LSSGB

Lean Six Sigma Green Belt

Mohamed Naser

MOHAMED NASER

PMP, PMO-CP, Lean6Sigma, AMC

BSc of Mechanical Engineering
2004, Helwan University
Project Management Diploma
2009, AUC

Project Manager, PMP Coach, PMO Hub Leader, Speaker.

Mohamed Naser, PMP, PMO-CP, he has more than 14 years of experience as a project manager in different fields such as Oil& Gas, Construction, Food Industry, and Renewable Energy. He also works as PMP coach& mentor to help project managers to implement the project management professional techniques in their profession. He also works to promote the concept of PMO among the organizations in the middle east, he was selected as PMOGA Qatar hub leader. He is currently the Chief Business Officer at Watershed Management Consulting. He is BSc of Power Mechanics Engineering.

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2013-2015 Cairo
Abu Qir Thermal Power Plan, Project Engineer, DSD Ferrometalco 2011-2013 Cairo
Zafarana Wind Farm Renewable Energy Phase-3, Project Engineer, DSD Ferrometalco
2009-2011 Cairo
Operation& Maintenance, Operation Engineer, GUPCO
2006-2009 Red Sea
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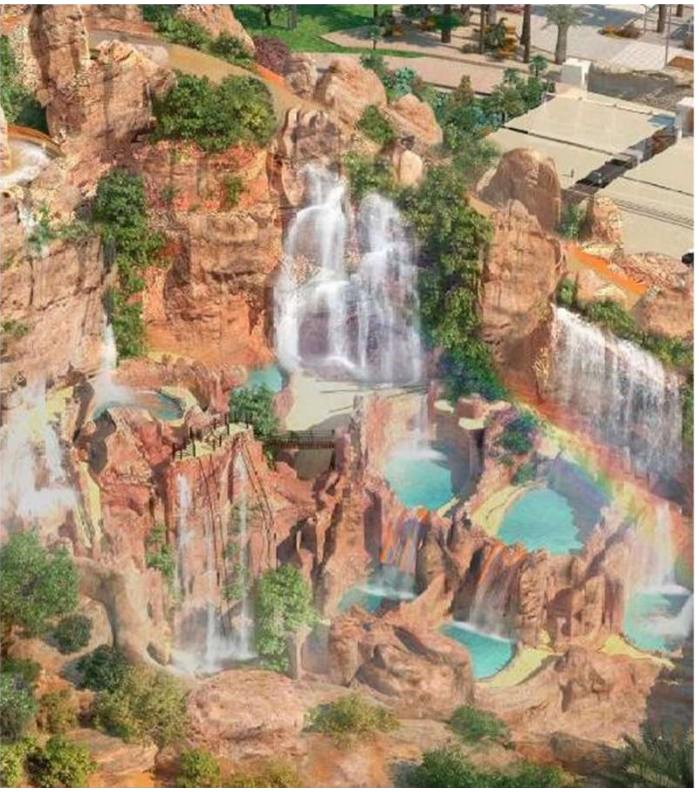


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PMP® Original Grant Date: 10 November 2015
PMP® Expiration Date: 09 November 2021

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CHAIR, PMO GLOBAL ALLIANCE

CANDIDATE NUMBER: 3825336
CERTIFICATE NUMBER: 13702467
EFFECTIVE FROM: September 6, 2019
NO EXPIRATION DATE

PMO GLOBAL ALLIANCE AUTHENTIC

OUR CONFERENCE SPEAKERS

The final group of speakers will be announced on October 31st, 2019.

PAULINA AUGUSTOWSKA

Head of PMO at x-kom

PALOMA MARTÍN

Head of special projects office administrative secretariat at Honorable Cámara de Diputados de la Nación

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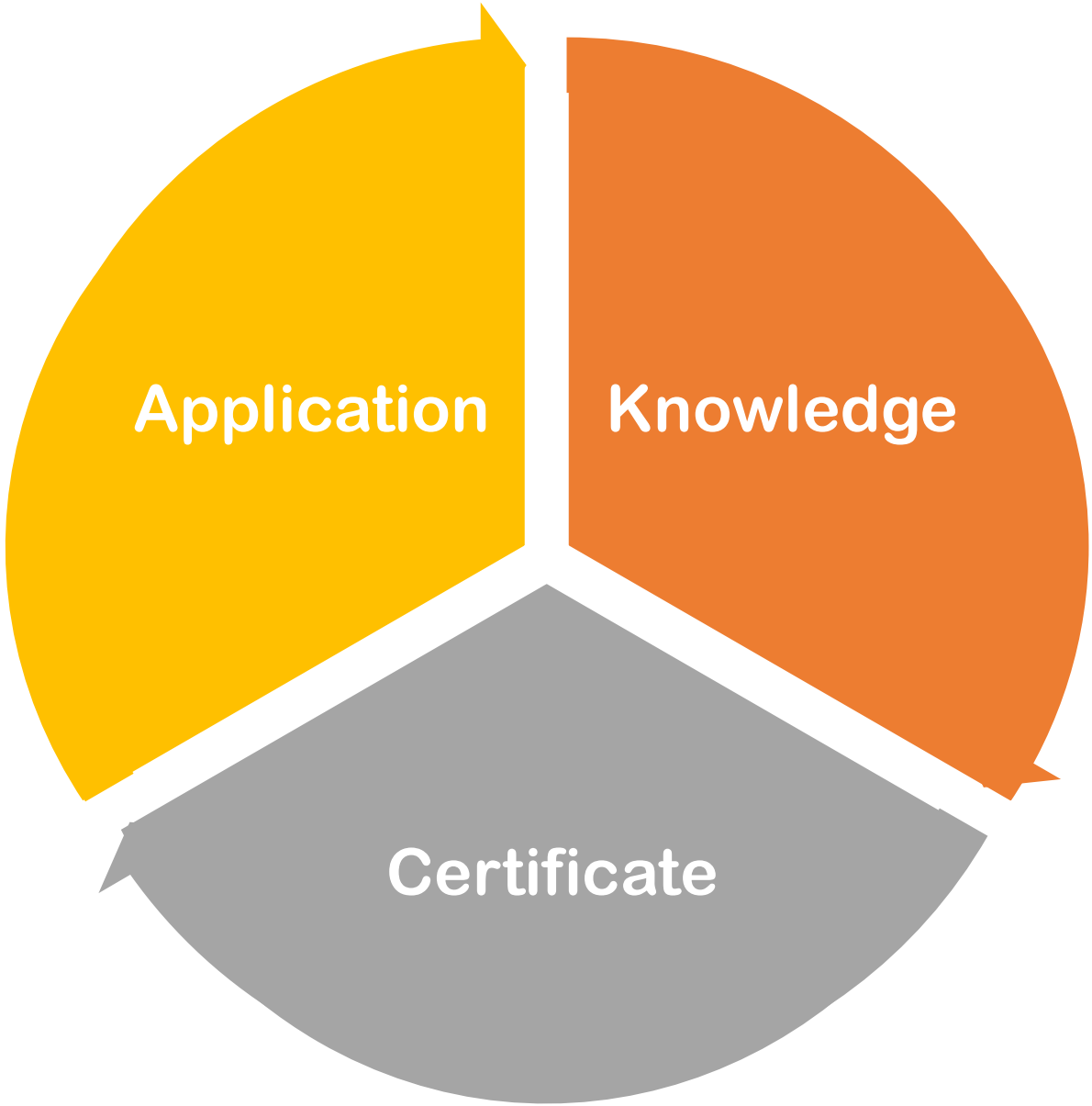
CBO Chief Business Officer at WatershedPM

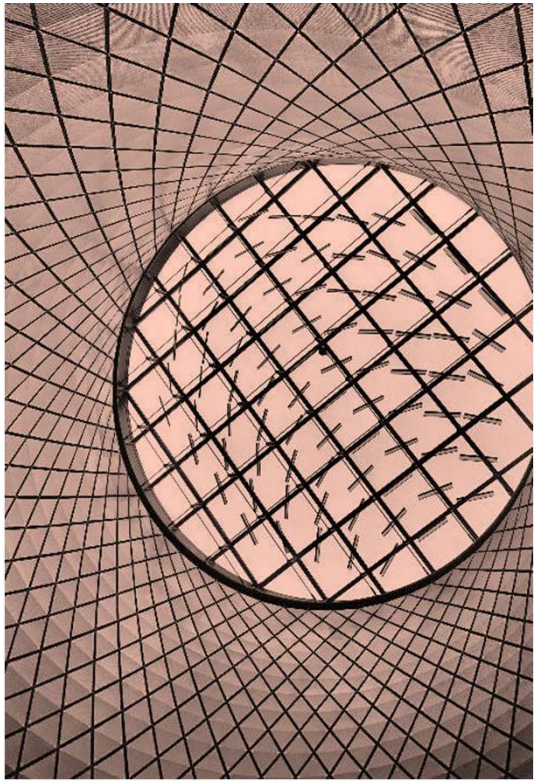
MAURIZIO CIRAOLO

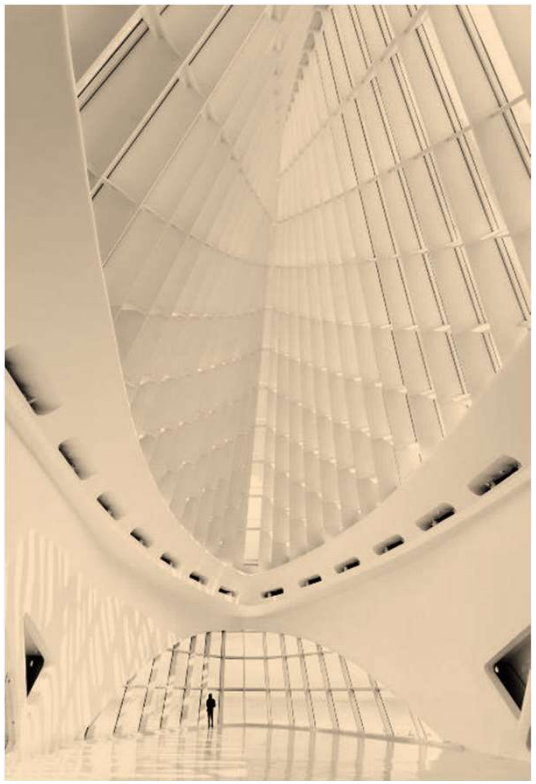
PPM Division Manager at Horsa


PERSONAL
DEVELOPMENT

Objectives

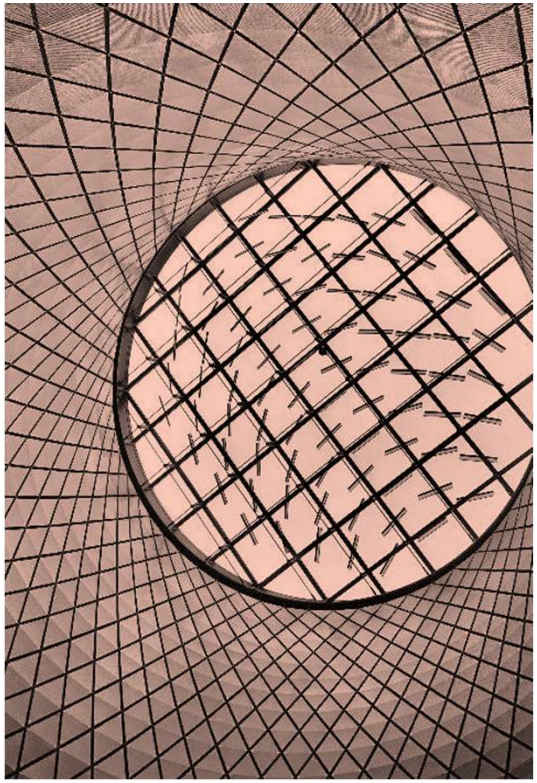


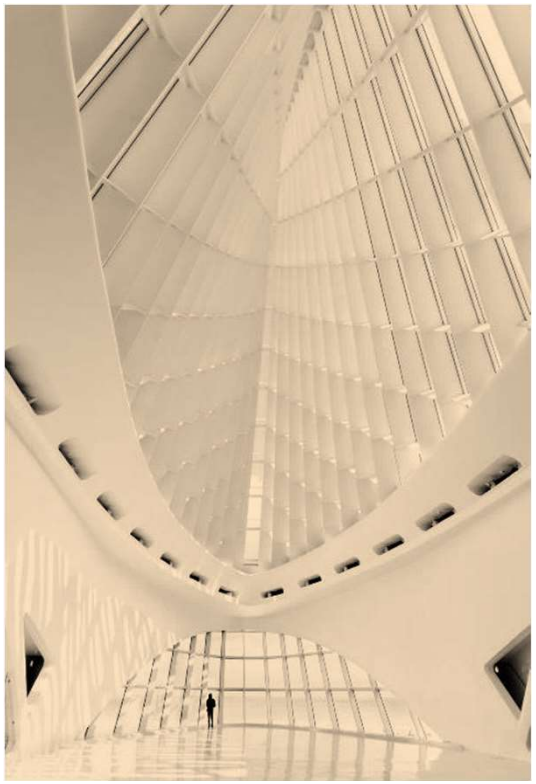





How we work

1. Ch1 Introduction
2. Ch2 Identify Stakeholders
3. Ch3 Setting up Six Sigma Project
4. Ch4 Define
5. Ch5 Measure
6. Ch6 Analyze
7. Ch7 Improve
8. Ch8 Control
9. Ch9 Lean Essentials
10. Ch10 Lean Tools and Features



