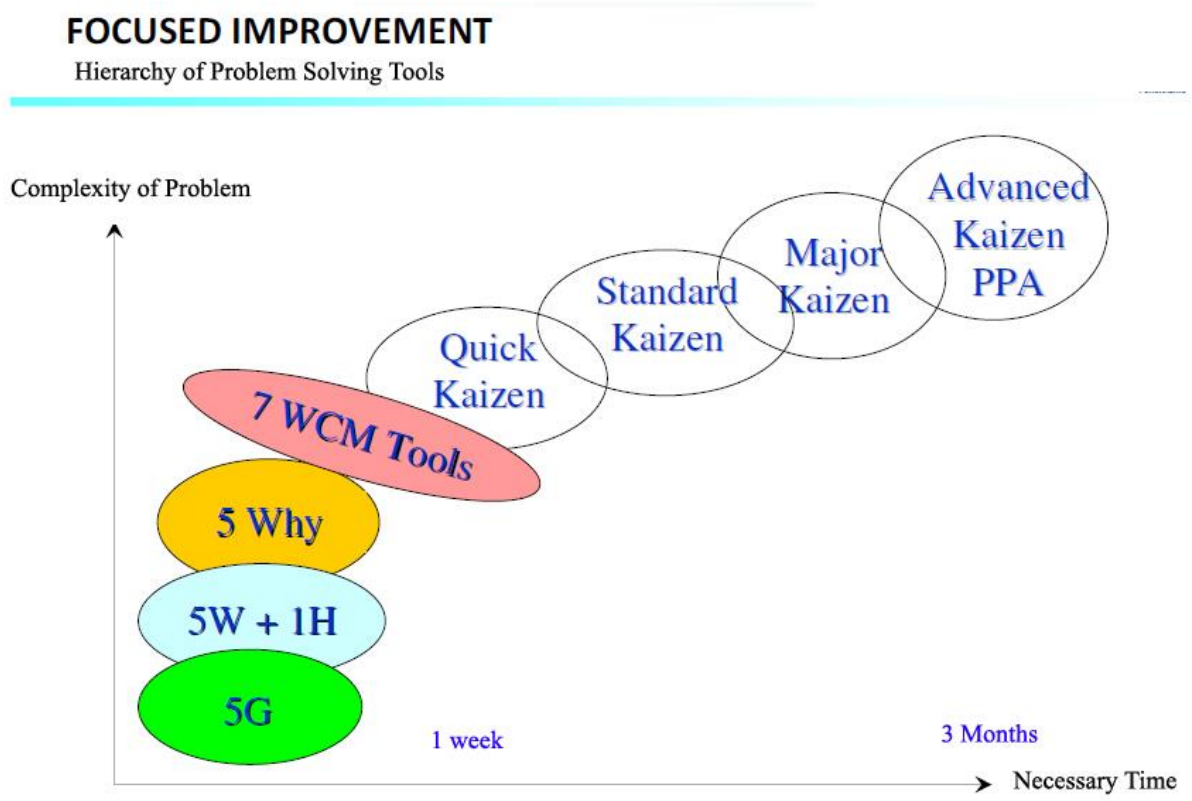
5. DEVELOP THE PROJECT:

Focused improvement pillar will have to choose the most appropriate problem solving technique as a function of problem to be addressed. The diagram below will explain the steps described in the problem solving technique choice.



The diagram explains how problem solving technique is chosen depending on how much time the solution of the problem will take that is how much money is

invested in solving the problem. In WCM everything is calculated in terms of money and more time means more money which changes the technique of problem solving.



At this stage the team selected to solve the problem will carry out 7 more steps following PDCA technique.

In the further stages of Focused Improvement pillar, analysis of the solution of problem is carried out in terms of Cost to benefit ratio. If working as planned, the plan is extended horizontally in the similar areas in the final step of the pillar.

One of the main targets of FI pillar is create coherence between pillars in order to make an organization work as one organ. It is important in an organization that the competences of all pillars in solving their problems are not at a major difference.

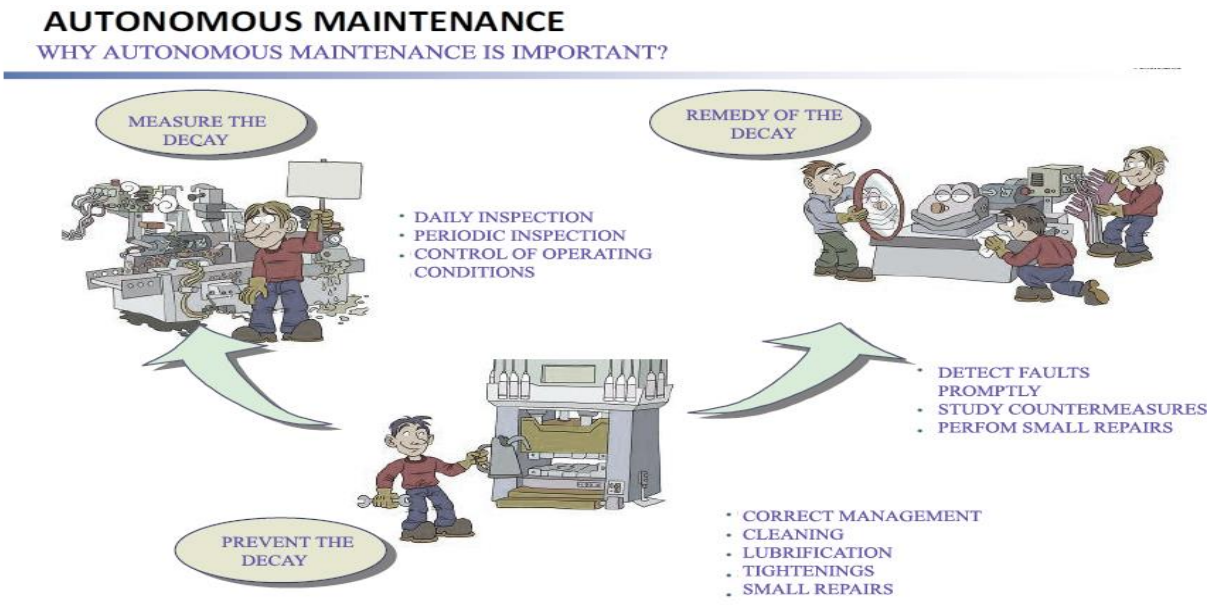
3.4.4 AUTONOMOUS ACTIVITIES:

Autonomous Activities is the fourth pillar of WCM and it is further divided into two sub pillars which are Autonomous Maintenance (AM) and Work place Organization (WO). AM works to maintain the basic conditions of machines whereas WO pillar deals with labor force working in the assembly line. Their primary target is to make labor force autonomous in finding the problems and maintaining the basic conditions necessary for efficient production.

3.4.4.1 AUTONOMOUS MAINTAINANCE:

The need of this pillar is for improving the availability of the means of labor and quality of products through the involvement of employees in production, giving them additional responsibilities in the management and maintenance of machinery and equipment. In other words the objective is to make them autonomous in maintaining the basic conditions of equipment and machinery. Autonomous maintenance realizes that such activities are necessary for the purpose of

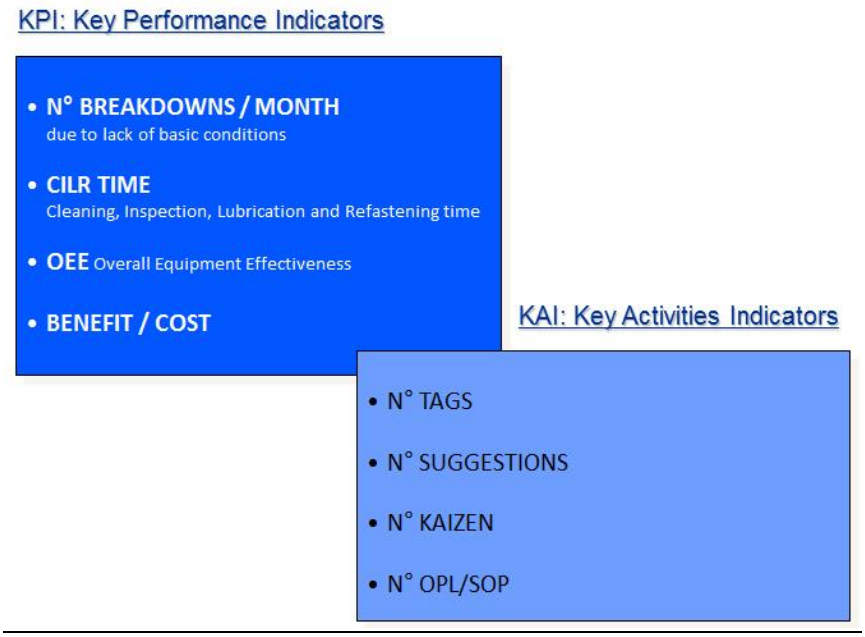
- Reestablish the basic condition of plants
- Stop the accelerated deterioration
- Develop skills on the product and the installation
- Define and achieve the cycle of maintaince
- Creat jobs for elemination of anomalies and quality defects



Following are capacities necessary for the operators to perform the autonomous activities

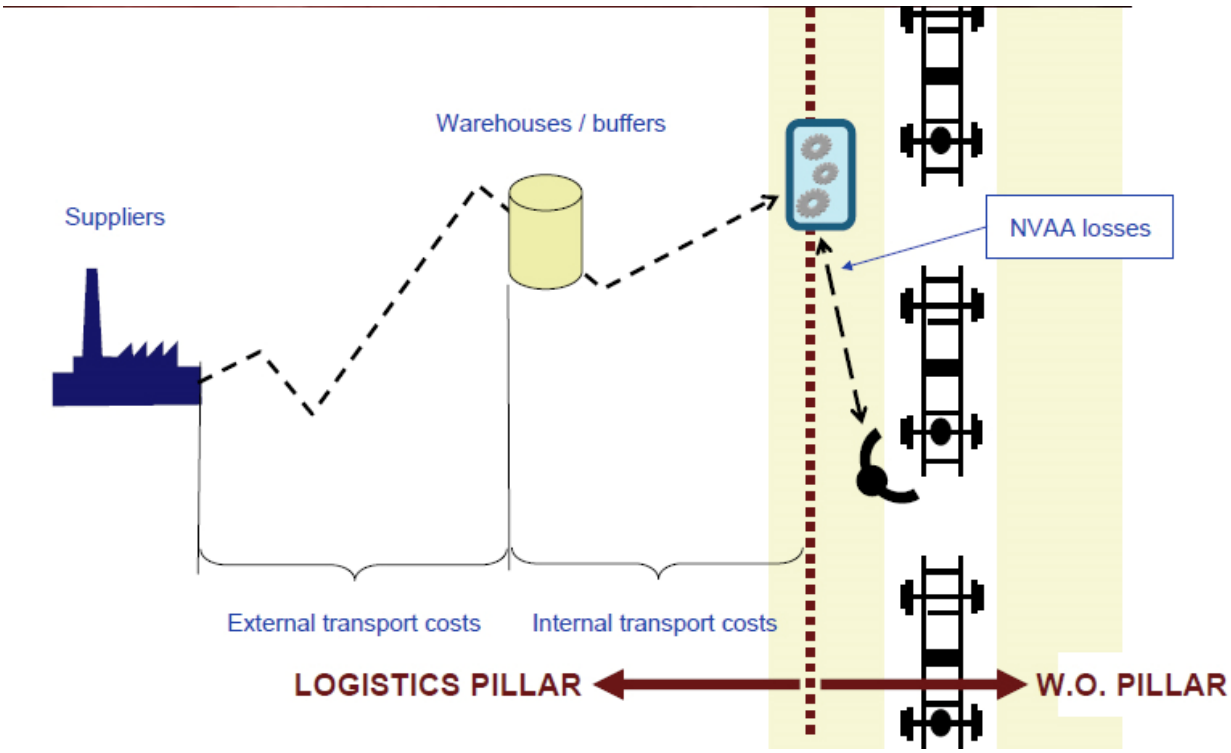
- ACTIVITIES FOR THE MEASUREMENT OF DECAY
  - Daily inspection
  - Periodic inspection
  - Control of the operating conditions
- ACTIVITIES FOR THE PREVENTION OF DECAY
  - Correct management
  - Lubrification
  - Cleaning
  - Registrating the data regards anomalies
  - Collaboration with the mantenance for the definition of countermeasures
- ACTIVITIES FOR THE REMEDY OF DECAY
  - Substitution of minor components
  - Rapid and correct notification of breakdown
  - Assistance to repair the breakdown and other interentions of maintenance.