Chapter 1
Introduction

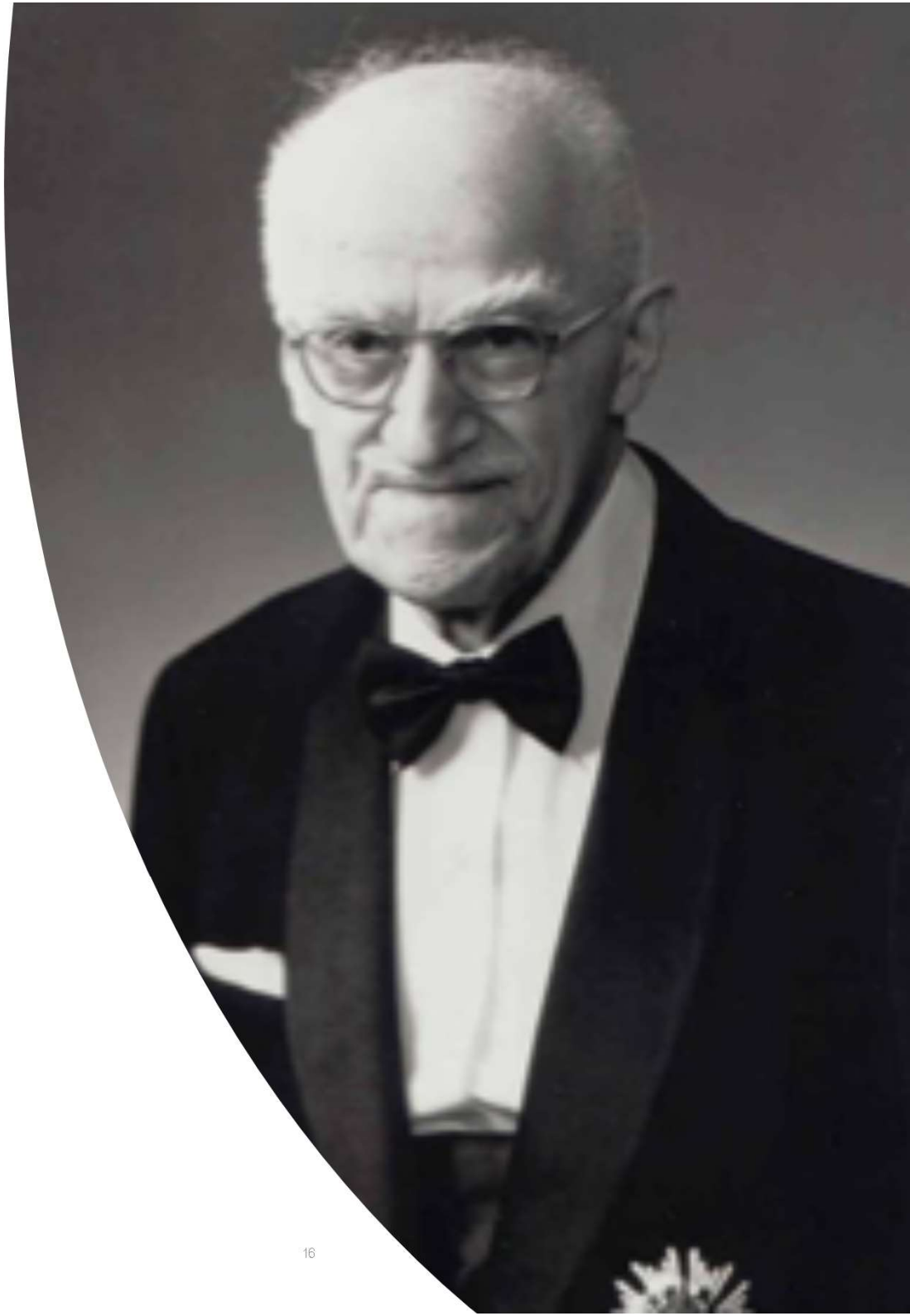
History of Quality

Edward Deming

- SPC Statistical Process Control to identify the cause of variations.
- Quality depends on the policies of management, management should prepare the environment in which quality can be achieved, he is the owner of theory "Theory of Profound Knowledge" which talks about how management should create conditions where every worker contribute towards quality improvement.
- PDCA, plan do check act (Deming cycle-PDCA)
- He is owner of book "Out of the crisis" it set 14 management guidelines can used by US companies to improve quality and compete with Japanese manufacturing.

Joseph Juran

- Develop Pareto principle 80-20
- Quality from customer perspective has two aspects:
  1) more features
  2) freedom from trouble, so improving the quality should deliver these two aspects to customers.
- He has a book called "Quality control handbook" provides information to companies for improving performance through better quality.
- Quality trilogy model which uses: Qality plan- Quality improvement- Quality control for improving quality.
- He founded the Juran institute 1979

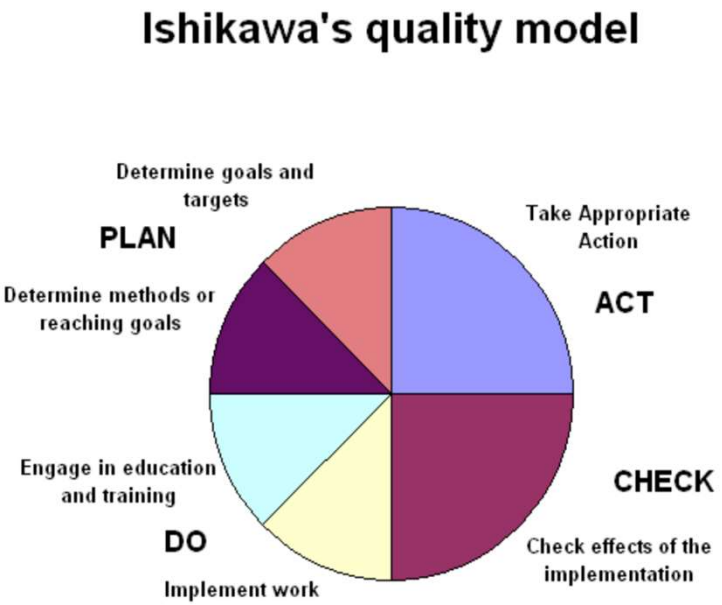


Philip Crosby

- Conformance to requirements
- Not as exceeding expectation
- Cost of non-conformance
- Plan for Zero defects, anything less is not acceptable
- Do things right the first time

Kaoru Ishikawa

- Use cause and effect diagram (Fishbone diagram)
- Expand of PDCA
- Quality improvement is always a continues process and can be taken a step further
- Using the quality tools
  - control chart
  - Pareto chart
  - Histogram
  - Run chart
  - Scatter diagram
  - Flow chart



Genichi Taguchi

- Effect of external disturbance
- Min noise whenever possible
- Quality loss function is a concept used to quantify decrease the perceived value of the goods by the customers once the quality decrease.
- The use of design of experiments

Evolution of Six Sigma

- The first one who use the term six sigma was Bill Cohen scientist in Motorola
- Johan Carl Guass, who is the first one started working on normal distribution of six Sigma.
- Several companies used Six Sigma to improve the quality and reduce the cost)such as Motorola($16Billion saving)-GE-Allied Signal- Citibank)
- 6 Sigma 3.4defect/million 99.9997%
- Factors that make Six Sigma more effective tool than other traditional quality techniques:
    1. Comprehensive
    2. Project based approach
    3. Cohesive process based approach
    4. Quantitative approach
    5. Commitment from all levels of organization

Comprehensive

It is comprehensive methodology which include the best practice from other traditional quality techniques.

The six sigma DMAIC methodology looks at the whole project life cycle.

It links the business goals and the customer expectations

It can be used by all companies across different business areas including manufacturing, finance, technology, construction, , engineering, …ect

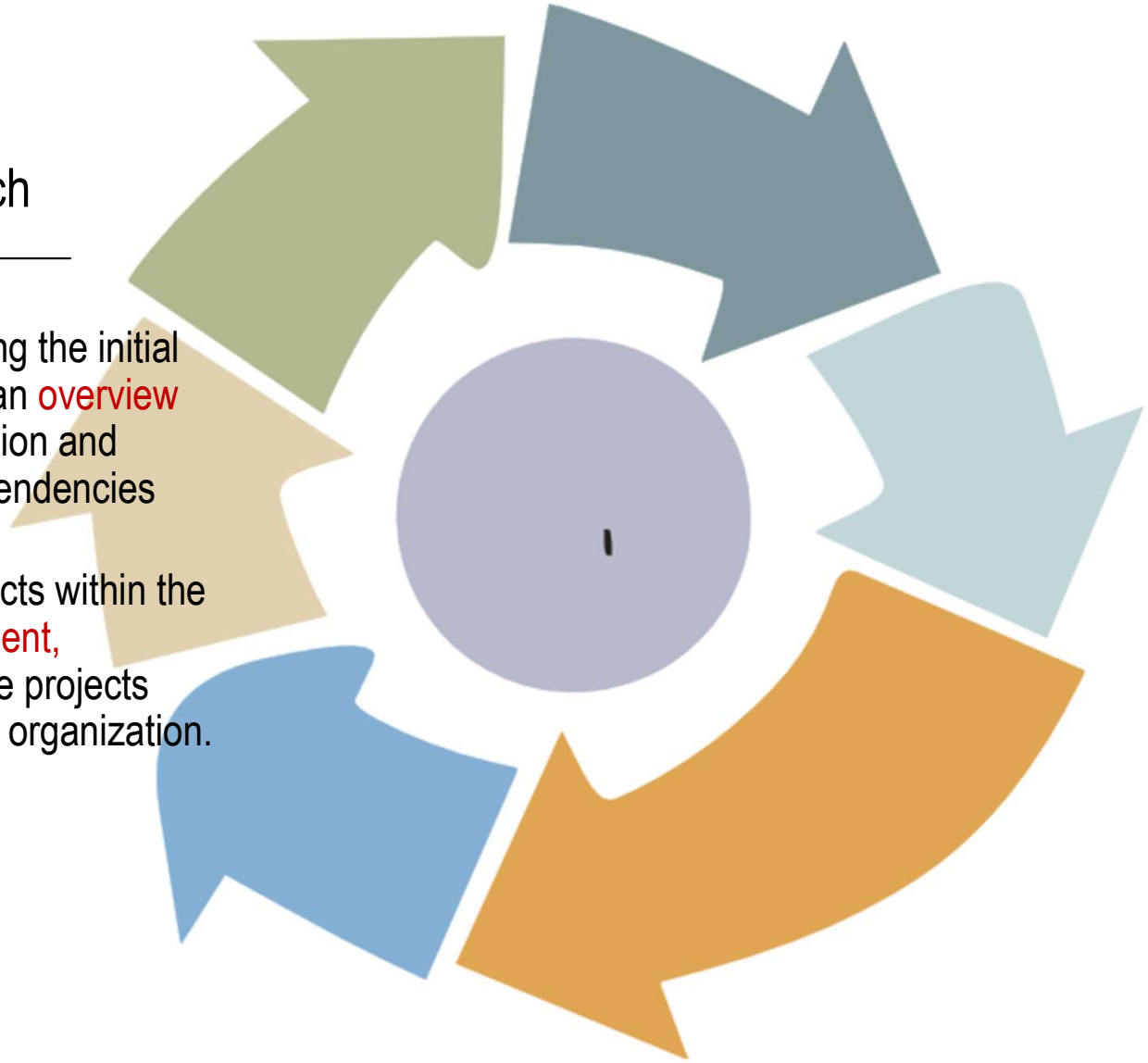
It can be used by companies at different sizes, big, medium, small even with less than 30employees

Project based approach

- Six sigma uses the concept of project management, so it is used as a project.
- Six sigma project has a defined start date and end date, a pre-defined project charter with goals, objectives and deliverables.
- It uses the 10 PMP knowledge areas.

Cohesive process based approach

- A detailed process maps created during the initial stages of a six sigma project provide an overview of complex processes in the organization and identify the relationships and interdependencies between processes.
- Six Sigma can evaluate different aspects within the organization including people, equipment, environment, materials and identify the projects which can provide max benefits to the organization.



Quantitative approach

- Six sigma uses rigorous quantitative and statistical techniques by providing mathematical analysis to determine which project offers the max benefits at the least cost.
- The following quantitative six sigma concepts are used to ensure:
  - The project goals align with the organizational goals
  - There are long term benefits from the six sigma project.

Commitment from all levels of organization

- Six sigma formalizes an organizational structure for its projects and ensure commitment from all levels of the organization to achieve the quality goals.
- All stakeholders have a vested interest in successful implementation of six sigma projects.
  - Executive Management (Deployment Champions) is responsible for sponsorship of the project and allows for commitment of organizational resources to the Six Sigma project.
  - Master Black Belts and Black Belts act as consultants and experts in Six Sigma. They are also responsible for providing guidance and coaching to others in the organization about Six Sigma philosophy.
  - Six Sigma Green Belts serve as a liaison between the Black Belts and the project team. They perform the operations required for the Six Sigma project and work with the project team to ensure that appropriate deliverables are met.

Commitment from all levels of organization

- The project team works in executing the actual work of the project through guidance provided by Six Sigma Green Belts and Six Sigma Black Belts.
- Subject Matter Experts in different fields (e.g. Finance, Human Resources etc.) may be involved in providing expertise wherever required.

- Well defined organization structure, project hierarchy, pre-defined roles and responsibilities, all of this create the feeling of "shared ownership and responsibility" which is critical in successful in project implementation.

Defining of Six Sigma

- Six sigma refers to decreasing the number of defects to 3.4 defect per million opportunities (ie 99.9997% success rate).
- It attaches variation in processes- minimizing defects and waste- hence improving the bottom line.
- Six sigma philosophy strives towards perfection
- It includes tools and techniques for careful definition, analysis, measurements of business processes to improve process capability.
- It relies greatly on statistical techniques to measure and quantify success.

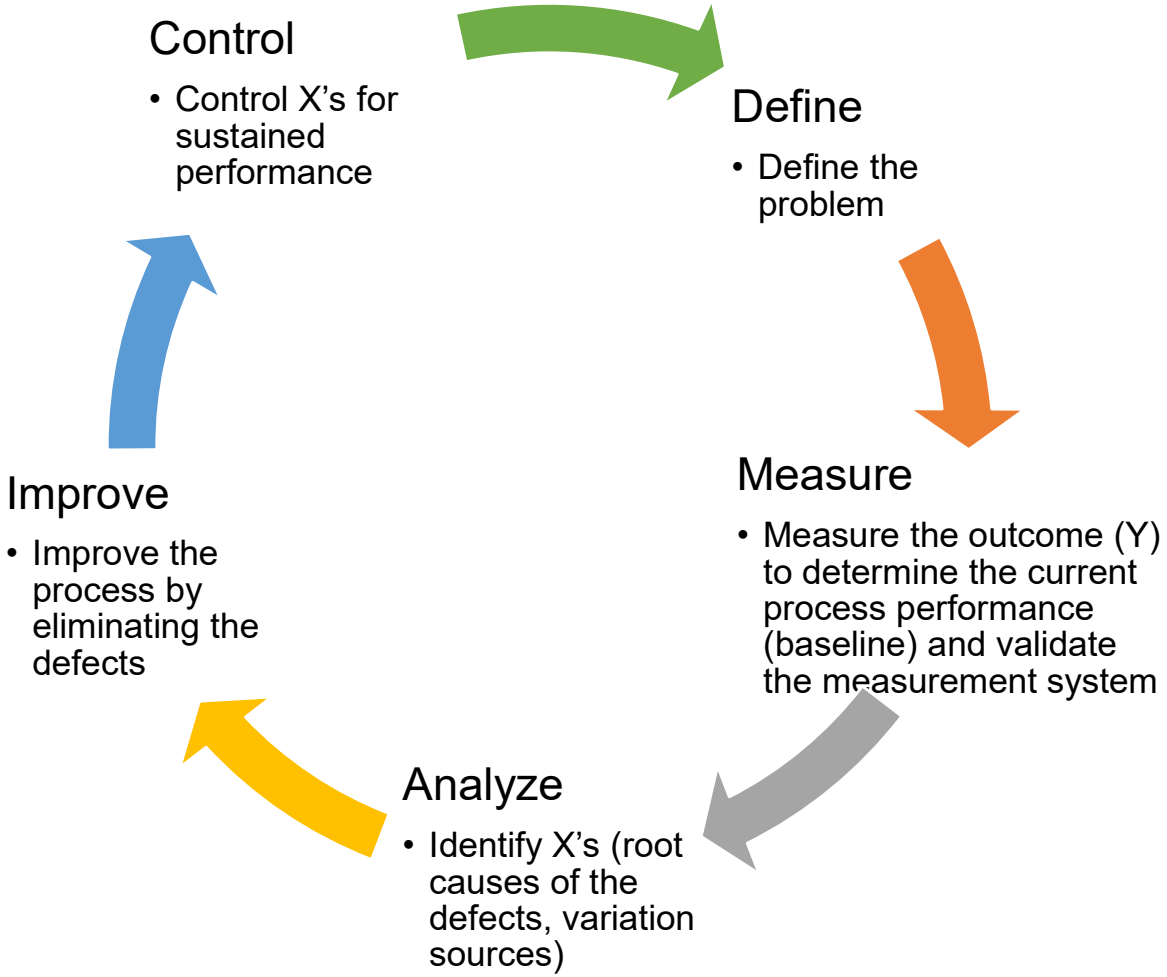
- Six sigma is a quality methodology that can be used to clearly understand and organization's business processes and customer needs, and either:
  - Redesign the business processes or
  - Provide/make incremental process improvements as desired.

Six Sigma Score	Defects per million Opportunities	Okay Percentage
2	308537	69.15%
3	66807	93.32%
4	6210	99.38%
5	233	99.98%
6	3.4	99.99966%

- Six Sigma score
  - As the Six-Sigma score improves, the variation in the processes reduce drastically, thereby increasing the reliability of the system, which reduces the need for rework.
  - The reduction in amount of rework reduces cycle time and improves customer satisfaction.

Six Sigma Cycle

- DMAIC is a data-driven Six Sigma methodology for improving existing products and processes.
- The DMAIC process should be used when an existing product or process requires improvement to meet or exceed the customer's requirements.
- This initiative should be consistent with the business goals of the organization.



1. Define

- Identify the areas of improvement and define goals for improvement activity and ensure that resources are in place for the improvement project
- It focuses on a customer requirement in identify project CTQ (Critical to Quality), CTQ is a product or service characteristic that satisfies a customer requirement or project requirements.

Inputs

1. Need for Six Sigma project
2. Executive Management Sponsorship
3. Core team identified

Tools& Techniques

1. Organization hierarchy
2. High level process maps
3. High level Pareto charts
4. Idea generation and categorization tools

Outputs

1. Project Charter
2. Established metrics
3. Problem Statement
4. Roles and Responsibilities

2. Measure

- The Measure Phase evaluates the process to determine the current process performance, that is, the baseline.
- It uses exploratory and descriptive data analysis to help in understanding the data.
- The Measure phase allows you to understand the present condition of the process before you attempt to identify improvements. The inputs to the measure phase are the outputs of the Define phase.

Inputs

1. Project Charter
2. Roles and Responsibilities
3. Problem Statement
4. Stakeholder Requirements
5. Established metrics

Tools& Techniques

1. Data Collection Tools and Techniques
2. Measurement scales
3. Validation techniques
4. Statistical Distributions
5. Data Mining
6. Run charts
7. Detailed process maps and process charts
8. Stakeholder tools
9. Process Costs

Outputs

1. Well-defined Processes
2. Baseline Process Capabilities
3. Process parameters affecting CTQ
4. Cost of Poor Quality (COPQ)
5. Measurement Systems

3. Analyze

- The Analyze phase is used to identify few vital causes from a list of potential causes obtained from the Measure phase, actually affecting project outcome using six sigma methodologies.
- The data collected in the Measure phase are examined to determine a prioritized list of the sources of variation.

Inputs

1. Well-defined Processes
2. Baseline Process Capabilities
3. Process parameters affecting CTQ
4. Cost of Poor Quality (COPQ)
5. Measurement Systems

Tools& Techniques

1. Ishikawa Diagrams
2. Failure Mode and Effects Analysis
3. Hypothesis Testing
4. Process capability study

Outputs

1. Important causes of defects
2. Performance gaps
3. Special and common causes of variation
4. Defects Per Million opportunities (DPMO) and Sigma level

4. Improve

- The improve phase of Six Sigma is used to improve the system to do things better, cheaper or more rapidly by finding optimum solution for Y, implement the new approach and validate using statistical methods.
- The main objective of the improve phase is to improve the process by eliminating defects.

Inputs

1. Important causes of defects
2. Special and common causes of variation
3. Defects Per Million opportunities (DPMO) and Sigma level

Tools& Techniques

1. Return on Investment (ROI)
2. Solution Design Matrix
3. Design of Experiments
4. Taguchi Robustness concepts
5. Response Surface Methodology
6. Project planning and management tools
7. Prototypes

Outputs

1. Costs and Benefits of different solutions
2. Selection of solutions for implementation
3. Implementation Plan

5. Control

- The control phase of Six Sigma is used to develop and implement process control plan to ensure sustenance of the improved process.
- The major activities in the control phase are to validate measurement system, verify process improvement and develop control mechanism. So far we have identified the best settings for each of the vital 'X'. The key now is to ensure that the X's don't fluctuate away from the targeted setting.
- Process control is an important tool to ensure that the Six Sigma project delivers lasting benefits.

Inputs

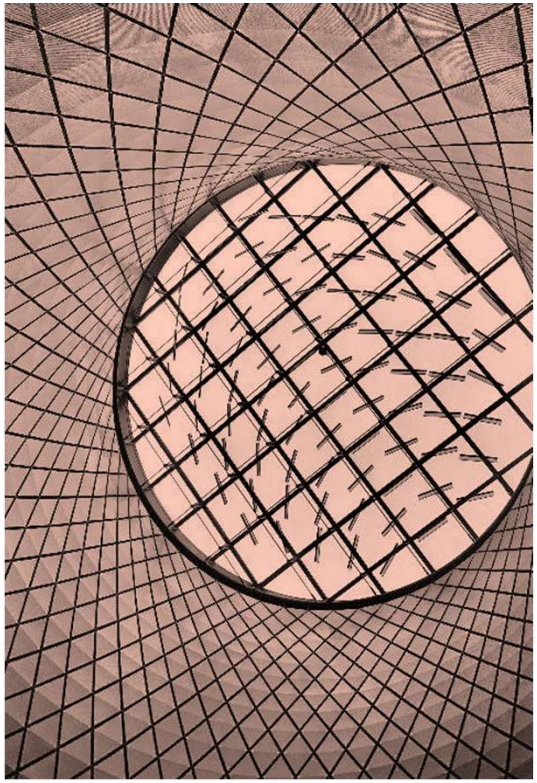
1. Costs and Benefits of different solutions
2. Selection of solutions for implementation
3. Implementation Plan

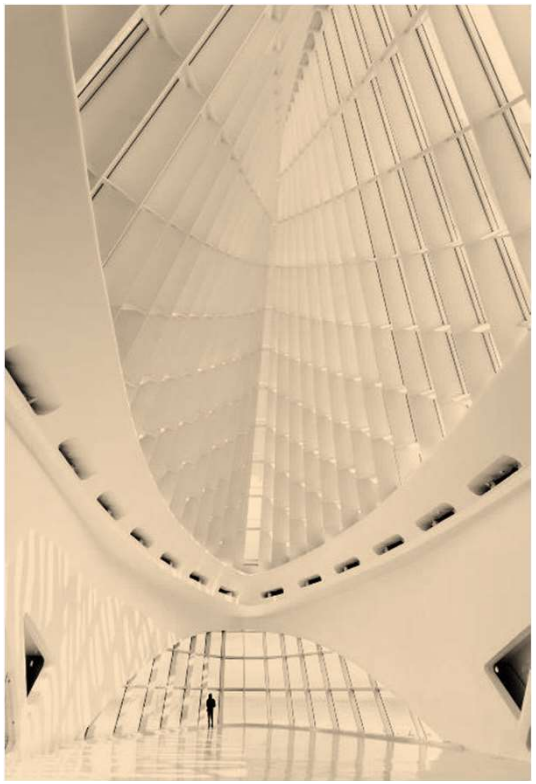
Tools& Techniques

1. Control Plan
2. Statistical process control
3. Learn Enterprise
4. 5S
5. Kaizen
6. Kanban
7. Total productive maintenance
8. Measurement system reanalysis

Outputs

1. Implemented Solutions
2. Revised Measurement Systems
3. Control Plans for Sustaining benefits
4. Improved Process capabilities
5. Lessons Learned



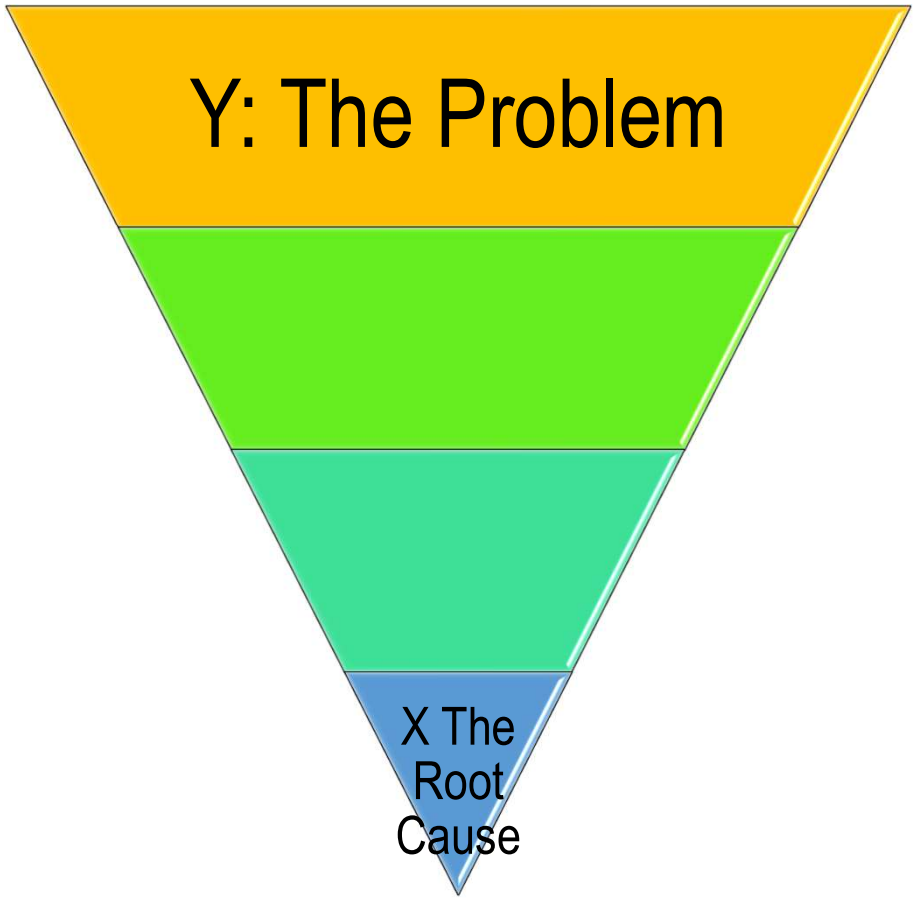
Chapter 2
Identify Stakeholders

Stakeholders

- Project stakeholders are individuals and organizations that are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or project completion; they may exert influence over the project and its results
- To collect the requirements, we follow the balanced scorecard tool which is used to measure different stakeholder goals and translate them to metrics, how?
- Determine the vision and strategy of the organization
- For each stakeholder determine the Y=f(X), where Y is the result that the stakeholder needs, and X is the effects, ex. Customer satisfaction (Y) can be achieved by decreasing the defects, improving the services… (X)
- The balanced scorecard is progressively elaborated through the project.