<u>KPI & KAI:</u>

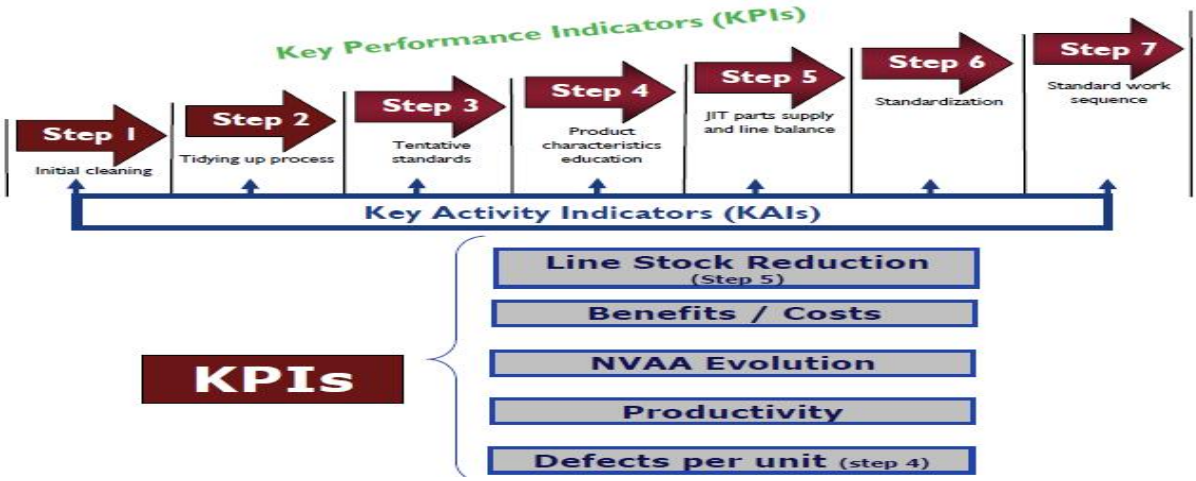


3.4.4.2 WORK PLACE ORGANIZATION (WO):

WO Key concept is to increase line productivity. The way to do is to Minimize material handling**,** Eliminate MURI (Unnatural Operations), MURA (non repetitive operations) and MUDA (non value added operations) by improving the Operations Create a multi-skilled manpower Introduce gradually LCA (Low Cost Automation) Achieve a stable production by minimizing disturb factors caused by several problems as for example breakdowns Control abnormal situations by minimizing defects creation e minor stoppages Separate labor from equipment.



7 STEP APPROACH:



STEP 1: INTIAL CLEANING 5S:

Learn “cleaning is inspection” through cleaning and removing unnecessary materials from work area. Following activities must be done

- Teach the importance of 5S andapply it.
- Thoroughly remove unnecessary materials.
- Eliminate trash, dirt and dust.
- Put parts shelves, part boxes,working tables, jigs and tools inorder.
- Conduct survey and analysis fordropped parts, and takeremedial action.

- Tag the area where there is anyproblem.
- Clearly display storage area forparts, tools and jigs.
- Clearly display storage area fordefects (scraps, items to berepaired).

Before

After

STEP 2: TYDING UP THE PROCESS:

Look for ease of reading and workability through tidying up work area. Following are the activities necessary for the second step

- Take countermeasures against thesources of trash, dirt and dust.
- Countermeasures against heavy items(manual moving up and moving down,transportation).
- Eliminate bending operation.
- Eliminate irregular turning operation.
- Display legible labels for parts shelves.
- Modify parts shelves for ease of use.
- Practice FIFO for these parts placed onthe parts shelves.
- Review installation methods for partscontainers.

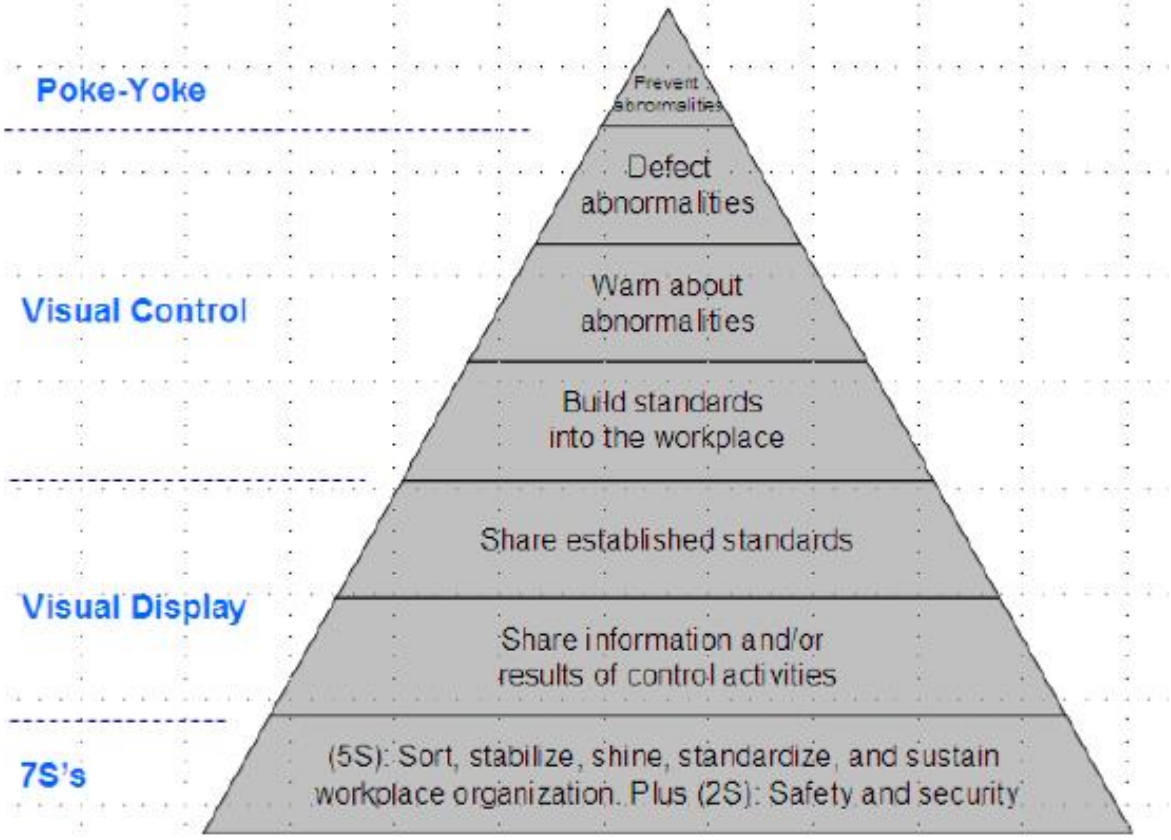
- Ask the following four questions :
    - How do you do this work?
    -How do you know you are doing this work correctly?
    - How do you know that the outcome is free of defects?
    - What do you do if you have a problem?
- Establish autonomous qualitychecking for the difficult parts tocheck their quality at laterstages by either
    - self-inspection
    - next-stage inspection
    - use of a quality check manor
    - the introduction of fool proof devices
- Review improvements andconfirm these results.
- Install some measures forpreventing scratches

STEP 3: TENTATIVE STANDARDS:

Set tentative standards to maintain process conditions attained in Steps1 and 2. Following activities are necessary for step 3

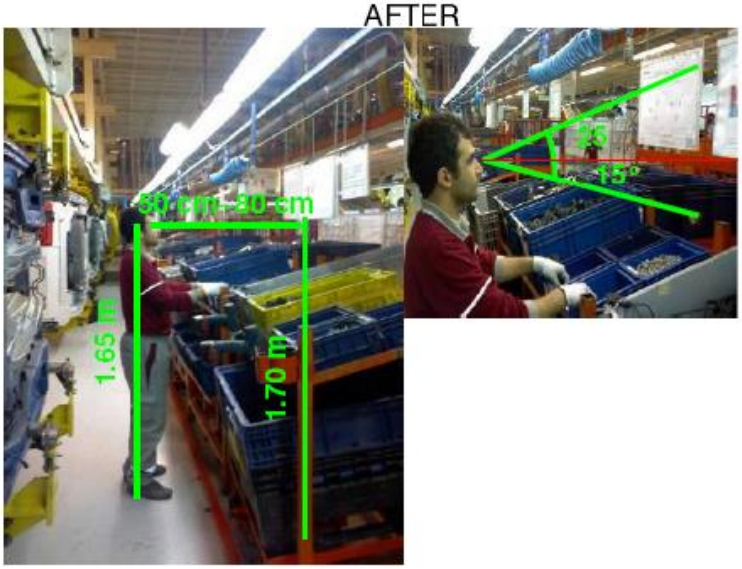
- Set tentative cleaning and inspectionstandards.
- Practice visual control.
- Improve line efficiency.
- Establish standard operation.
- Thoroughly follow rules set by operatorsthemselves.
- Install some measures for prevention ofwrongly assembled parts and nonassembled parts.