Add page no5 ch2

- Example of Balance Scorecards- progressively elaborated
  - Y= improve customer satisfaction is function in (X1,X2)
    - X1 Achieve better quality
      - Y1 Achieve better quality is function in (X11,X12)
        - X11 Manufacturing better product
          - Y11 Manufacturing better product is function in (X111,X112)
            - X111 Reduction of defects
            - X112 Providing additional features
        - X12 Better customer service
    - X2 Lower Cost



Benefits of balanced scorecards

- Getting inputs from stakeholders and aligns them with strategy and vision of the company.
- Balance the stakeholders needs
- Quantify the objective results Y in terms of effects X
- Determining critical vital effects Xs
- You focus on the most vital Xs that if improved, will have a significant effect on the results Ys

- Voice of Customer= stated and unstated customer needs
- Steps to understand the voice of the customer:
  - Identify the customer
  - Collect and analyze customer data
  - Determine critical requirements
- In Six Sigma project, the customer may be classified as:
  - Internal, in the organization
  - External, outside the organization
- Customer loyalty
  - That you keep the customer loyal to you which mean he/she will choose you to purchase or do the service, in the mean time you should make effort to create/grow the customer loyalty.

Data collection and analysis

Source of Data	Examples of data available	Examples of data collection Techniques
External Environment and competitors	Market Share, Growth in market, Product features etc.	Publications, Comparative study of competitors' products etc.
Financials	Sales, Profit, Growth, Return on Capital employed etc.	Company financials, Balance Sheet, Profit & Loss Statements etc.
Company processes	Defects per million, cycle time etc.	Measurement of internal processes etc.
Customers	Customer Satisfaction, Customer Perception etc.	Surveys, Focus Groups, Interviews, Observations etc.

- Data collection is the first step to create the six sigma, so it should be accurate and proper.
- To collect data, you should know:
  - 1) source of data,
  - 2) examples of data,
  - 3) collection techniques

Data can be classified in two types (you should know type of data to choose the right six sigma tools)

- Discrete data (numbers)
  - Number of people- no of defects-…
- Continuous data (information)
  - Weight- Customer waiting time- cars speed

Data Collection Techniques

- Survey
  - Is used to get information from a small group of stakeholders.
  - The results of the survey will be used as input to the six sigma processes

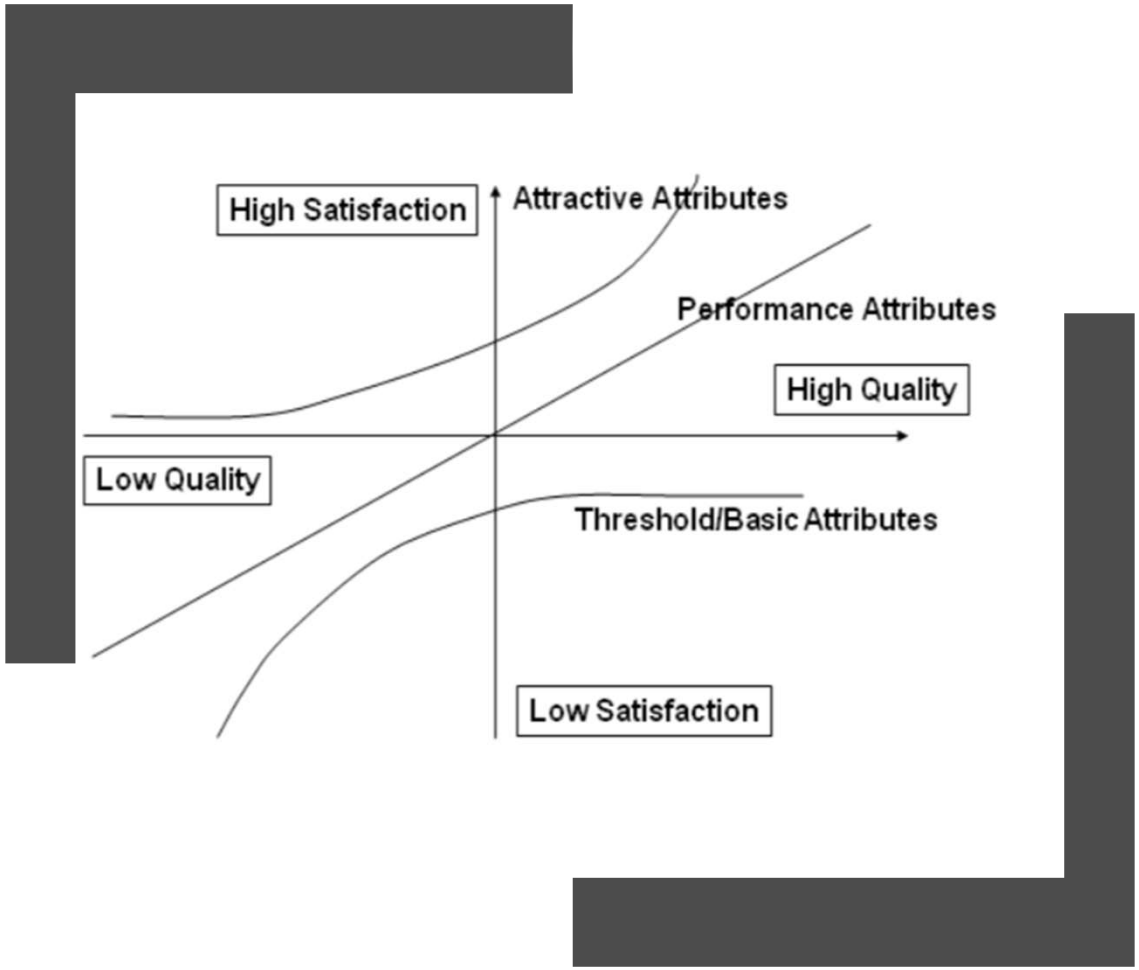
  - Surveys are divided into 3 high level steps
    - A) Creating the questionnaire
      - Determine types of questions
        - Demographic info about customer (age-gender…)
        - Attitudinal (like/dislike…)
        - Service/product attributes (how customer perceives different parameters of product or service)
      - Determining response types
        - Open end questions (views or opinions)
        - Rating questions (rating 1 to 5)

Data Collection Techniques

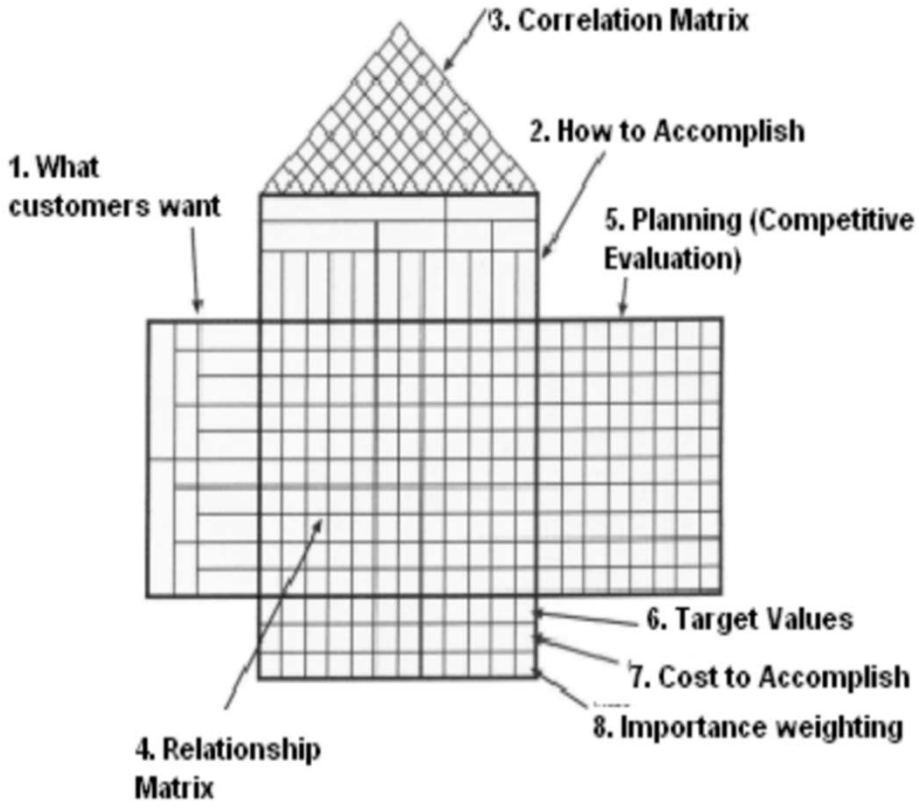
- Survey
  - Ranking questions
    - Let the customer provide ranking 1 to 5
    - Yes/no questions
    - Likert scale, measure strength of an opinion
  - Validating the questionnaire
    - Once the questionnaire is created, the questions are validated to ensure that all the question are covered.
    - You may make small group of users to check if the questions are clear or not
- B) Sending the questionnaire to respondents
- C) Collecting and analyzing the data

Data Collection Techniques

- Focus Groups
  - It is important to evaluate the existing product and get new ideas
  - It consists of 6-10 people selected due to some common characteristics as required for the focus group.
  - Focus group is open-ended discussions, it covers much wider range of issues than surveys
  - The moderator or facilitator
    - Creates environment which allows free flow of information.
    - Ensures that everyone in the group gets to voice their opinions.
- Interviews one-to-one meeting
- Observation observing the behavior of customers



- Kano Model (determining product attributes to be imported by customers)
  - Kano classified product characteristic into three categories
    - Threshold/basic attributes سمات
      - Customers assume these attributes to be present in the products (mandatory).
    - Performance attributes
      - The more performance attributes the products have the more customer satisfaction.- promotional
    - Attractive attributes
      - Attributes which delight بهجةcustomer, they pay for premium.



- Quality Function Deployment (QFD) or house of quality (8 steps)
  - After receiving inputs from customer, QFD can be used to map the voice of the customer
  - QFD include inputs from all groups inside the organization and forms the basis for determining the requirements of the project.
  - QFD is carried out by cross function group
  - The result of QFD is called "House of Quality"
  - QFD provide the following information
    1. What customer want
    2. How to accomplish (how to satisfy the customer)
    3. Co-relationship Matrix, it is the relation between various 'how to accomplish'
    4. Relationship (relationship between what customers want and how to accomplish) it is (strong/medium/weak/no relationship)
    5. Planning (competitive evaluation), it shows the company products and other competitors.
    6. Target values, it refers to the attributes of the product
    7. Cost of Accomplish, cost will be incurred to accomplish the target.
    8. Importance weighting, it shows the importance of particular feature.

- Benchmarking (4 phases- 10 steps)
  - It is to measure the company performance against those of other best-in-class companies to determine the best practices.
  - Robert Camp has broken the process into 10 steps in 4 phases (Benchmarking= PAIA).
    - Phase1: Planning
      - Step1 what are functions-outputs should be benchmarked.
      - Step2 Identify external organizations with superior work practices for comparison.
    - Phase2: Analysis
      - Step3 Determine what data sources are to be used.
      - Step4 Determine the current level of performance-identify the gap.
    - Phase3: Integration
      - Step5 Develop a vision of future operation.
      - Step6 Report progress on an ongoing basis.
    - Phase4: Action
      - Step7 Establish functional goals linked to the vision of organization.
      - Step8-9 Develop action plans and implement the best practice findings.
      - Step10 Update knowledge on current work practices, this is the crux of continuous quality improvement.

- Important process performance Metrics required for Six Sigma
  - Defects vs Opportunities
    - Crosby, “Defect is a failure to conform to requirements.” Opportunities are the things which must go right to satisfy a customer.
  - DPU (Defect per unit),
    - DPU 25/1000 means 25 defect units per 1000 production units.
  - RTY (Rolled Throughput Yield),
    - Probability that a single unit can pass though all processes without defect.
    - Ex. There are three processes A-B-C to produce a unit. A success rate 90%, B 80%, C 90% RTY=0.9*0.8*0.9=0.648 = 65%
  - DPMO (Defects per Million Opportunities)
    - DPMO=number of defects*1,000,000)/(total number of opportunities) وسطين في طرفين

- Present value (PV): It means the value today of future cash flow, it means that if you will gain 1000$ after 3 years, what is the value of this amount now. $PV=FV/(1+i)^n$, (FV) is future value, (i) is interest rate, (n) number of years.

- Net Present Value (NPV): It is the summation of PV of benefits minus (–) summation of PV of cost over period of time.
  Select the project with bigger or max NPV (take the max and don't look to the number of years).

- Internal Rate of Return (IRR): How much percentage (%) will return as a revenue from this project. Select the project with bigger or max IRR.