Figure The visual workplace



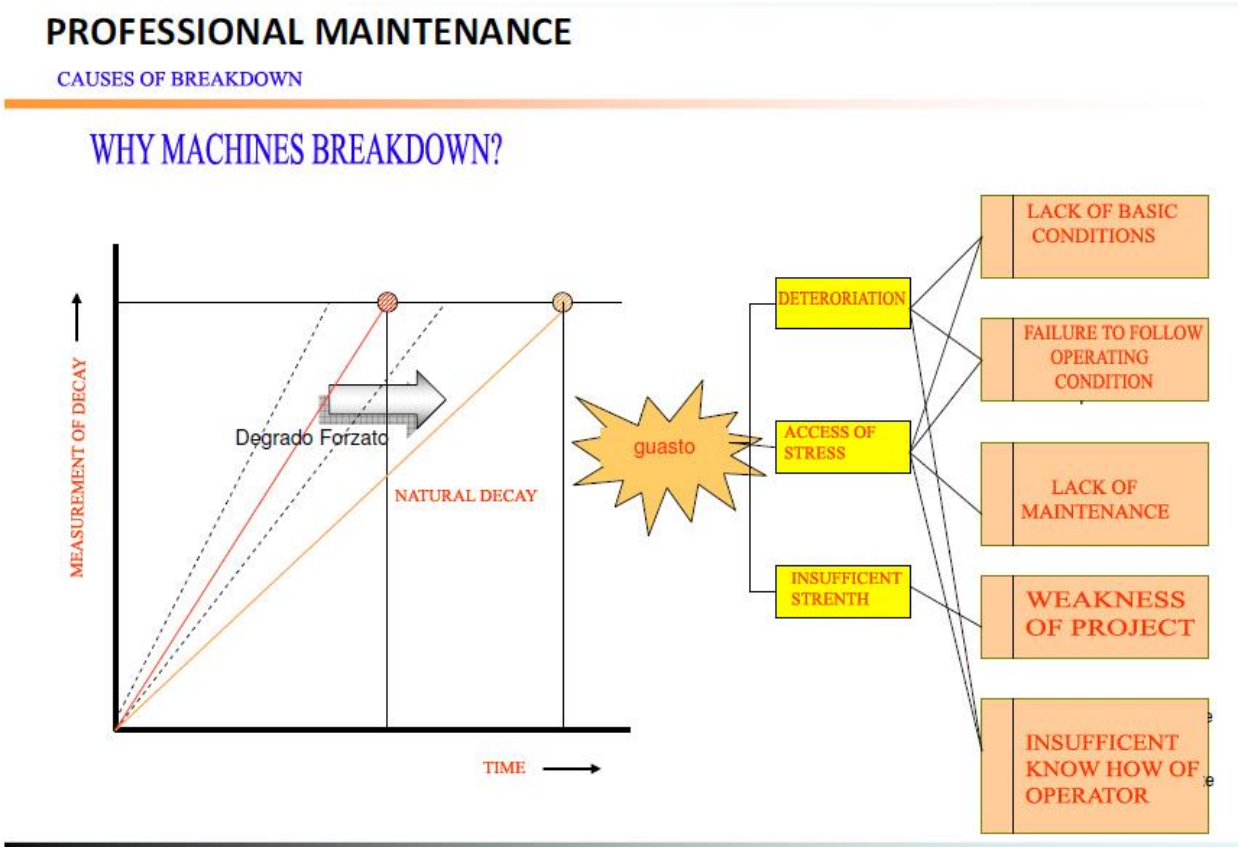
BEFORE

AFTER



3.4.5 PROFESSIONAL MAINTENANCE:

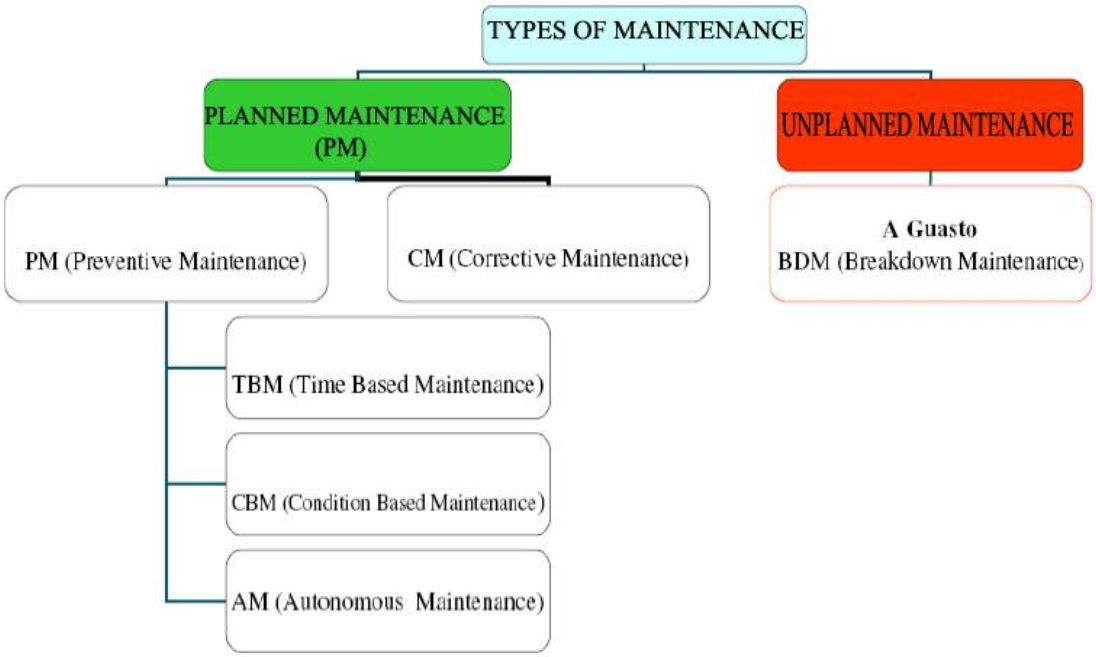
Professional maintenance pillar is responsible to optimize the reliability of the plant that is economically sustainable. By increasing the reliability the loss of quality and the risk of injuries will reduce. Among other responsibilities one of the most important is to develop the activity of planned maintenance so that breakdown maintenance can be reduced. They are responsible to use the most appropriate type of maintenance to establish and maintain the optimum conditions of facilities. They have to promote good activities to minimize the downtime for scheduled maintenance of facilities. The final target of all their activities is to achieve the level of zero breakdowns.



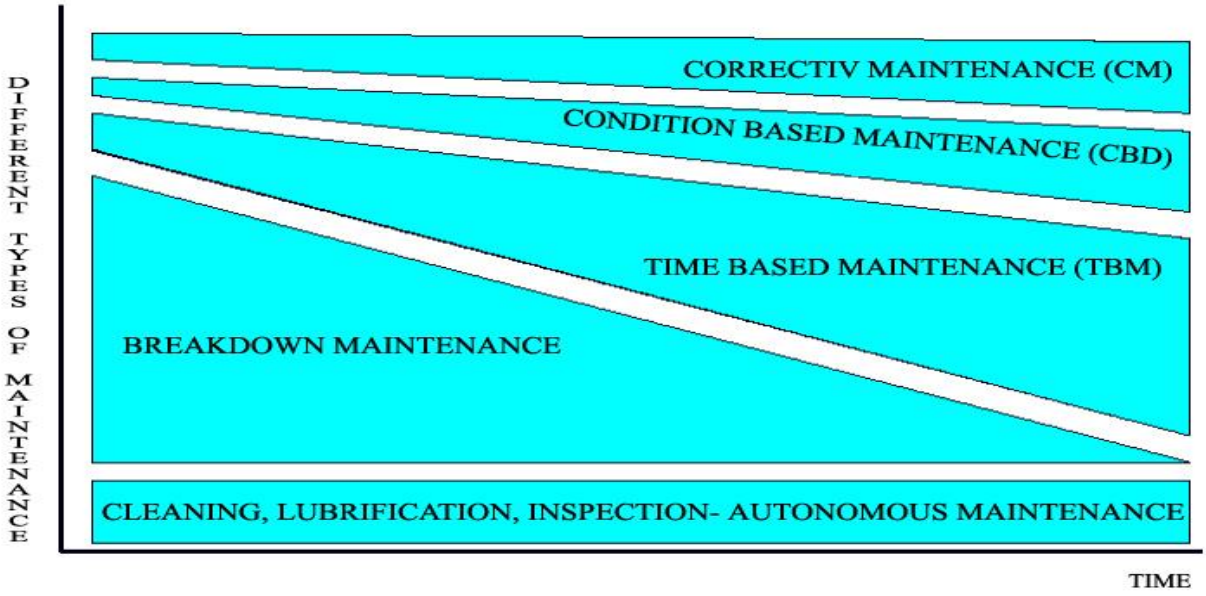
This diagram shows the causes of breakdowns which brings forced degradation of the machine before its life time. Lack maintenance, failure to follow operating conditions, lack of basic condition are some of the reasons that brings the break downs into equation. However different types of maintenance programs are among the responsibilities of PM pillar to tackle different reasons of breakdowns.

PROFESSIONAL MAINTENANCE

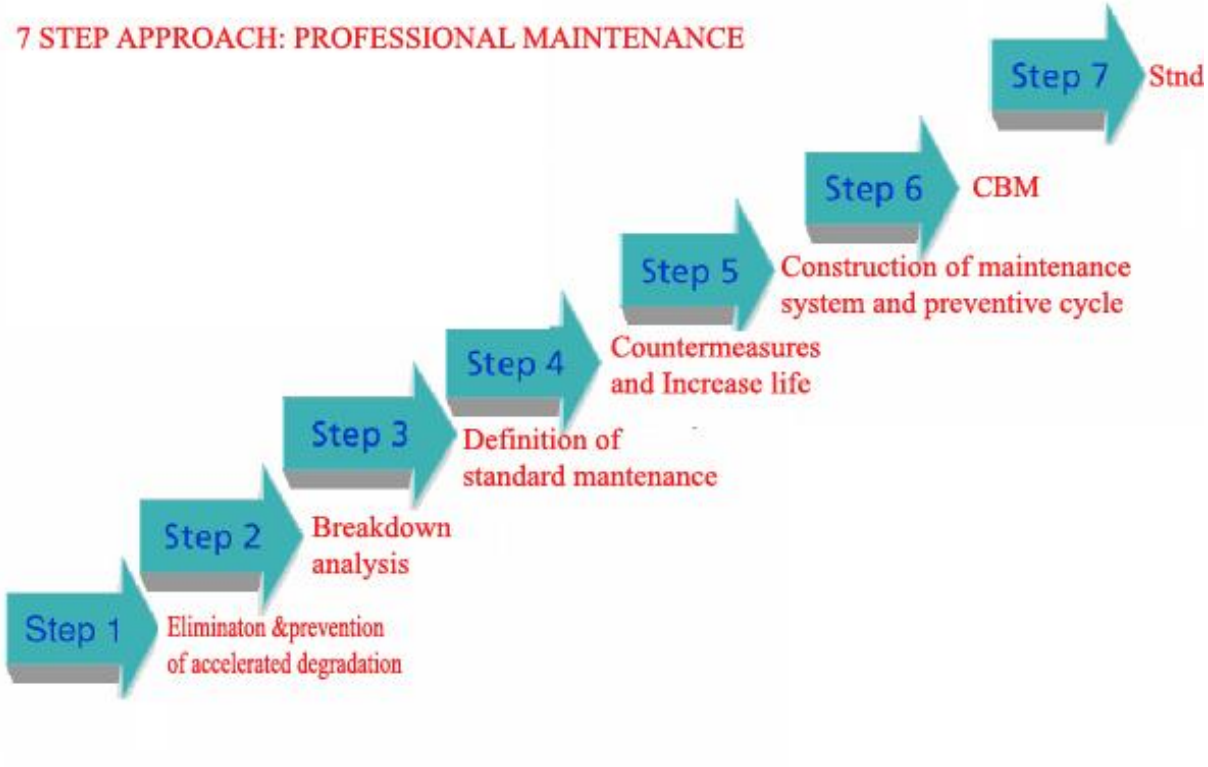
TYPES OF MAINTENANCE



The figure above shows different types of maintenance programs that are carried out in order to reduce the breakdown maintenance which is always unplanned and unwanted. In the next figure we will explain how over the period of time break downs can be reduced by increasing these planned maintenance programs.



3.5.1: 7 STEP APPROACH:



STEP 1:

The objective of step one is to eliminate and prevent the accelerated degradation of machines and establish mean time between failures (MTBF). Mean team between failures will give you the frequency of the breakdowns.

The principal activities necessary for step one is as follows

- Recover the degradation, mainting the basic condition of machine and eliminate forced degradation
- Set up the board game (define team, skill team members)
- Report breakdowns (EWO)
- Creat machine ledger
  - Make lay out of machine
  - Perform decomposition of machine
  - Classify the components
  - Definition of crictical components

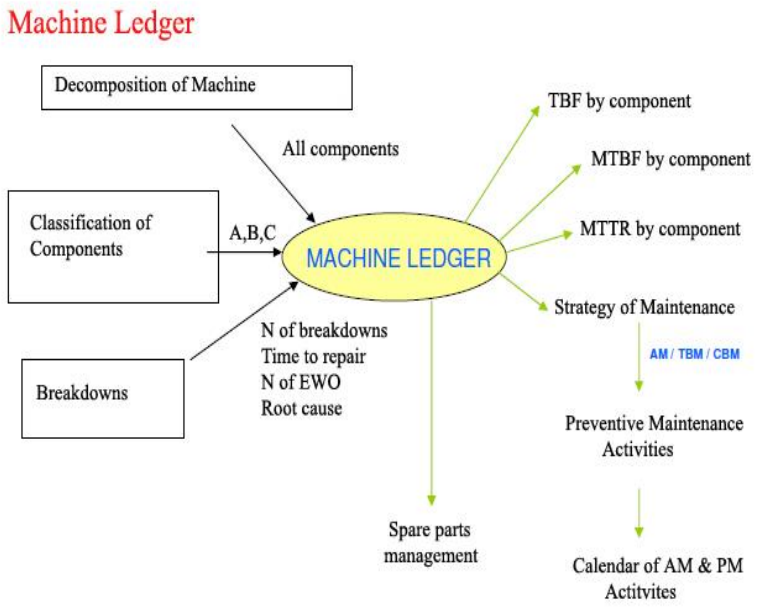


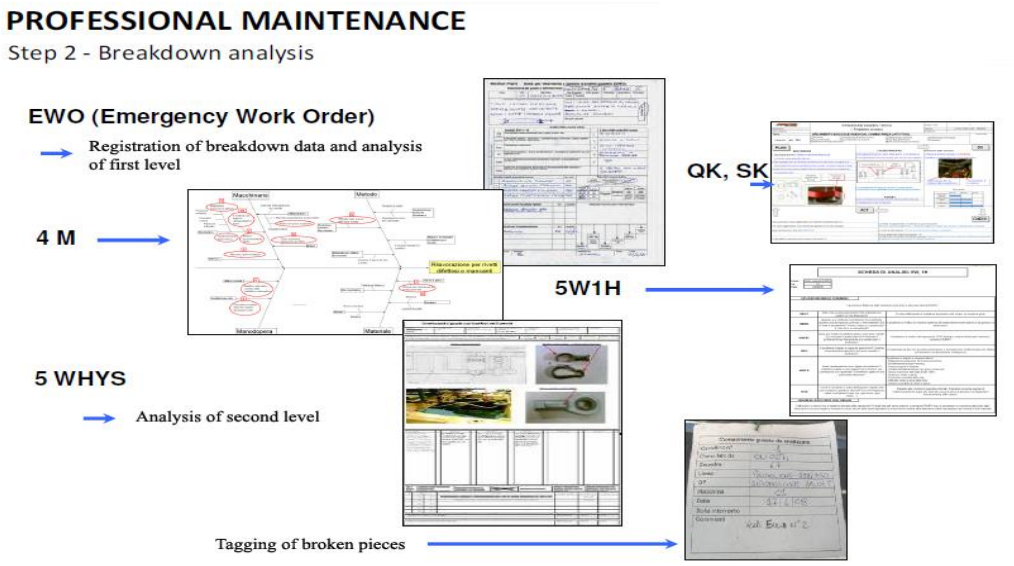
Diagram explaining Machine Ledger

STEP 2: BREAKDOWN ANALYSIS:

The objective of step two is to check the severe and repetitive faults and prevent their reoccurrence. Another objective is to increase the efficiency by reducing the stops due to breakdowns.