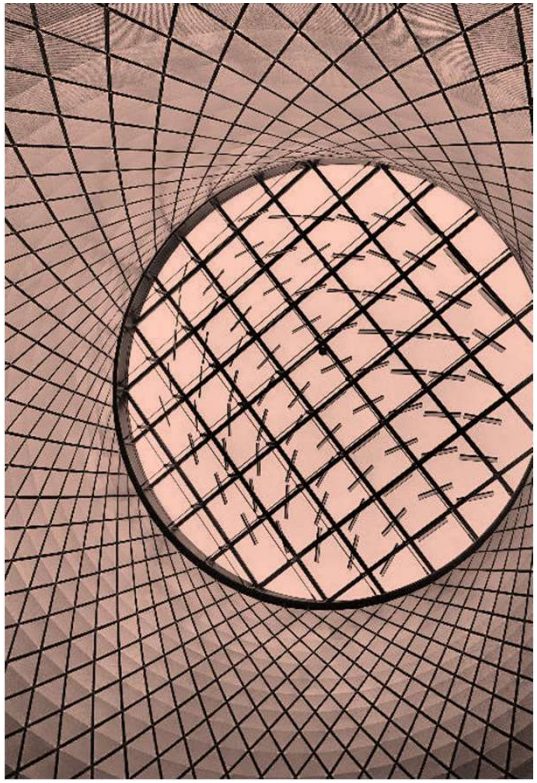
- Payback Period (PP): How much time it takes to recover your investment in the project then you start accumulating profit. Select the project with min duration.

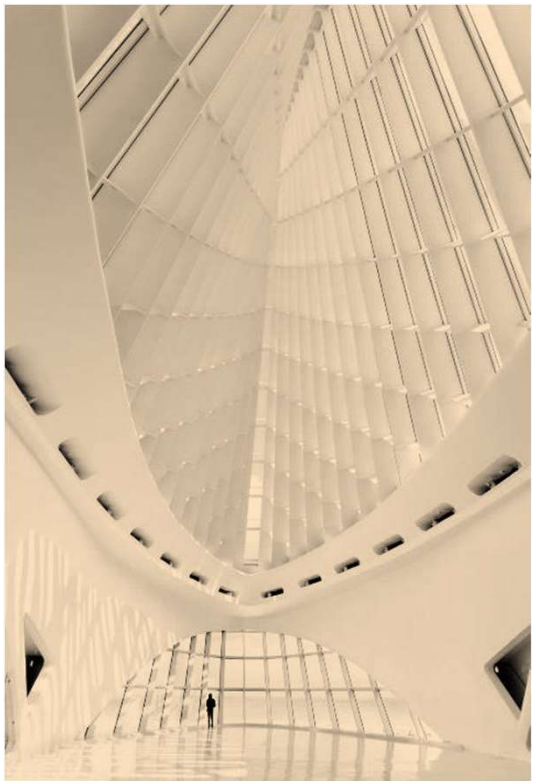
- Benefit-Cost Ratio (BCR): It compares benefit to cost ratio, if the benefit-cost ratio is >1 it means the project will gain benefits more than cost, otherwise the project will gain cost more than benefits.

- Opportunity Cost (OC): The opportunity given by choosing another project.

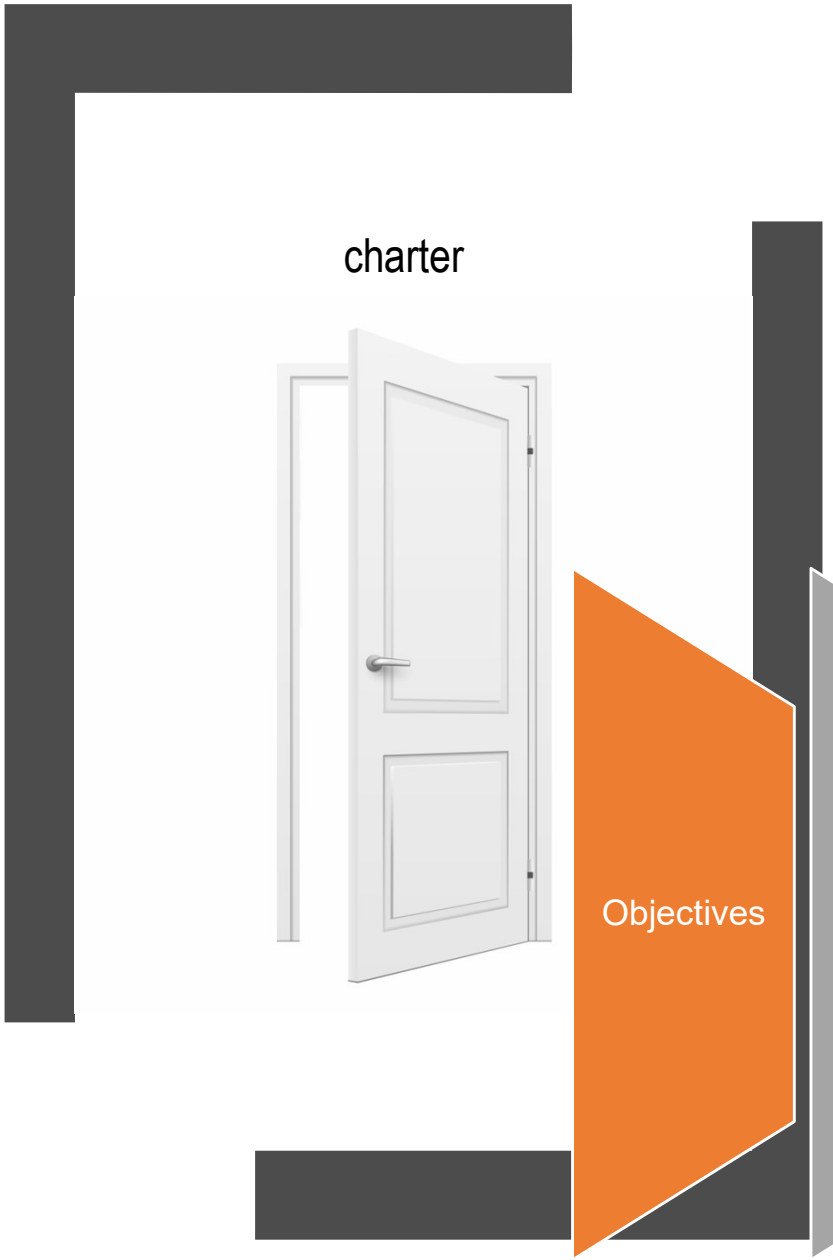
- Sunk Cost (SC): when you decide to stop the project, the money paid is gone and not considered over budget amount,

Ex. If project budget is 200,000$ and it is now 300,000$ cost (100,000$ over budget), this 100,000$ will not be considered when organization decide to continue or quit.

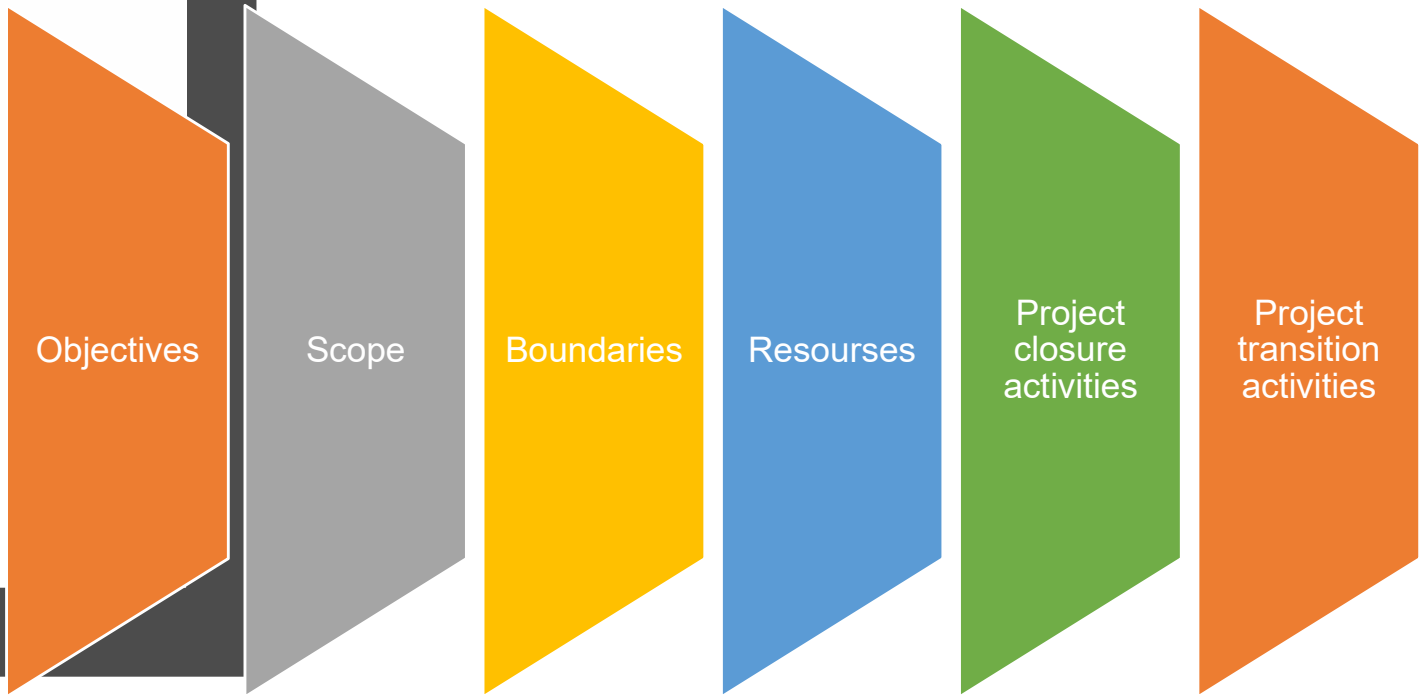





Chapter 3
Setting up Six Sigma Project



- Project charter and charter negotiation
  - What is the project charter and what it includes?
  - While creating the charter, there are several issues to be negotiated with the stakeholders such as:



Elements of team initiation	Importance
Clear purpose and goals	The project charter must clearly specify the objectives of the project to provide direction to team members. Clearly stated goals improve accountability and probability for success of the project.
Roles and responsibilities	Each team member should be formally provided with knowledge of his/her role in the project and associated responsibilities. If necessary, proper training may be provided to ensure that team members can undertake the responsibilities assigned.
Management support and team empowerment	No Six Sigma project can succeed without management commitment and support. Management must designate a sponsor who should ensure that the project team gets necessary support and is empowered to get information and resources from within the organization as required.

Important concepts for team dynamic

- Initiating teams
  - Understanding the key elements of initiating teams and their importance

Stages of team evolution

Forming

- they begin to know each other, it includes avoiding of conflict.

Storming

- conflict may occur.

Norming

- harmonious cohesiveness.

Performing

- truly collaborative.

Adjourning

- either work finish, leave to other tasks, or new member is joined, may be discontent with doing the same repetitive tasks.

Recognition

- end of project, objective completed, members get recognition for their performance.

Maslow's hierarchy of needs, what people need in an organization

Self Actualization — Doing what one can do best, self development

Esteem — reputation, respect from others

Social — Love, approval

Safety — Personal& economic security, health

Physiological — Food, water, clothing, sleep

Herzberg's theory of motivators and hygiene factors

- He constructed 2 dimensional paradigm of factors affecting people attitude about work, Hygiene and Motivators (The satisfiers related to what a person did while the dissatisfies related to the situation in which the person performed his tasks).

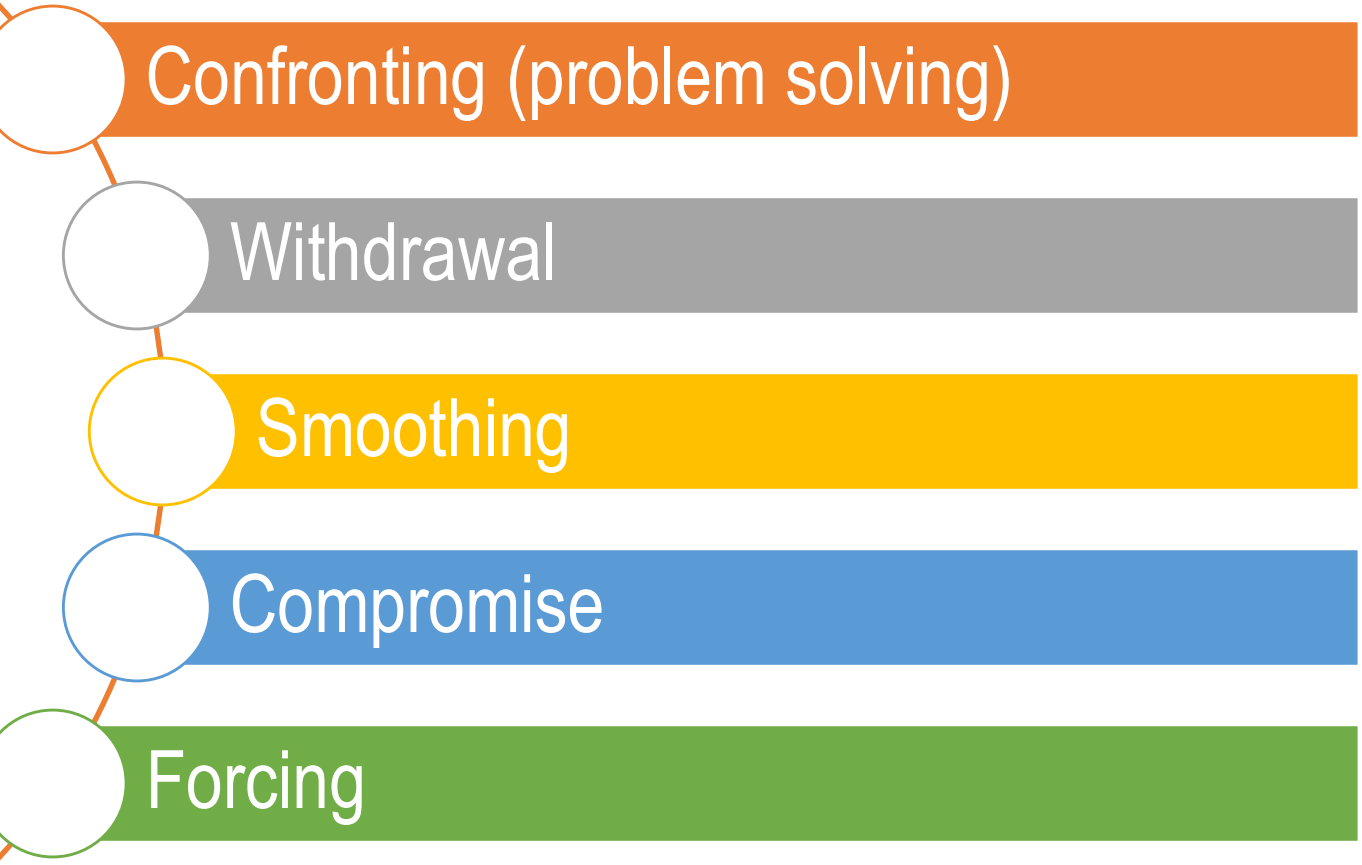
Hygiene (Dissatisfiers) relate to the context or environment in which the task is being performed

- Factors are such as company policy, supervision, interpersonal relations, working conditions, and salary
- Absence of hygiene factors will create job dissatisfaction, existence of hygiene will not create satisfaction.