The principal activities of step two is as follows

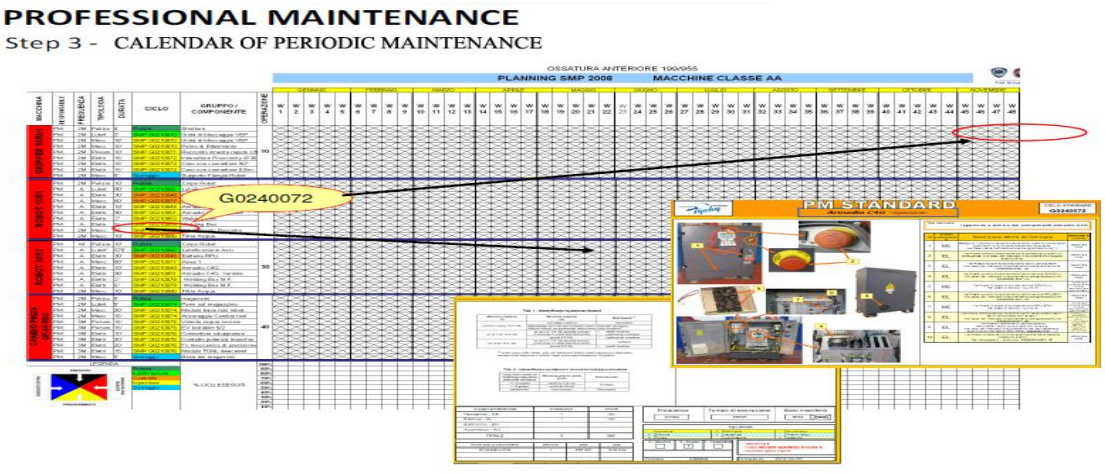
- Make a breakdown map and report machines on lay out
- Stratification of breakdowns according to types of breakdowns
- Collection and analysis of EWO modules
- Subdivide by cause of breakdowns
- Definition of uniform system of breakdown management and efficency of machines.
- Techniques of problem solving and research of the real cause of problems



STEP 3: DEFINITION OF STANDARD MAINTENANCE:

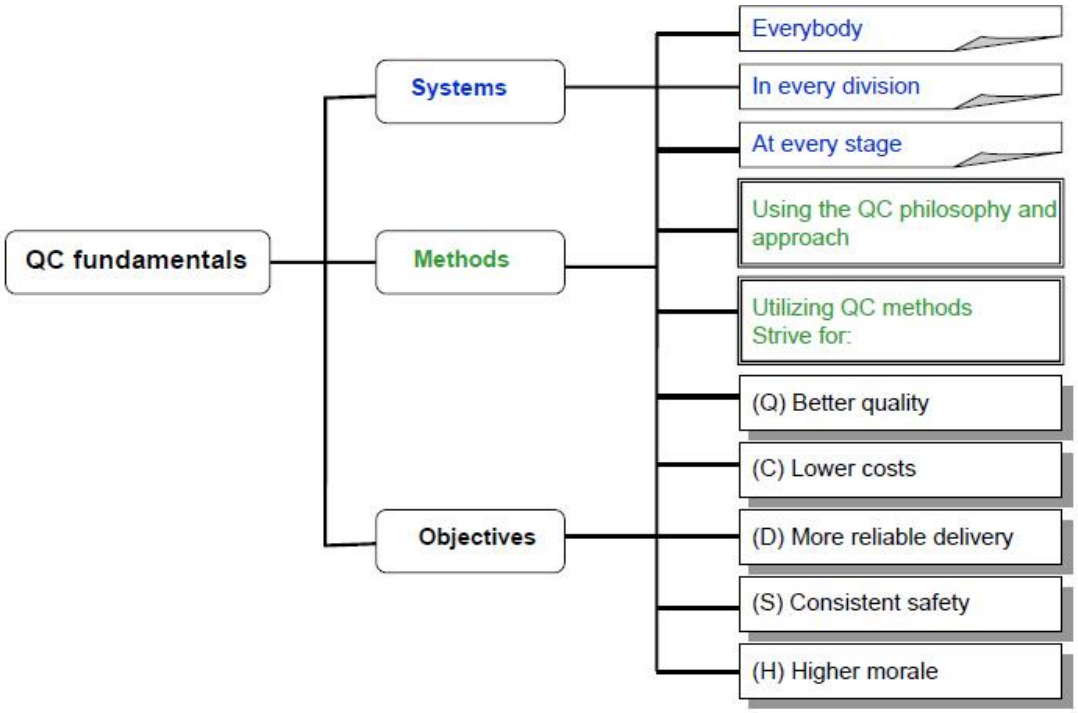
In this step initial standards are set based on the activities and results achieved in the first two steps. These standards are then consistently followed and extended horizontally. Following are the principal activities of step 3

- Constitute a system of standard maintenance cycle (PM)
- Develop instructions of work
- Introduce calendar of activities
- Monitor the compliance of PM activities (completed in time? Etc)
- Introduce a monitoring post and review the performance of the standard maintenance
- Verify the TBF of class A components



3.4.6 QUALITY CONTROL:

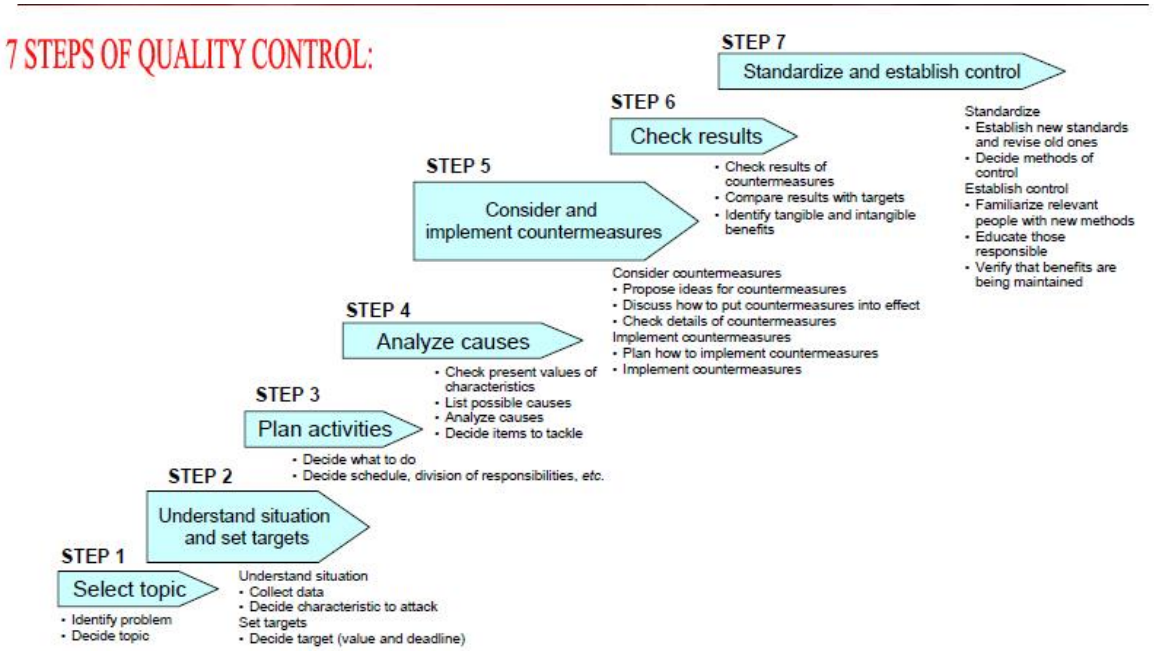
Quality control is the activity where every employee gets involved in, from the CEO down to the lowest worker. It is an activity performed in every division within the organization, including general affairs, accounting, engineering, production, and so on. It is performed at every stage of the process of providing goods and services to customers, including market surveys, product planning, design, and production, sales, and after-sales service. It Places great importance on the QC approach and way of looking at things. It makes the use of QC methods absolutely necessary. It Enhances management mechanisms such as quality assurance, new-product development, cost control, production management, (sales management,) safety management, and personnel development, and rotates the PDCA (Plan, Do, Check, Act) Wheel. It Controls and improves Q (Quality), C (Cost), D (Delivery), S (Safety) and M (Morale). These features are related to systems, methodology and objectives.



7 STEP APPROACH OF QC:

The QC seven step formulas is the basic procedure for solving problems scientifically, rationally, efficiently and effectively. It is a fundamental problem

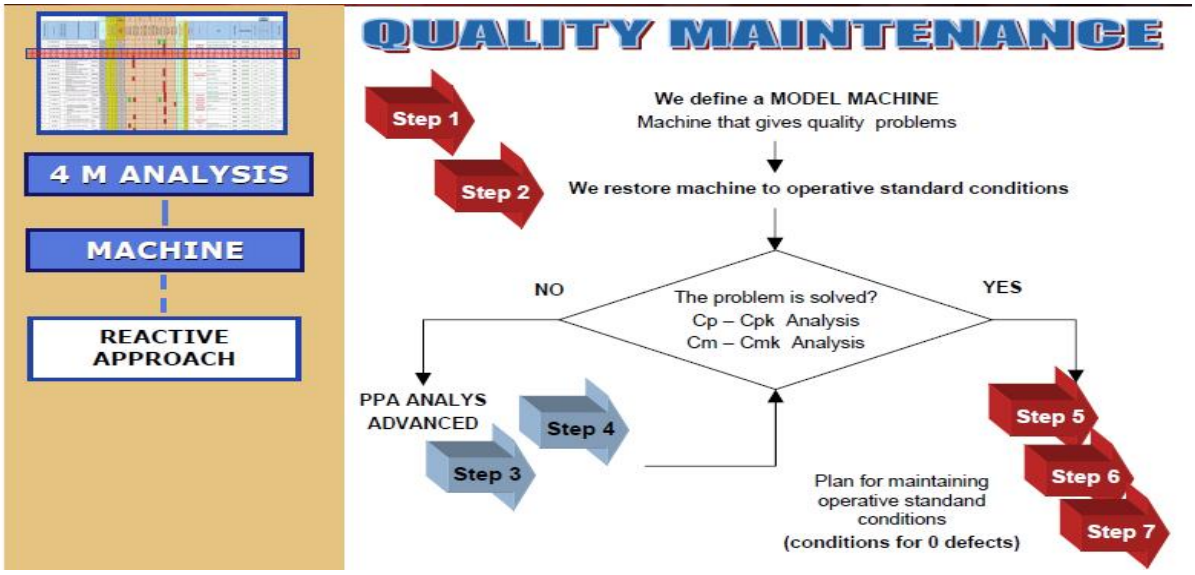
solving stratagem that allows any individual or group to solve even difficult problems even rationally and scientifically.



Here we will describe the reactive phase of quality control as we did earlier with all the other pillars.

<u>REACTIVE APPROACH:</u>

4M Analysis is carried out to find the root cause of the quality defects and the 7 step approach is carried out according to source of problem.



The diagram above shows how a model area is chosen in the step one and in step two the quality team works to restore the standard operative condition of the machine. If the desired result is achieved then no further quality defects will generate however if desired results are not achieved step 3 and step 4 are carried out before maintaining and standardizing the final results.

3.4.7 LOGISTICS

The purpose of logistics pillar is to create a lean material flow in order to eliminate wastes and inefficiencies and to improve the service level. The vision is to create a layout for a good internal and external logistics, implement and maintain a synchronized flow of information between parts of sales, purchasing, logistics, pre-production and production. The objectives of logistics pillar are to reduce stock, reduce lead time, and improve customer service level and minimum material handling cost.