Motivators (satisfiers) relate to the tasks being performed

- Factors are such as: achievement, recognition, the work itself, responsibility, and advancement

Conflict Management



Management/leadership styles

Roles played by people in a project (Destructive- Constructive)

- Destructive Roles
  - Aggressor
  - Dominator
  - Devil's Advocate
  - Topic Jumper
  - Recognition Seeker
  - Withdrawer
  - Blocker
- Constructive Roles
  - Information Seekers
  - Information Givers
  - Encouragers
  - Clarifiers
  - Harmonizers
  - Consensus Takers
  - Gate Keepers
  - Initiators

Brainstorming

1. •Topic selection
2. •Idea generation
3. •Regrouping
4. •validation

Nominal group technique (NGT)

- It is used as consensus planning tool to prioritize issues.
- It facilitates decision making and org planning where creative solutions are sought.

1. Generating ideas and write them down (individually).
2. Recording ideas, all ideas written on board.
3. Discussing ideas, each idea to be discussed and evaluated set priorities on ideas..
4. Voting on ideas, individual vote privately on high priority ideas, then group decision making.

Affinity diagram (developed by KJ, Kawakito Jiro),

- Used to categorize ideas from brainstorming session.

1. Write all ideas.
2. Ask team to group the ideas.
3. Use voting about these grouping step.
4. The final step is like organization chart.

PDPC chart

- Process Decision Program Charts
- Help to determine the potential problems before they occur so that action can be taken

1. Select team which is aware of the process and related risks.
2. Create a flow chart which shows the activities of the project
3. For each task in the plan note down what can go wrong
4. Determine possible explanations and solution to problems identified.
5. Output from this process can be use as input to the risk management plan.

Force Field Analysis FFA

- Helps in effectively managing changes by identifying and increase the driving force and minimizing the restraining forces.
- There are driving forces and restraining forces for every changed:

Driving forces

- They are used for the change such as skills-procedures-people (ex. Increased productivity-lowering of costs-…).

Restraining forces

- They decrease the driving forces such as (addition funding- training-…).

PERT/CPM

PERT (Project Evaluation and Review Technique), it uses the weighted average estimate.

PERT=P+4M+O/6

Standard deviation= P-O/6

Variance=(Stand dev)^2

CPM (critical Path Method), longest path of project schedule.

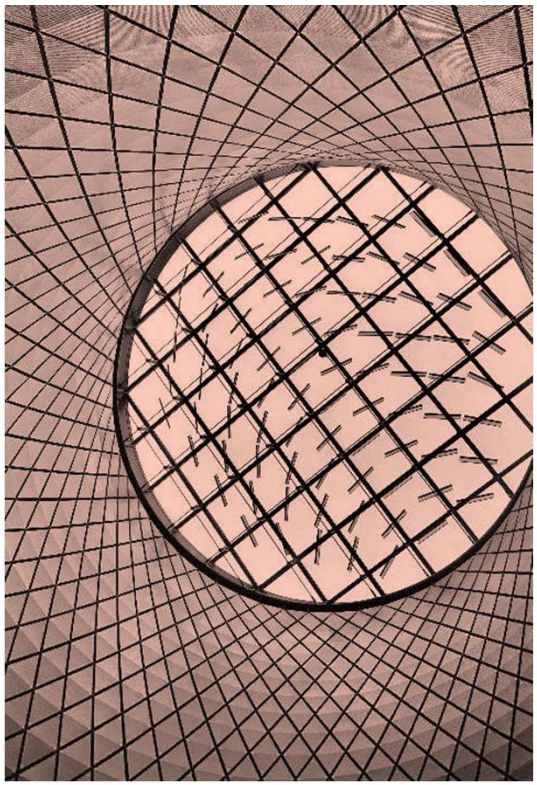
Schedule Compression

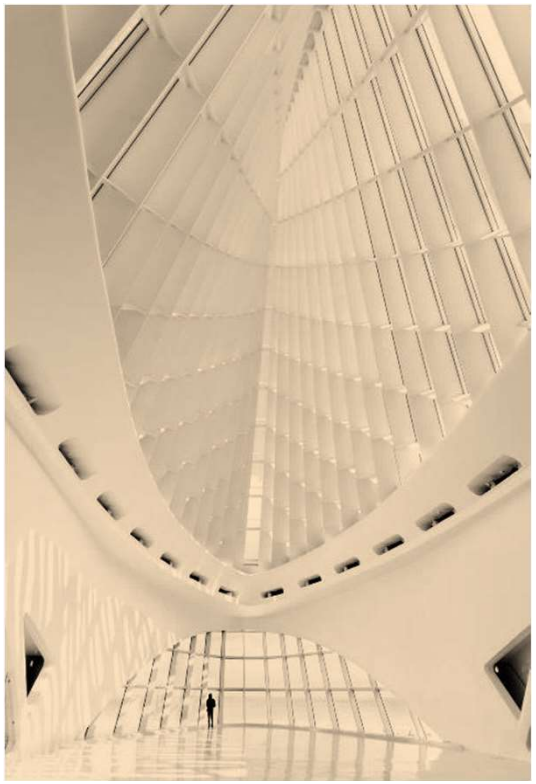
- Adding more resources
- Higher Cost

Crashing

- Doing more activities in parallel
- Rework

Fast tracking

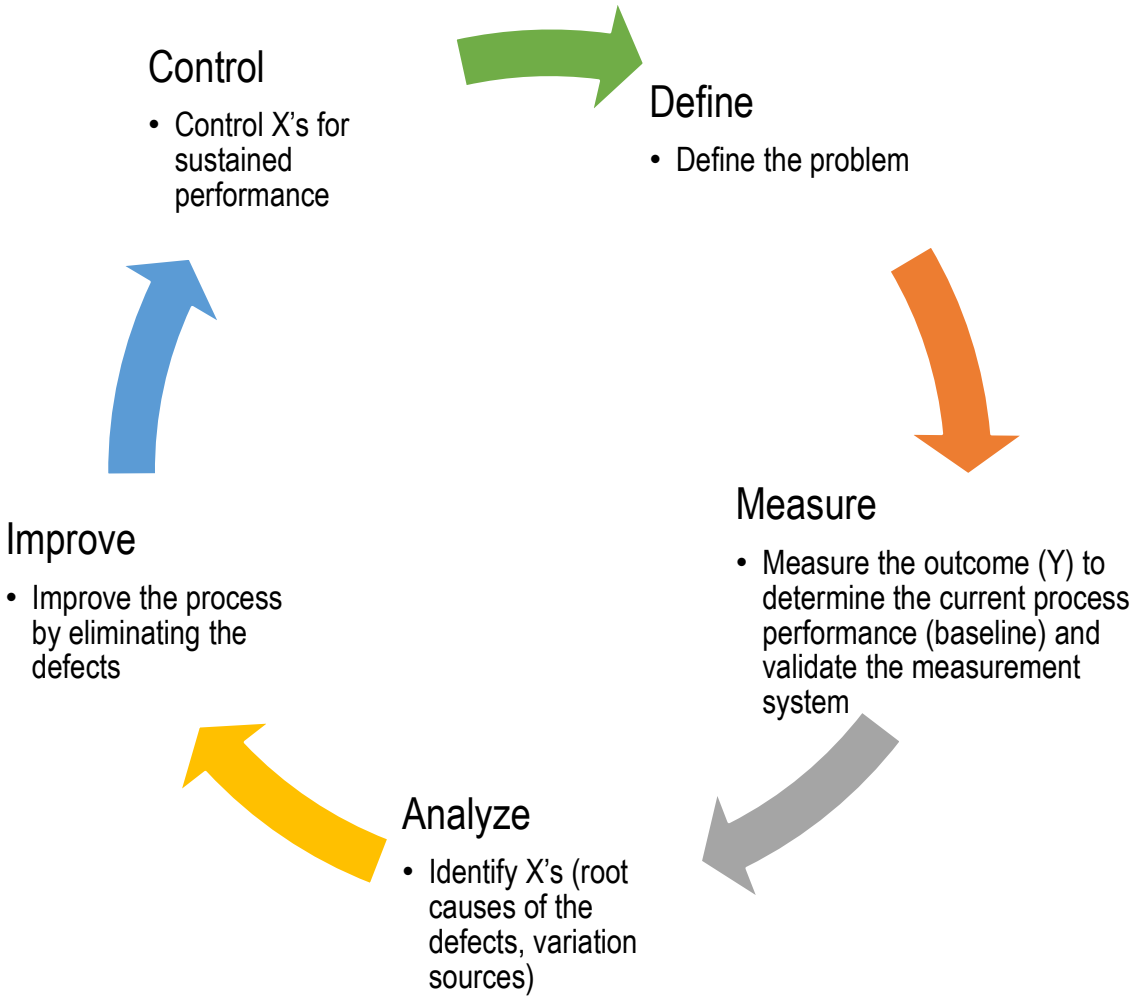





Chapter 4
Define

Six Sigma Cycle

- DMAIC is a data-driven Six Sigma methodology for improving existing products and processes.
- The DMAIC process should be used when an existing product or process requires improvement to meet or exceed the customer's requirements.
- This initiative should be consistent with the business goals of the organization.



Define

- Identify the areas of improvement and define goals for improvement activity and ensure that resources are in place for the improvement project
- It focuses on a customer requirement in identify project CTQ (Critical to Quality), CTQ is a product or service characteristic that satisfies a customer requirement or project requirements.

Inputs

1. Need for Six Sigma project
2. Executive Management Sponsorship
3. Core team identified

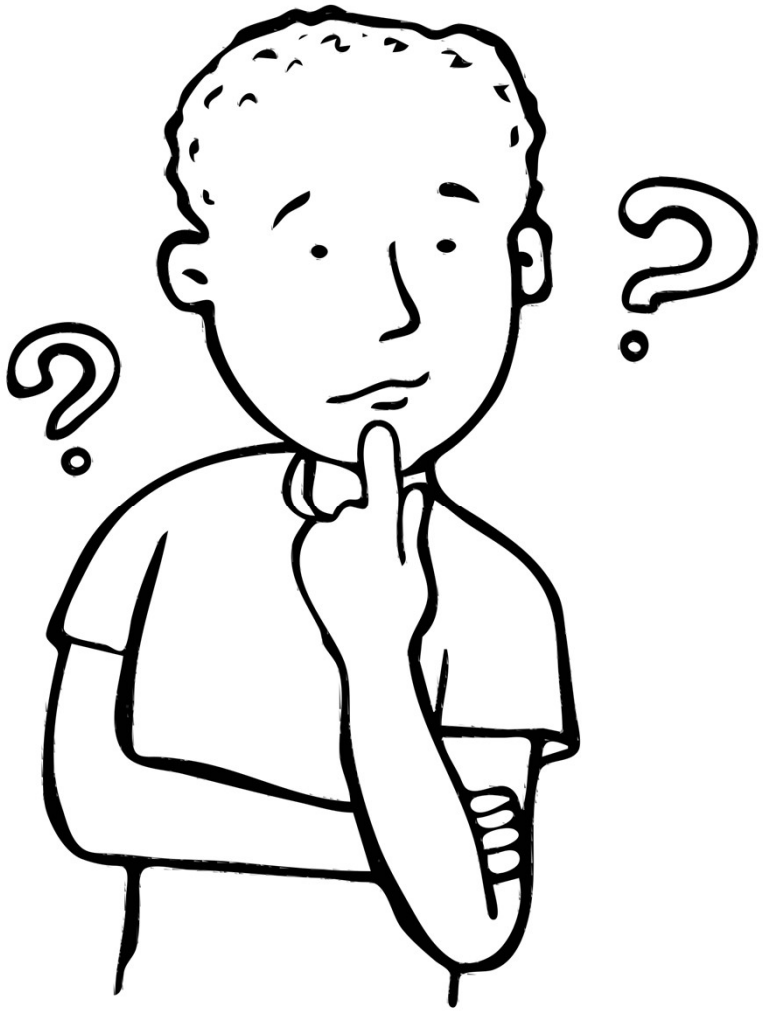
Tools& Techniques

1. Organization hierarchy
2. High level process maps
3. High level Pareto charts
4. Idea generation and categorization tools

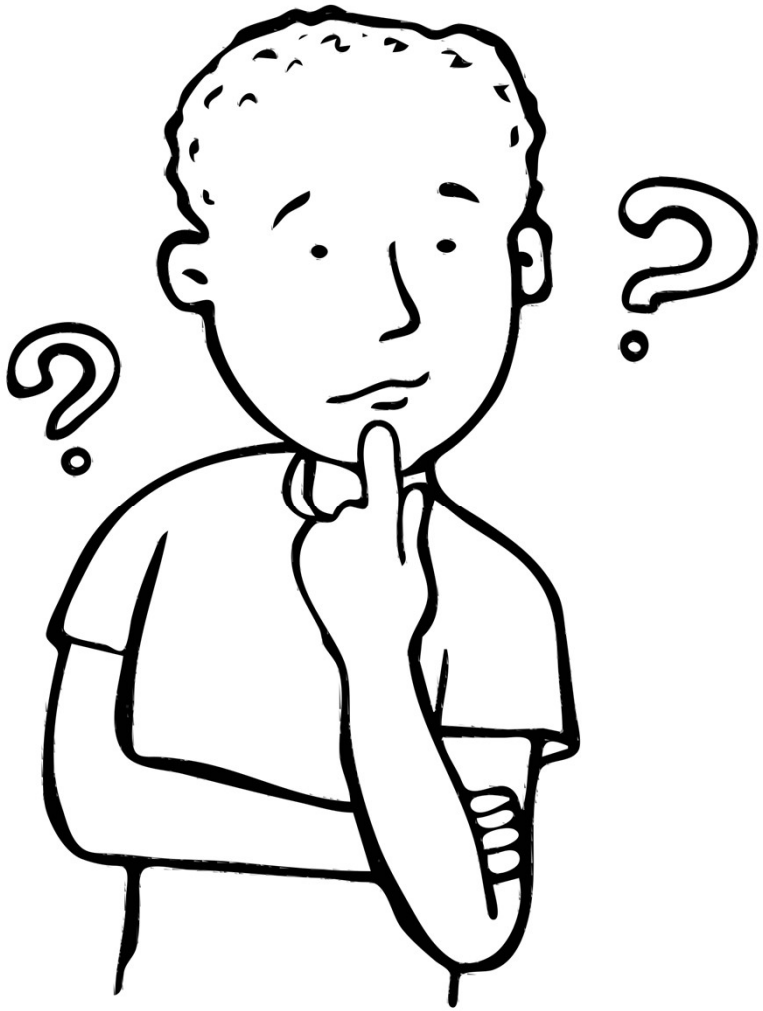
Outputs

1. Project Charter
2. Established metrics
3. Problem Statement
4. Roles and Responsibilities

- Inputs
  - Need for Six Sigma
    - Provide better value added.
    - Focusing on customer satisfaction.
    - Reduce cost.
    - Decrease defects.
    - Create long term viability advantage.
  - Executive management sponsorship.
    - Provide high level for six sigma project needs.
    - Resources required to the project.
      - Human resources
      - Financial support
    - Coordination with other internal groups in the org.
    - Motivation and support to initiate the project.

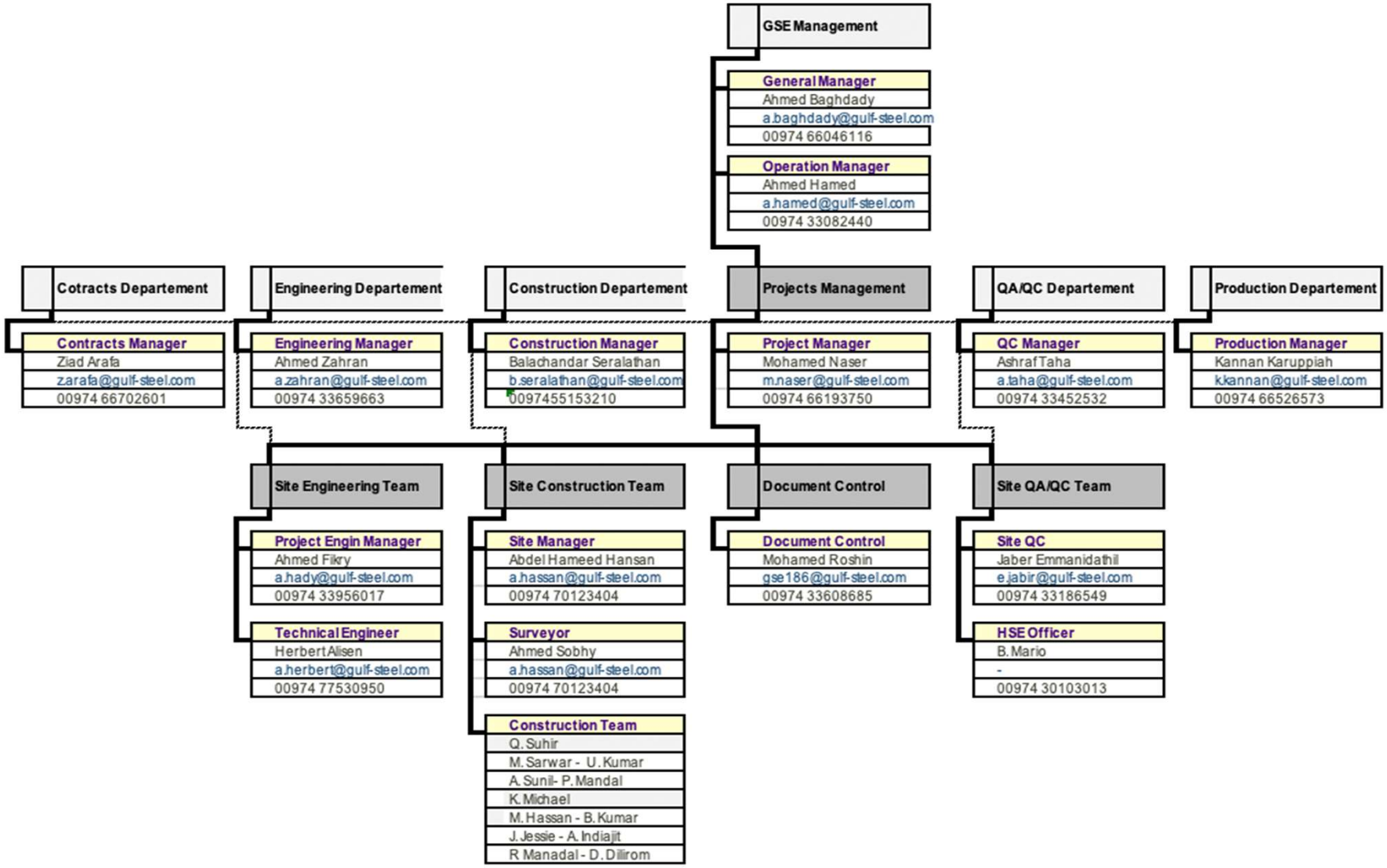


- Inputs
  - Core team identified
    - Project manager
      - Coordinate the activities for the project
      - Has knowledge of project management methodology
      - Responsible for project deliverables
    - Six Sigma expert
      - Green belt or/and back belt
      - Understand the methodology
      - Ability to interact with other subject experts.
    - Additional resources
      - Core team.



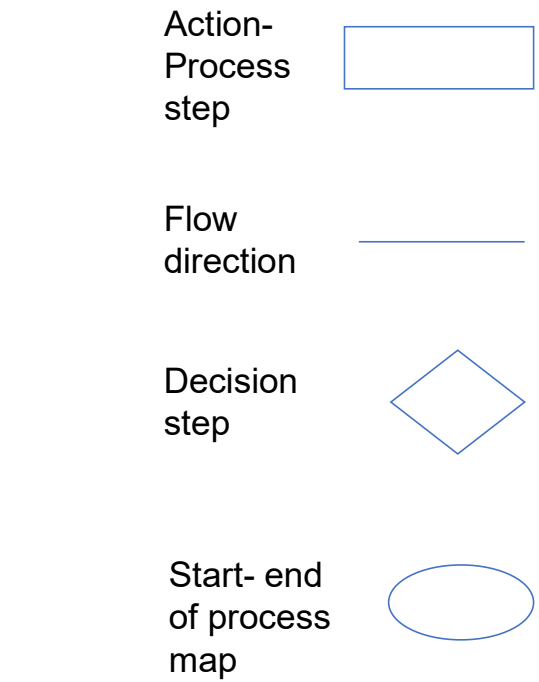
Organization Hierarchy

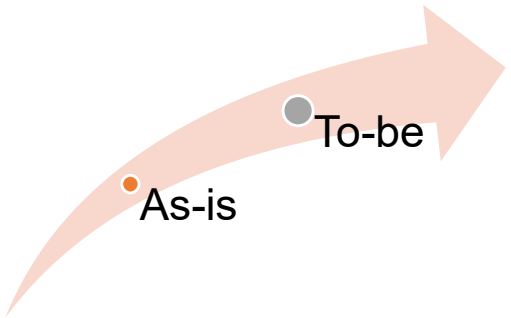
- Hierarchical structure which shows the different people in an organization and their associated skills
- Organization hierarchy allows the six sigma project team the ability to understand where they can get



High Level Process Maps

- It gives a view of how work flows through the company.
- It is a graphic representation of processes in a company showing the sequence of tasks performed and their relationships.
- Helps clarify several process steps and process flow which may not be understood clearly before
- Helps all members of the team gain appreciation for the work being done by others in the team
- Visually shows the various alternatives possible and helps in selecting an appropriate solution
- Standard symbols are used in creation of process maps
- Process maps are progressively elaborated
- Function team to map all the “as-is” processes which are exist now.
- Create “to-be” processes.





High Level Pareto Charts

1. PM is using six sigma effort to determine the lost bags in the airport, you decided to use Pareto analysis.
2. You start talking to the baggage department who provided you with information about problem categories.
3. You select the time interval for 1 year back.
4. Rank the total % of each category.
5. Create the % curve
6. 20% root causes which result of 80% of problems
7. Start taking action to solve these 20%

High Level Pareto Charts

Check Sheet for My Master Degree Monthly Study Defects

Sr	Error- Deffect- Problem	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	%
3	Do house work	III	III	II	III	II	IIIII	III	21	16%
2	Busy at Work	IIIII	IIIII	IIIII	IIIII	IIIII-IIIII	I	IIIII	36	28%
4	Lazy	I	III	II	I	I	I	II	11	9%
5	Lack of time management	I	I	II		I	I		6	5%
1	Tired	III	IIIII-IIIII	IIIII	IIIII-IIIII	IIIII	IIIII-IIII	III	45	35%
6	No enough resources	I	IIIII	I	II				9	7%
	Total	**18**	**19**	**12**	**15**	**15**	**14**	**15**	**128**	**100%**