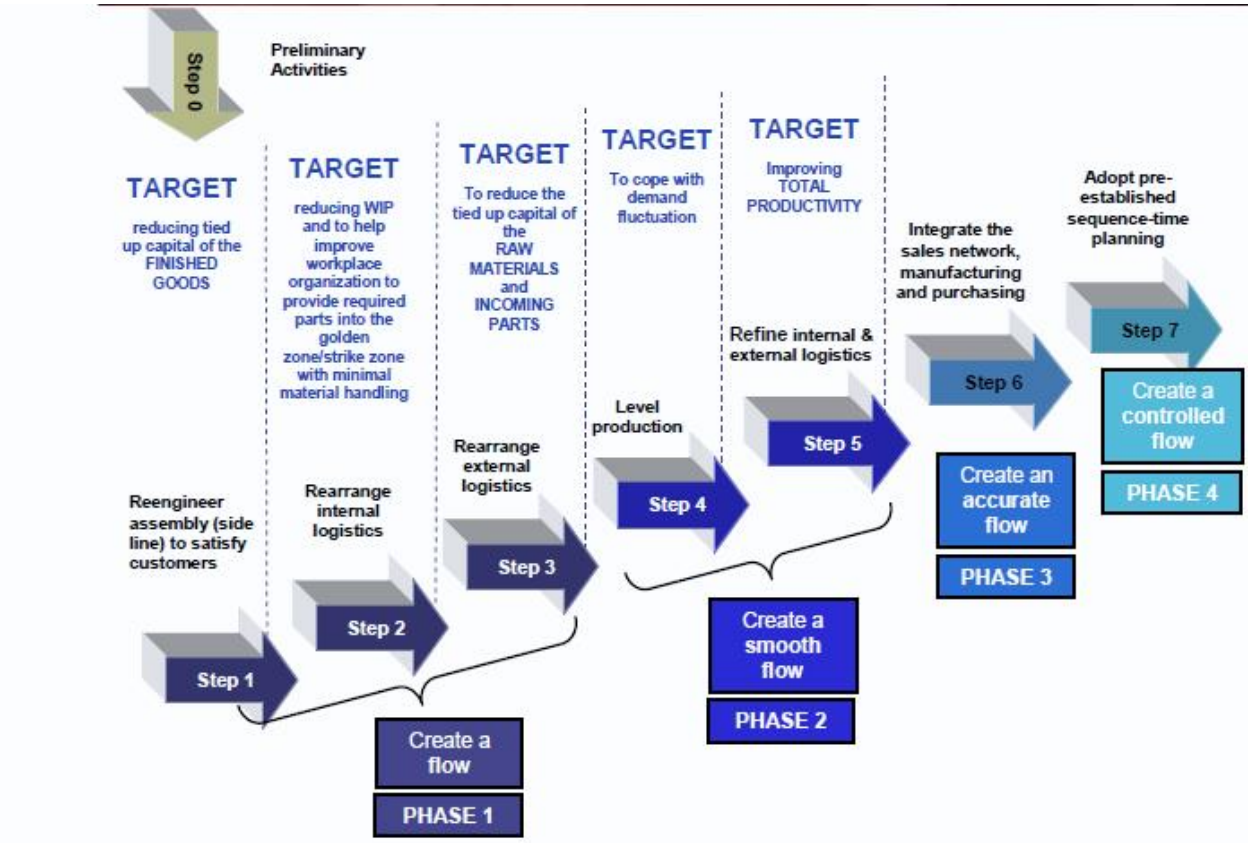
The key performance indicators of logistics pillar is as follows

- Stock (coverage days, value)
- Occupied area
- Supply lead time
- Customer service level
- Handling
- Logistics cost of equipment
- Usage (inventory level)

The key performance activities of logistics pillar is as follows

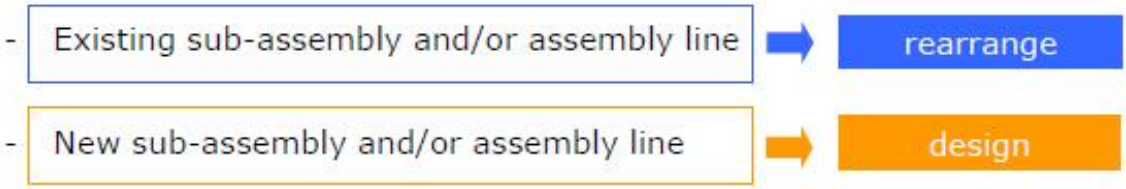
- One poine lesson/ standard operating procedure (OPL/SOP)
- Kaizen
- Packinging instructions
- Milk run
- FLT reduction (Forklift reduction)

7 STEP APPROACH OF LOGISTICS:



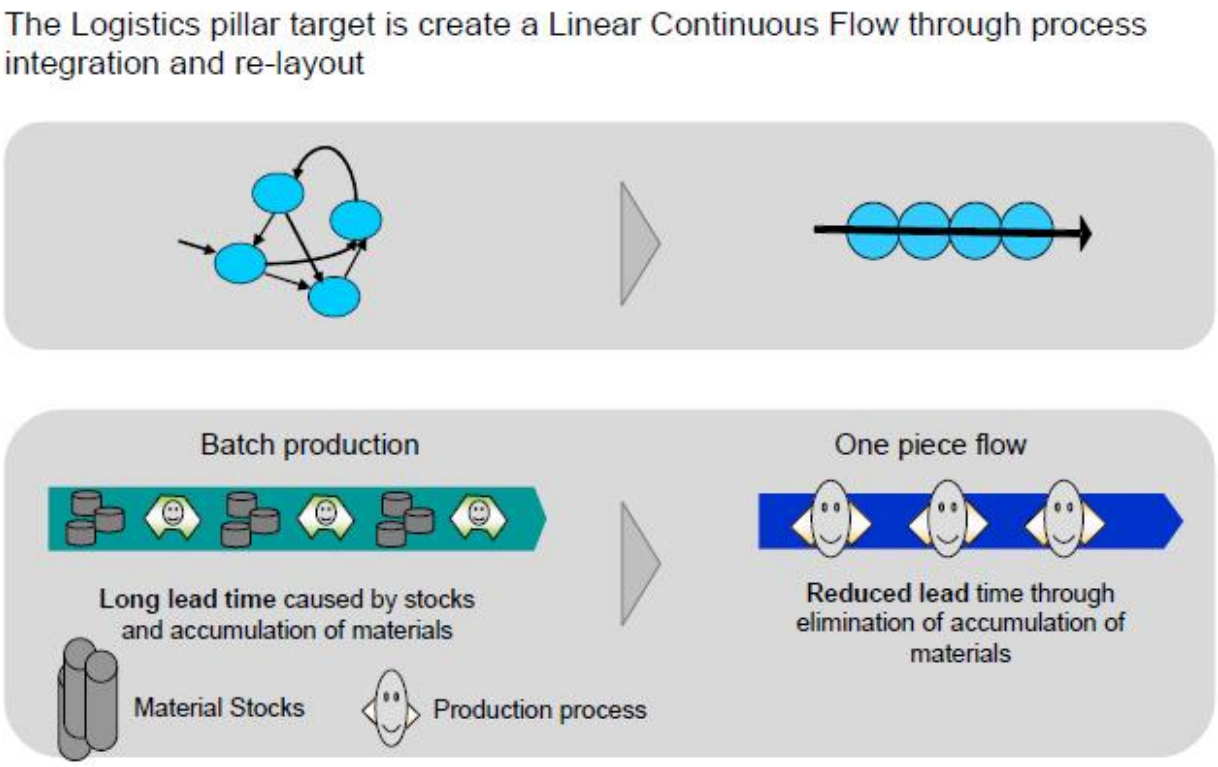
STEP 1: REENGINEERING THE ASSEMBLY:

Main focus of step one is to redesign and organize line and workstations working together with workplace organization pillar. At the end of step one and step two; the main line should be rearranged from a point of view of layout and internal logistics flow. Activities of step one and step 2 could be realized in the following two different contests



During these two contests logistics pillar has to work with WO/EEM pillars for rearrangement or redesign of assembly line. Following are the principal activities of step one

- Organize and re-engineer the side line to create continous flow
  - Buffer reduction
  - Product oriented lay out
- Colloborate with Work place organization for developing 5S activities
- Identify and classify the parts needed by the workstation



STEP 2: REARRANGE INTERNAL LOGISTICS:

Step two is focused on creating the material flow inside the plant defining and realizing internal feeding cycles (frequency, route and transport carts for all P/N analyzed).

Following are the principal activities of step 2

- Based on material classification results from step one, we have to implement the proper internal material flows (JIT, JIS, Kanban).
  - Creation of picking area
  - Develop transportation feeding routes from warehouse to picking areas and from picking areas to the line
- Implement visual management in all the areas as well as floor marking

STEP 3: REARRANGE EXTERNAL LOGISTICS:

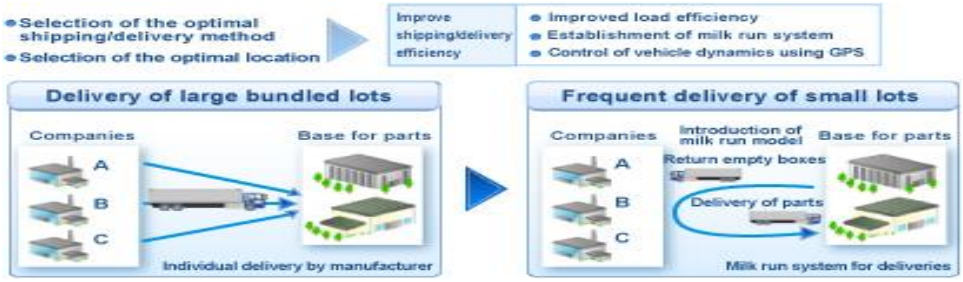
Step 3 is focused on driving the Logistics WCM improvements further up the Supply Chain (**external logistic**), now out of the plant:

- involving suppliers
- organizing the inbound transports
- optimizing the way of material receiving for the plant's incominggoods

The goal of Logistics WCM for Step 3 is to complete a project that smoothers the inbound material flow to the plant (external logistics) and reduces logistics wastes.

Redefine the plant external material flow by pushing back to the supplier those changes already implemented internally. There are two essential contests of activity in order to achieve the goal:

- **Material receipt**: it consists of smoothing inbound traffic by levellingreceiving activities
- **Transportation**:
  - Mixed (shared) transportation: milk run
  - Mixed loading
  - Direct delivery
  - Standardization of the packaging
  - Utilization of available in-house vehicles for external transportation



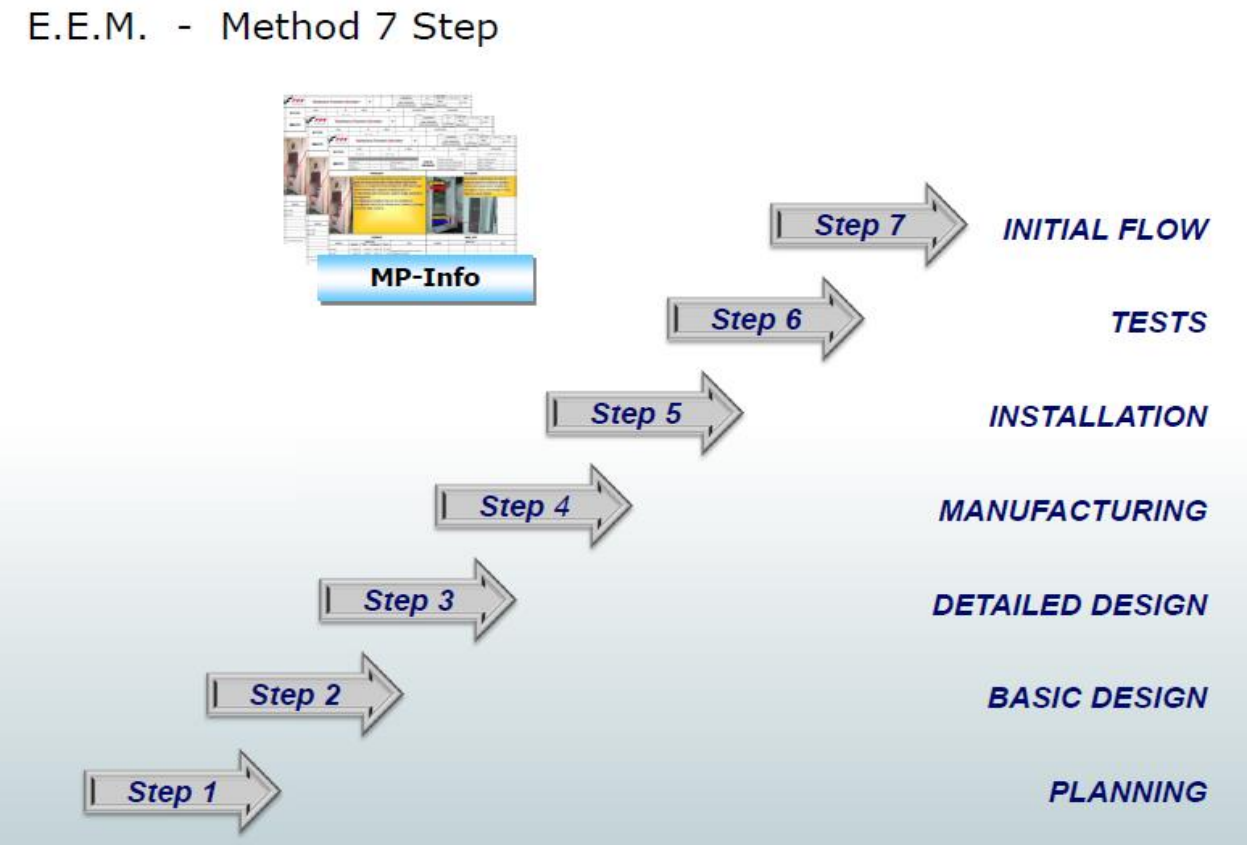
3.4.8 EARLY EQUIPMENT MANAGEMENT/EARLY PRODUCTION MANAGEMENT (EEM/EPM)

3.4.8.1 EARLY EQUIPMENT MANAGEMENT:

Early equipment management pillar does not start working at the start of WCM implementation as it mostly deals with new equipment management. The purpose of EEM pillar is as follows

- Achieve the requested quality
- Minimum life cycle cost
- Minimum lead time for equipment implementation and Start-Up Production
- Design for reliability and maintenance
- Design for flexibility
- Design for simplicity of operations
- Design for safety

Following the trend of my dissertation, first three steps of the pillar will be explained with examples.



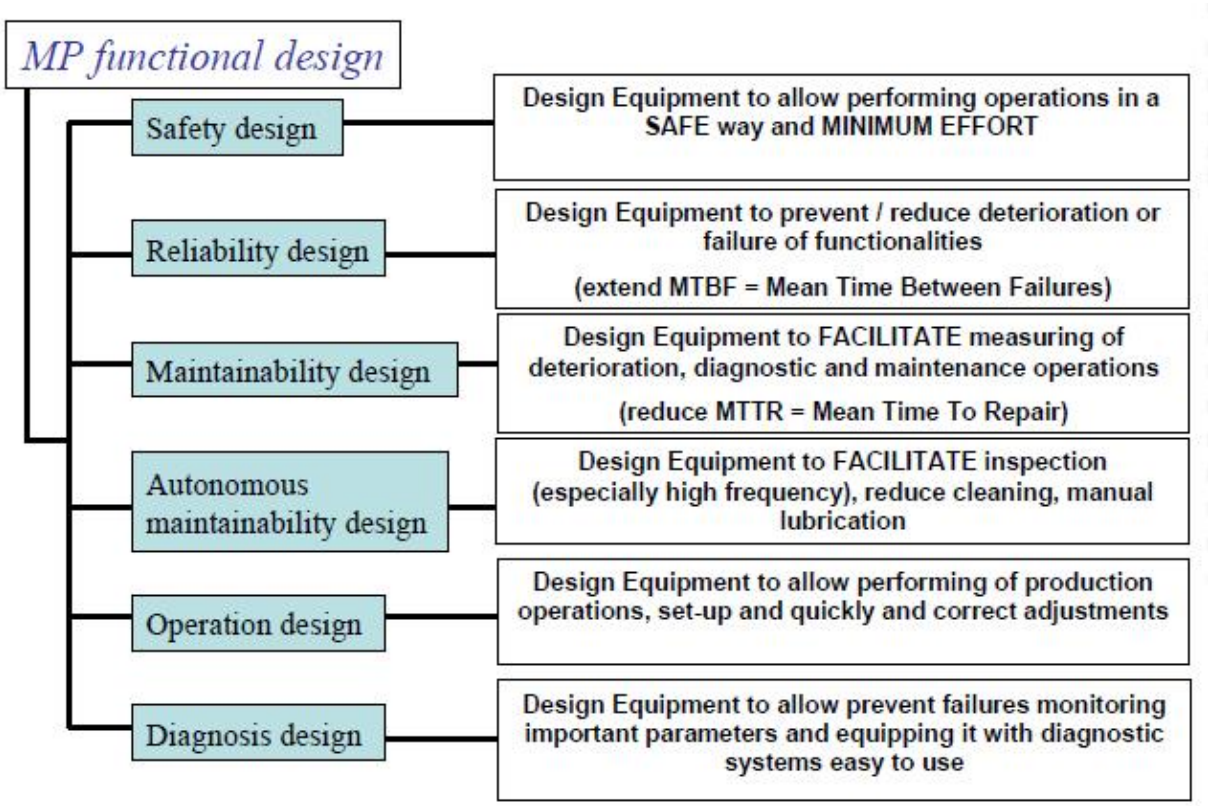
MP-INFO:

MP system (Maintenance Prevention) has as aim creation of a **data base of carried out solutions following problems found out during existing equipment's lifetime**.

These solutions could be generated during whenever instant of main 2 phases of equipment lifetime:

- *Development* phases (from concept to start-up – steps 1 to 7 of EEM)
- *Employ* of equipment in production phase

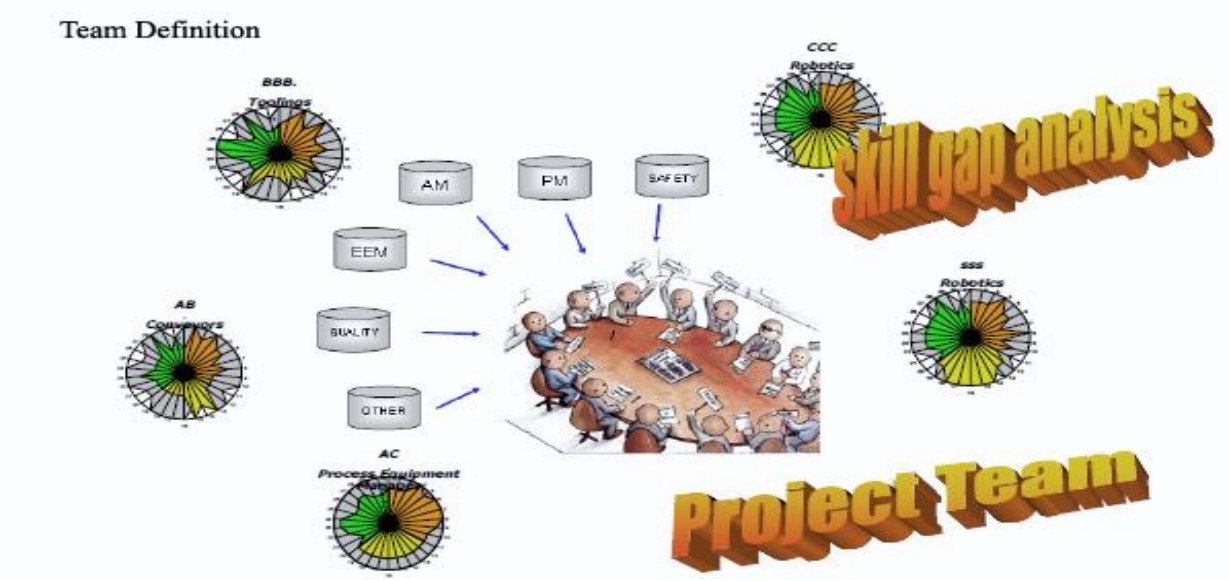
Following we can see main MP-Info categories which show *kind of impact* of the approached and solved issues described in the MP-Info.



STEP 1: PLANNING INTIAL IDEA:

The principal activities of this step are the definition of team required, their roles and responsibilities. In the first step skills gap analysis is also carried out to make sure the skill levels are up to date with the requirements. Following are the other important activities carried out in the first step

- Project needs and objectives
- Benchmarking
- Maintenance prevention (MP)- Data availability
- Flow analysis and macro chat
- Gantt- macro schelduling



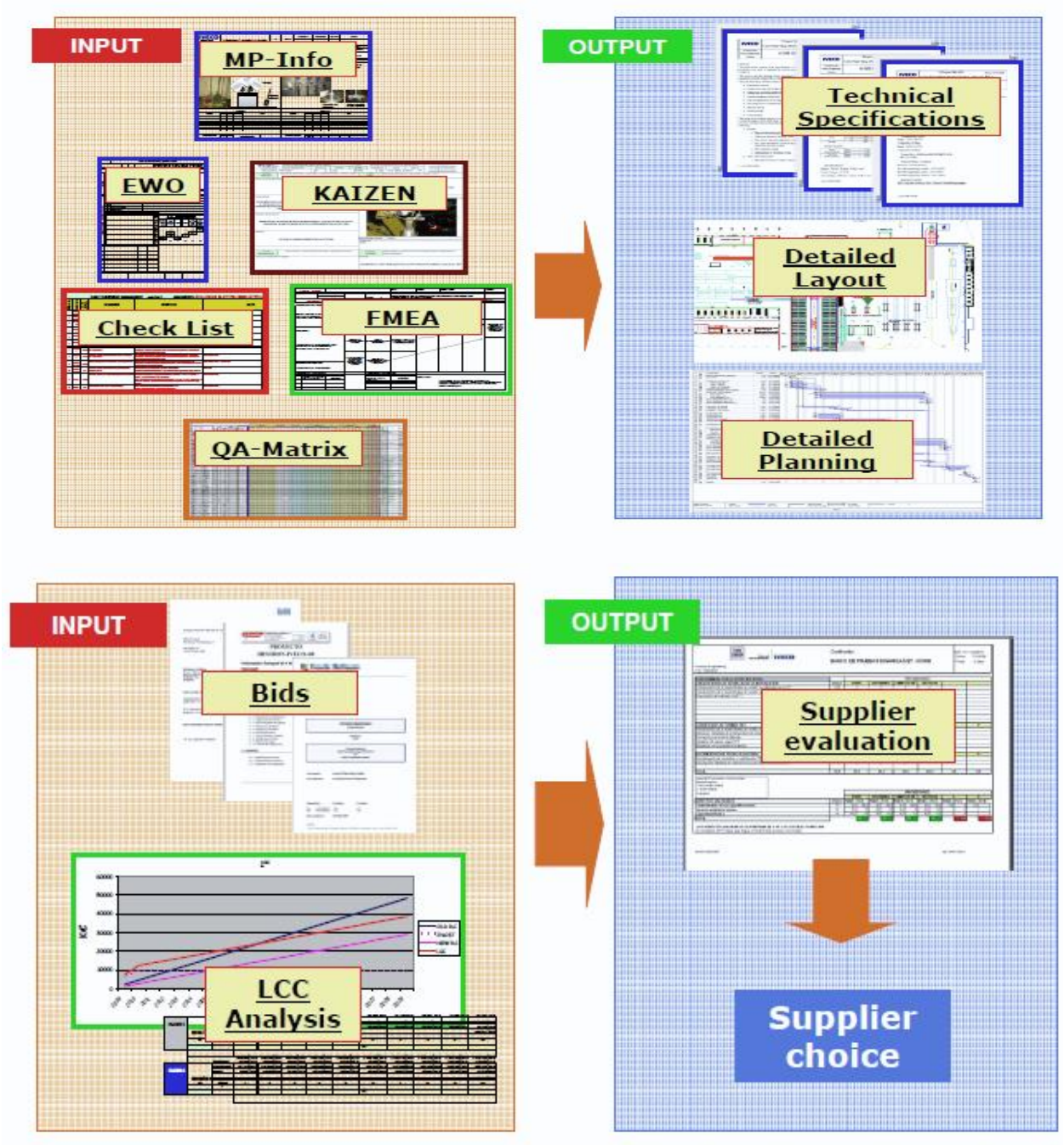
This picture explains the team definition process and in every step participants of the team could change therefore it is necessary to evaluate possible training needs through the process of skill gap analysis.

STEP 2: BASIC DESIGN:

Main activities of this step are as follows

- Team required , Roles and responsibilities (*updating*)
- Data Analysis
  - MP Analysis
  - EWOs - Breakdown Pareto
  - KAIZENs
  - FMEA
  - Q.A. Matrix
- Definition of Technical Specifications
- Detailed Plan
- Supplier Comparison (with LCC analysis) and supplierchoice

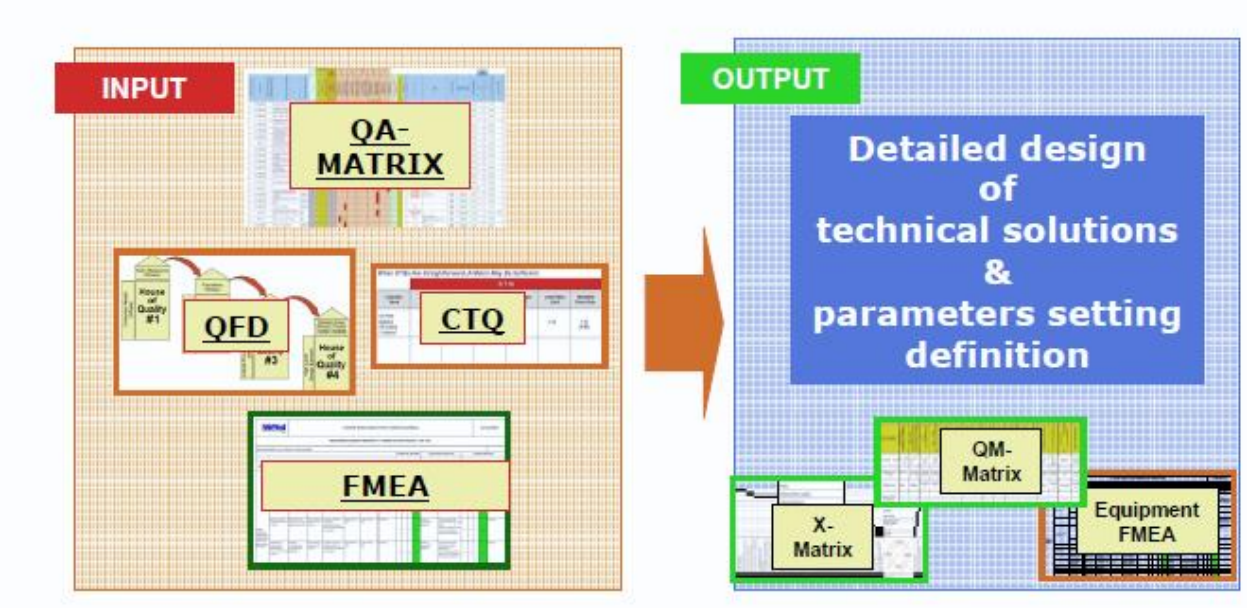
In Step 2 the activity of analysis of MP-info and other information is useful to identify technical solutions to be included in *Technical Specifications for Bidding Request* as scope of supply / manner of execution.



Activities of this stage are making an evaluation analyzing ***technical*** and ***economic*** **bids** and preparing LCC analysis of new equipment having as target choice of supplier.

STEP 3: DETAILED DESIGN:
Main activities of this is as follows

- Team required , Roles and responsibilities
- QA – Design
- Equipment FMEA
- MP Functional Design
- Equipment LAY-OUT and Micro Activities Scheduling



Working of QA design

In STEP 3 all MP-Info's (included in Step 2 in Technical Specifications of supply) are considered to develop their final detailed design in co-design with suppliers.

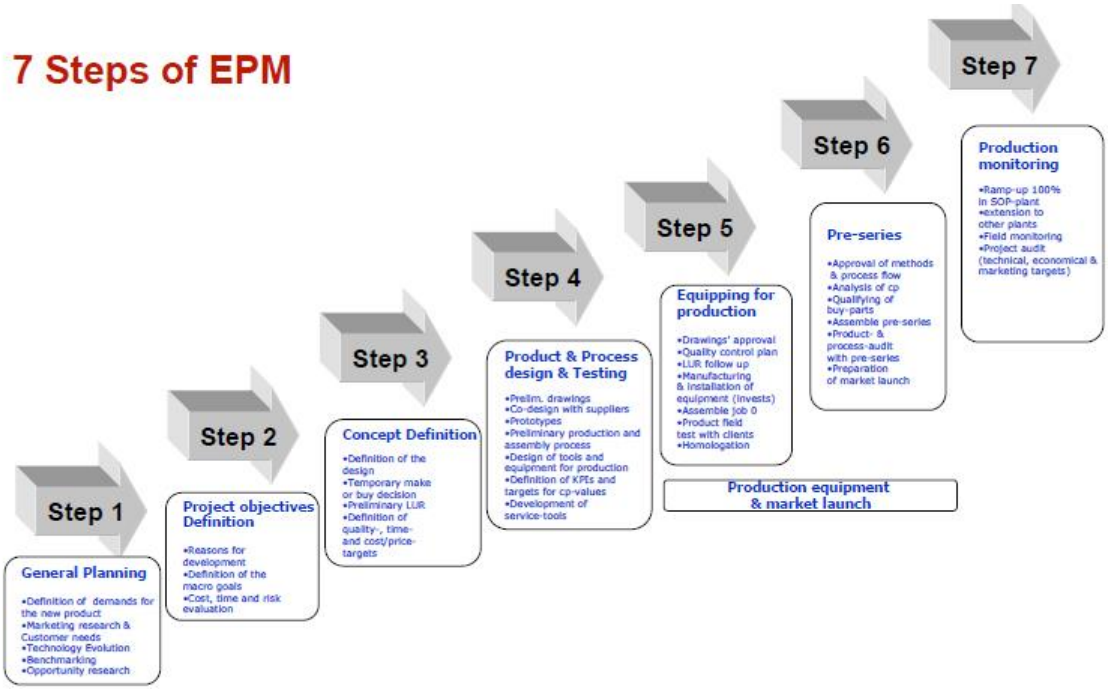
It's important that most part of MP-INFOs are already included in the Contract of Supply because some manner of execution described in MP-Info could be as variation versus manufacturing standards of the constructor and versus supply agreements that it may have towards its suppliers.

3.4.8.2 EARLY PRODUCT MANAGEMENT

Early product management pillar is used to optimize the cost of engineering process feeding this with manufacturing cost deployment. It is also used to increase the number of alternatives in the concept phase with the aim of finding the best solution. The purpose of EPM pillar is based on the following principals

- Focus management of the product development process on value added for the Customer.
- Manage data exchange between Cost Deployment and Cost Engineering inorder to guarantee correct balancing of costs and benefits.
- Improve efficiency and Focus of the Product / Process Engineering process.

7 STEP APPROACH:



STEP 1: GENERAL PLANNING:

Collect the information for preparing the planning of new product analyzing constantly internal and external input. We need to collect information about 3 issues:

- Law evolution: for example environmental laws in each country
- Analysis of choises of competitors on new models
- Analysis of market: for example analysis of logistic demand

R&D will change the company; R&D is the source of company activities. Today's R&D will create the future face of company. The R&D productivity is linked to ability to establish strategies and it's the result of the sum:

- Ability to determine objectives (selection of objectives)
- Ability to achieve the objectives (efficient application)
- Ability to adopt the obtained good results (business promotion).

STEP 2: PROJECT OBJECTIVES DEFINITION:

In this phase it's necessary to define the macro goals of intervention about commercial, economic, functional and quality aspects. In order to make it, it's possible to go deeply about relations between product and customer by market surveys. The target and the goals are classified as:

- Product and service Target
- Economic, time, di carry-over, standardization, productive capacity goals

At the end of step 2, you make the second Design Review and you sign the managerial Milestone MG1 with which you approve the Basic Requirement and the start of project.

STEP 3: CONCEPT DEFINITION:

In this step the **basic requirements** become the concept of Product/process and the goals are defined in term of

- Quality
- Costs
- Time

After definition of carryover from old product and the new contents of new product, you decide the make or buy strategy. for the supplier choice, it's necessary to have a supplier classification in term of:

- Quality requirement respect
- Cost requirement respect
- Time requirement

After Concept choice it needs a product / process target revision coherent with "Target Setting: this choices complete the "Cahier des Charges". The "Cahier des Charges" must be updated in the following issues:

- Objectives and scope of Intervention
- Market Analysis

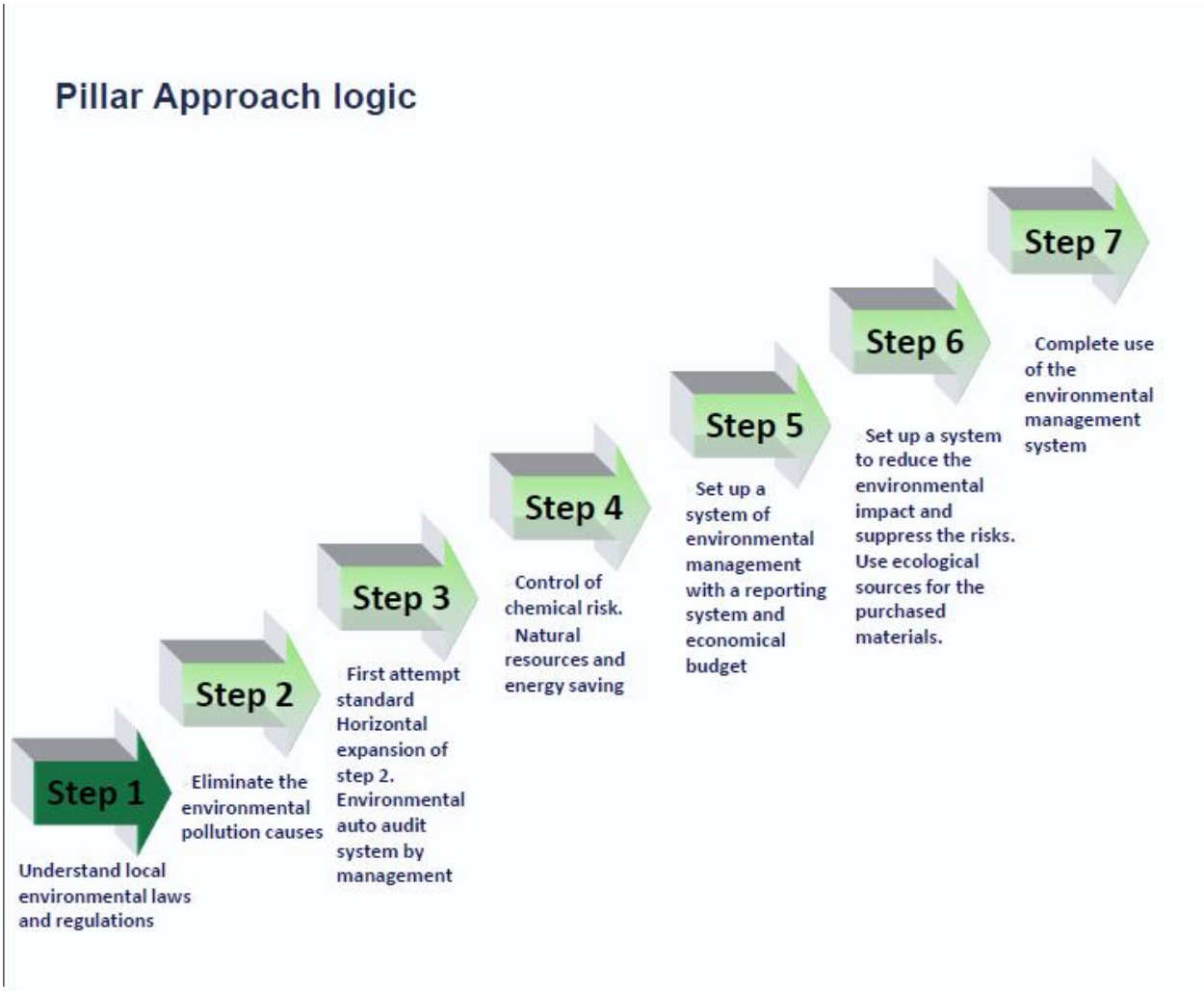
- Product Objectives
- Technical Definition of product / process
- First economic valuation of intervention
- Macro planning

At the end of step 3, you make the third Design Review and you sign the operative Milestone with which you choice the concept and managerial Milestone with which you approve the Cahier des Charges and investment draft.

3.4.9 ENVIRONMENT

This pillar is required in order to respect the laws specified by governments and to take care of energy consumption. The vision of this pillar is that all employees heed the protection of environment with each of their activities. Energy only used to add value i.e. zero waste. The plant must have a zero environmental impact. Objective is to define in qualitative way what you want to achieve in short term and in long term, referring to the phase in which you are. The target of is environment pillar is to define in quantitative what you want to achieve.

7 STEP APPROACH:



STEP 1: UNDERSTAND ENVIRONMENT LAWS AND REGULATIONS:

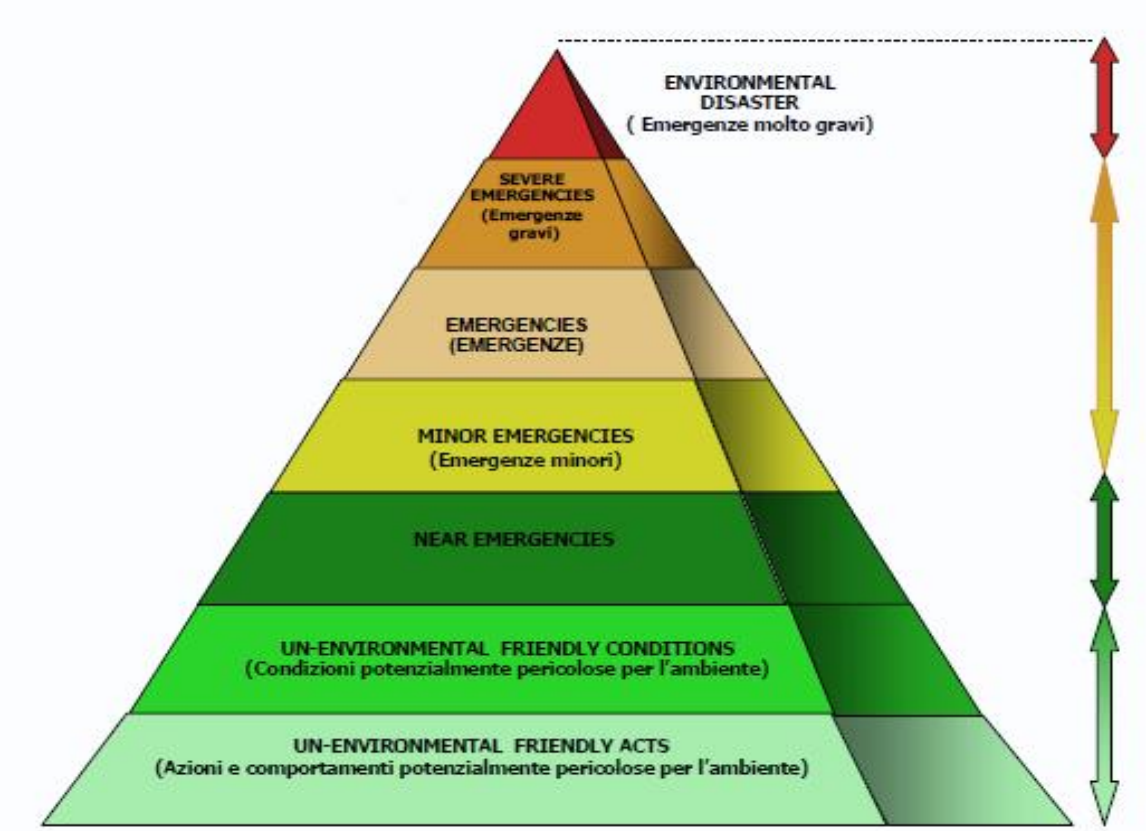
First of all, we must focus our attention on respect of local, national and international laws and regulations about environment. We must ensure speedy integration in our plant of new laws and modification of existent ones and we must also ensure spread of changes between all people involved.

It is really important to take under control *Environmental Law System* in long term in order to anticipate the modifications. In this way we can adapt our system to the changes with less effort in terms of time and money.

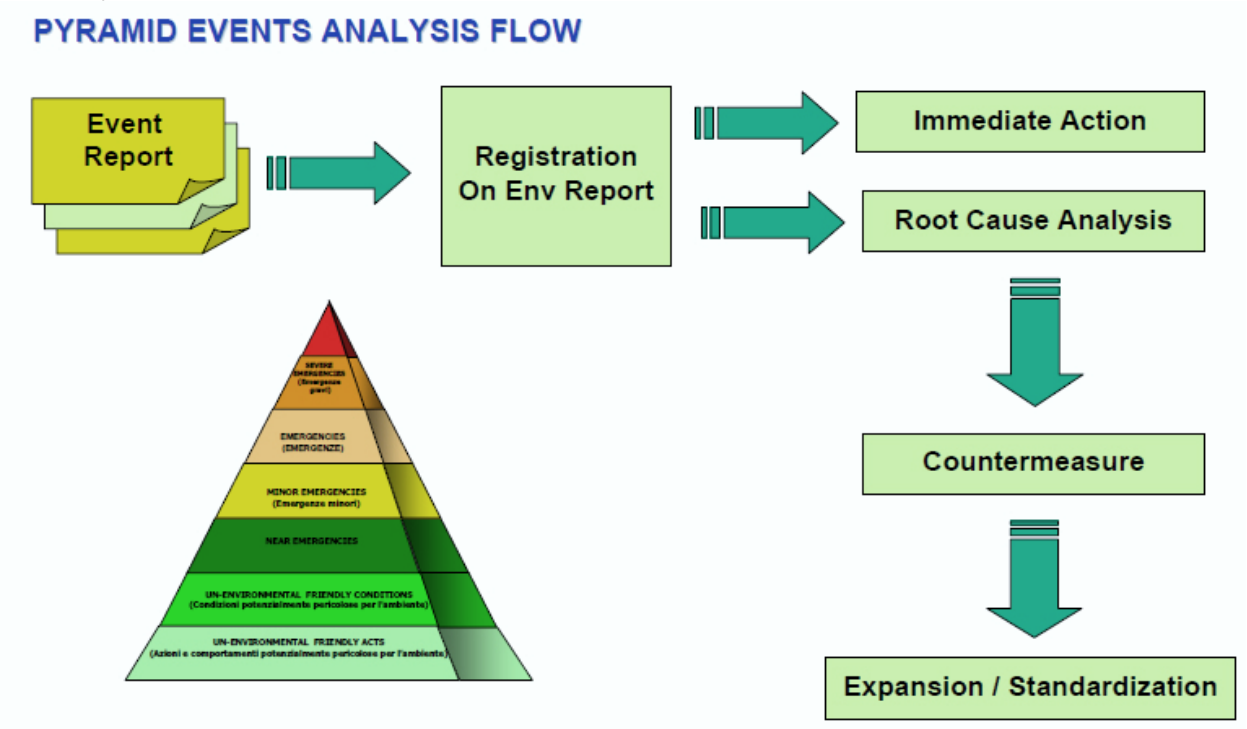
STEP 2: ELIMINATE THE ENVIRONMENTAL POLLUSION CAUSES:

In this step the environmental pollution causes are studied and eliminated through different tools and methods. 5R is one of the tools which is used specifically by environment pillar in order to first reduce and then eliminate the wastes. Environmental pyramid is another tool used to study the wastes.

The Environmental Pyramid is an evolution of Safety Henrich Pyramide and it has a similar meaning. We use it to take under control and analyze abnormal events/situations (accidents, near misses, conditions and acts) that have an environmental impact.



Environment pyramid characterizing different types of wastes according to the severity of the cause.



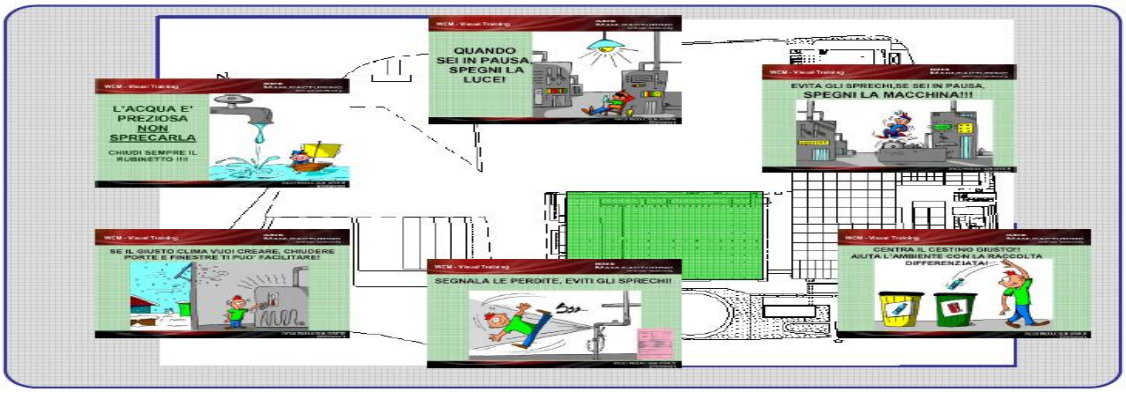
This image explains how each and every waste is characterized and record in order to first study, then eliminate and finally standardizing before expanding to similar areas in the plant.

STEP 3: INTIAL STANDARDIZATION AND HORIZONTAL EXPANSION:

For each environment event (accident or act/condition) we find an appropriate countermeasure. Now it's important spreading found solutions all over the plant using:

- Visual aids
- Visual Standards

All for helping people to be part to our effort in Environmental issues.



3.4.10 PEOPLE DEVELOPMENT

The main purpose of the People Development pillar is to identify and eliminate gaps of knowledge and competences, supporting all the other pillars in developing the organization competencies.

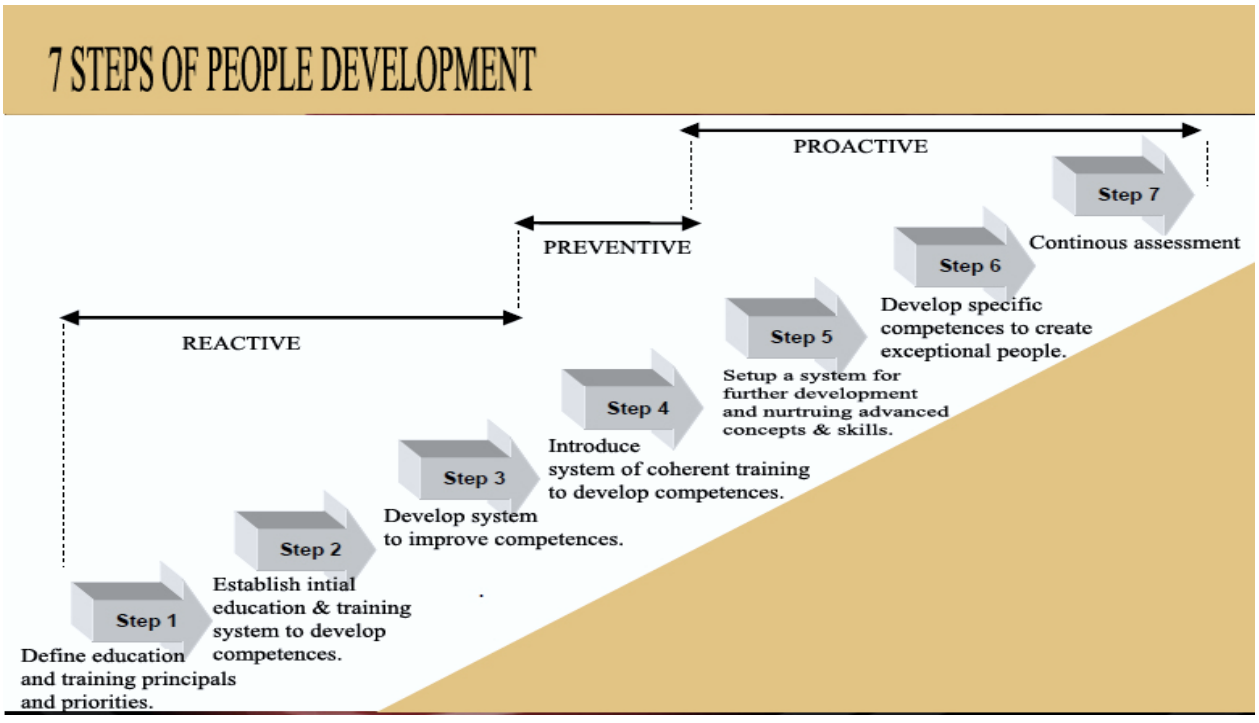
Initially this activity is developed in a reactive way (countermeasures to problems, losses and defects) and then with a preventive and proactive approach. It also includes the identification and the implementation of the right countermeasures to reduce absenteeism, and where this is not possible, it involves minimizing the problems caused by temporary absences of people through an effective replacement mechanism. It is also part of the People Development scope of activity where programs and initiatives to increase employees' involvement and

satisfaction (e.g. suggestion collection program) are identified and put into practice.

In the reactive phase, People Development priorities are identified by Safety, Security, Environmental, Cost Deployment (driven by major losses), QA Matrix (human errors more critical to Quality), 3M analysis by WO and Autonomous Maintenance (breakdowns and slowdowns). Then, in the preventive phase, PD is driven by the analysis of gaps between required and actual competences (including those related to WCA methods and tools) of the employees. Finally, during the proactive phase the direction is dictated by the expected changes in terms of the scope of activities, processes and company mission.

In any case, Education & Training (E & T) has to be provided only where necessary, with an appropriate level of detail and to the people who really need it. This is the focused approach of PD (e.g. through One Point Lessons, "training pills", etc.), as opposed to a more "traditional" approach (based, in some cases, on the belief that employee satisfaction may increase if they attend more courses).

Like other pillars; the pillar development of people development consists of 7 stages from reactive to preventive to proactive. The figure below explains the 7 steps approach of people development.



The People Development's Pillar Leader must be selected from those people in the company who have experience in managing such activities, including experience in Education & Training (for example people from the HR dept.).

Once a suitable Pillar Leader has been identified, he/she has to create a team in charge of developing all pillar activities. Somebody from Finance must also be in the team (e.g. the Pillar Leader of Cost Deployment), to help evaluate the economic aspects (costs and benefits) of the pillar development and the actions it puts in place.
Moreover, as the priorities for People Development come from the development of some other pillar areas (CD, WO, QC, AM/PM, SAF, …), the leaders of these pillars must be included in the PD Team.

Conclusions:

The methodology of the World Class Manufacturing is a structured program which is applied within the company to reduce all forms of waste and losses, with the ultimate goals of achieving zero accidents, zero waste, zero breakdowns and zero inventory.

By methods of World Class Manufacturing, better results can be obtained, which further motivate employees to perform better and show that successful are those who want those who are looking for a way to obtain success and have the courage and desire to be a leader. The results of the implementation of this concept and its methods is saved money, greater motivation of the people, greater safety at the workplace, better order and organisation in the workplace and greater cooperation among workers. The introduction of the WCM concept and its methods brings the company the improvement of efficiency and effectiveness and that the enterprises should look at this implementation as a challenge to further progress.

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