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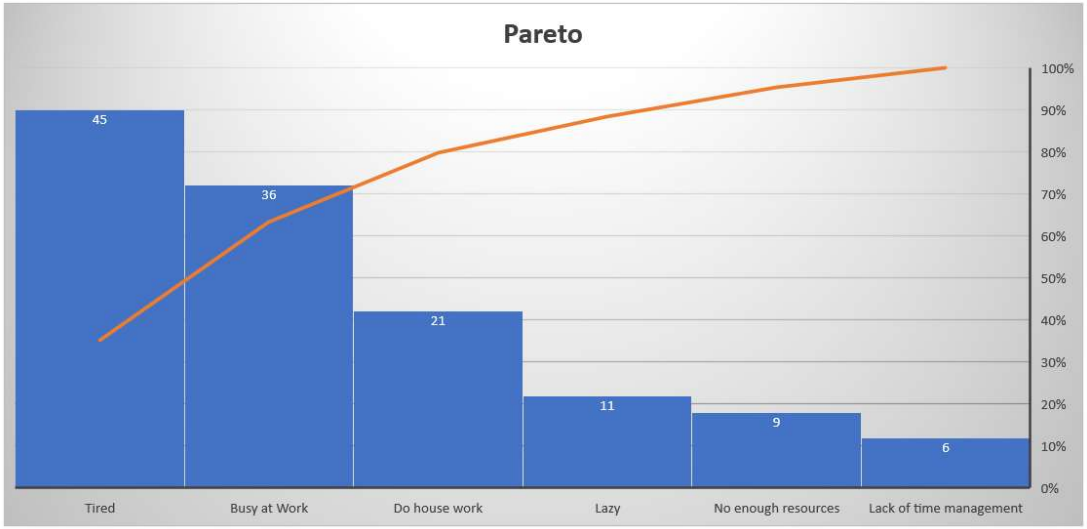
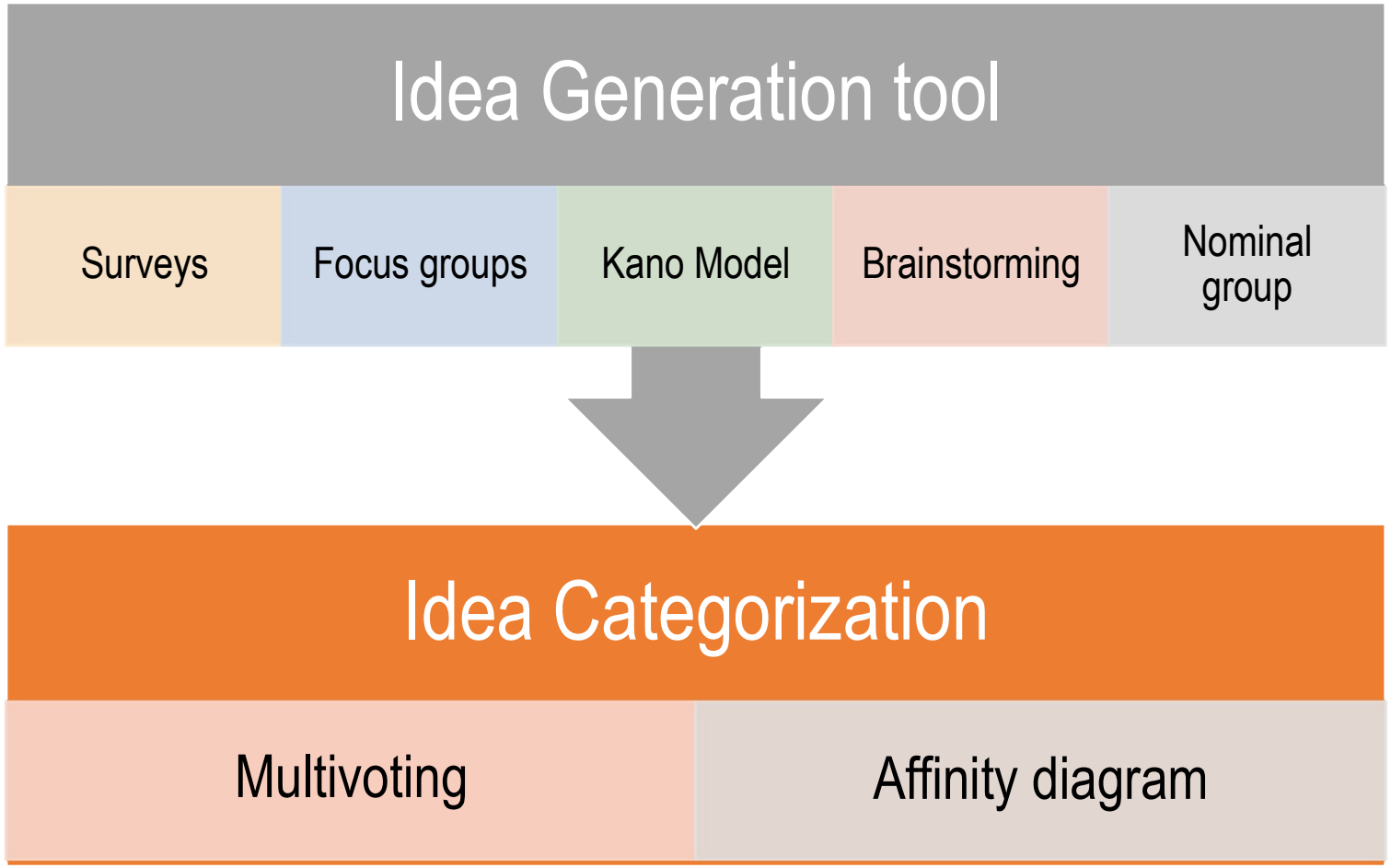


Define


Idea Generation tool
Surveys
Focus groups
Kano Model
Brainstorming
Nominal group
Idea Categorization
Multivoting
Affinity diagram

Define

- Outputs
  - Project charter
    - Issues by the sponsor or project initiator
    - Includes
      - Business case
      - Project description
      - Project PM
    - Charter negotiation on
      - Objective-scope-boundaries-resources-closure activities

Main Stakeholders	Stakeholder	Role	Contact
Approvals	Project Manager Name		Sponsor Name
	Project Manager Signature		Sponsor Signature
	Date		Date

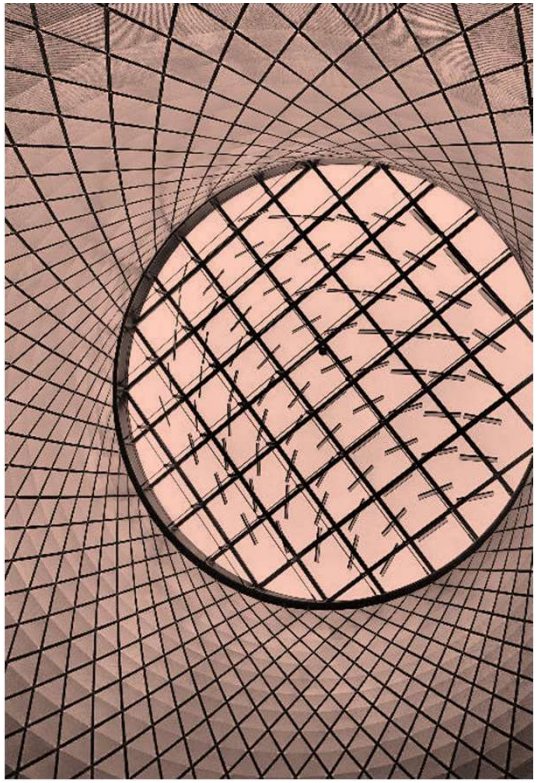
Project Name		
Client		
Project Manager		
Project Purpose		
Project Description		
High-Level Requirements		
High-Level Risks	Category	Risks
Project Objective	Objective	Suc criteria Approved by
	Scope	
	Time	
	Cost	
	Other	
Main Milestones	Milesonte Event	Due Date

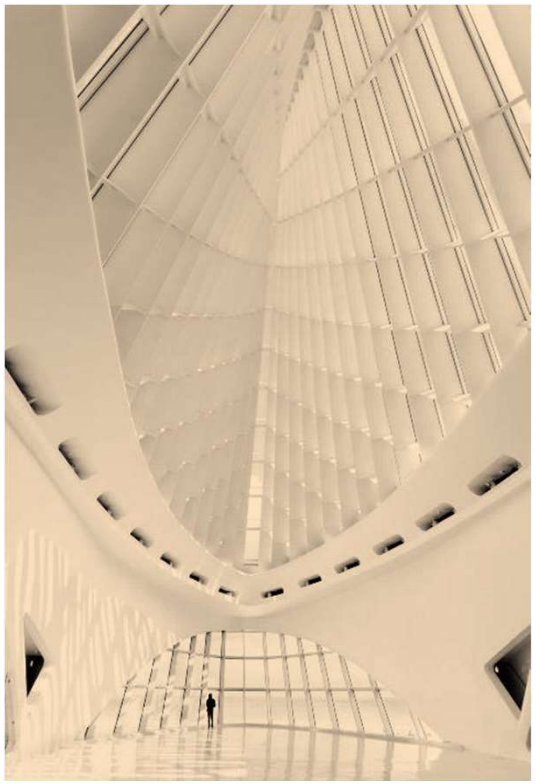
- Established metrics
  - Project team to establish standards which will determine the success metrics of the project.
  - Such as
    - Primary metrics (reduction of cycle time).
    - Consequential metrics (reduction of defect rate and improvement in received quality by customer).
- Problems statement focus
  - It includes
    - Baseline performance, the "as-is" system and its performance.
    - Improvement goals, the improvement possible if six sigma implemented "to-be" system.

- Roles and responsibilities
  - Roles and responsibilities for the resources (who do what- who decide what).
  - Such roles are:
    - Executive management (deployment champion)
    - Master black belt
    - Green belt
    - Project team
    - Subject matter expert
    - Project manager

• RACI

R-A-C-I						
Contract	Contract / Agreement	Approved BOQ	Initial Budget	IFC Drawings		
contract Manager	*R*	*A*	*A*	*A*		
contract Engineer	*R*	*R*	*R*	*R*		
PM	*I*	*I*	*I*	*I*		
operation manager	*I*	*I*	*I*	*I*		
Engineering	Review IFC	Raise RFI	Solve issues	Sumbit shop dwg	Attend tech meetings	Solve sever issues
engineering manager	*A*	*A*	*A*	*A*	*A*	*R*
engineering coordinator	*R*	*R*	*R*	*R*	*R*	*R*
designer	*C*	*C*	*C*	*C*	*C*	*C*
operation manager	*I*	*I*	*I*	*I*	*I*	*I*
PM	*A*	*I*	*I*	*I*	*I*	*I*
Construction	Site plan	Erection work	Equipments	Site meeting		
site engineer	*R*	*R*	*R*	*R*		
site manager	*A*	*A*	*A*	*R*		



Chapter 5
Measure

2. Measure

- Data collection to understand present system better .
- Validation and reliability of measurement system and key metrics.
- Determining the process capability for present system .[L SEP] focus
- Determining how progress and project success would be measured .[L SEP]

Inputs

1. Project Charter
2. Roles and Responsibilities
3. Problem Statement
4. Stakeholder Requirements
5. Established metrics

Tools& Techniques

1. Data Collection Tools and Techniques
2. Measurement scales
3. Validation techniques
4. Statistical Distributions
5. Data Mining
6. Run charts
7. Detailed process maps and process charts
8. Stakeholder tools
9. Process Costs

Outputs

1. Well-defined Processes
2. Baseline Process Capabilities
3. Process parameters affecting CTQ
4. Cost of Poor Quality (COPQ)
5. Measurement Systems

1. Define

Inputs
1. Need for Six Sigma project
2. Executive Management Sponsorship
3. Core team identified

Tools& Techniques
1. Organization hierarchy
2. High level process maps
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Outputs
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2. Measure

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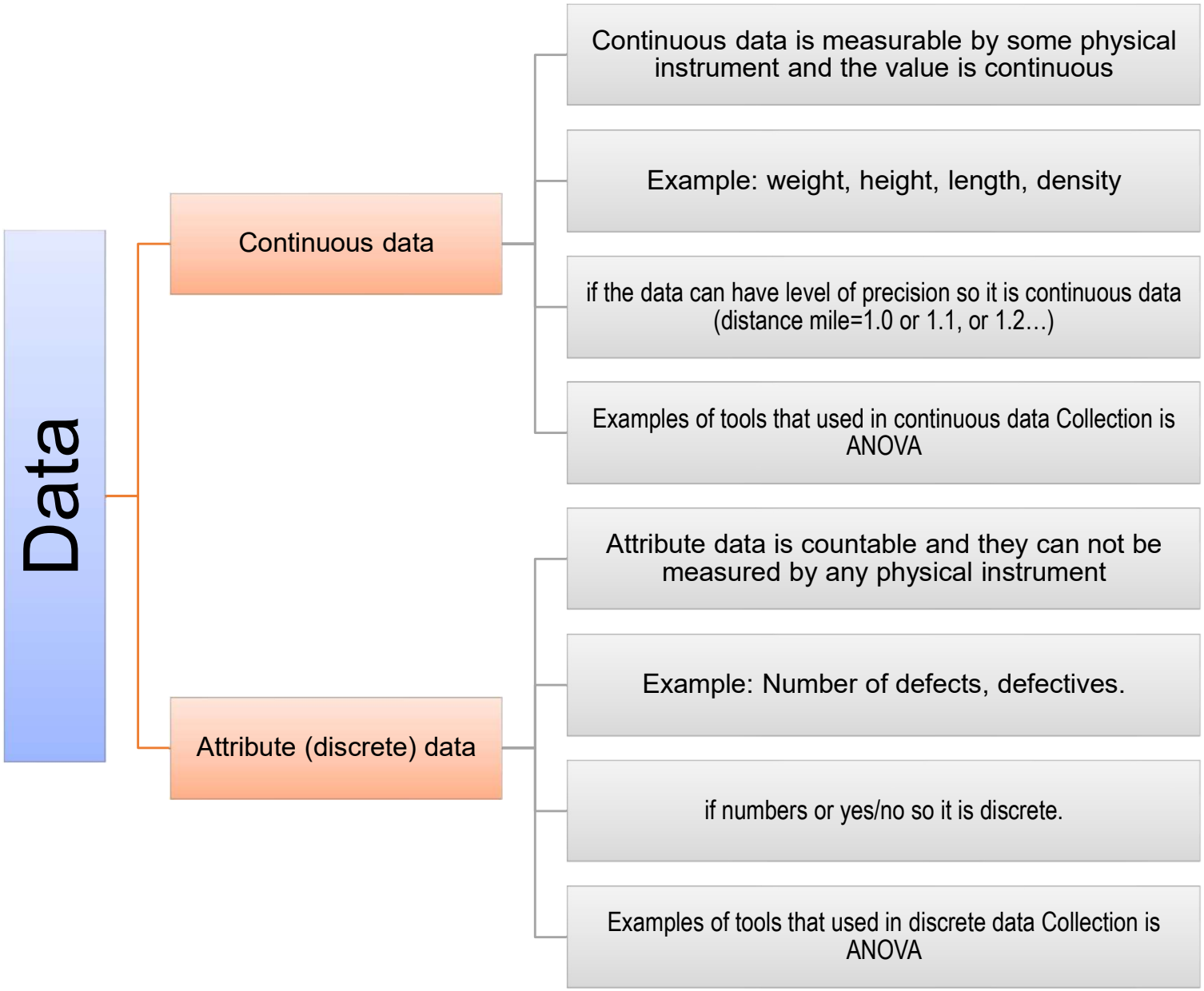
Data Collection Tools and Techniques



Data Collection Tools and Techniques

- Collect data using check sheet
  - Data collected from check sheet can be used in Pareto- cause & effect.
  - To start:
    - Set the objectives,
    - Ask what is the problems (ask the subject matter People- from logs).
    - Create form of collecting data
    - Collect frequency of data to be measured
    - Tally the data by adding the total numbers of them

Data Collection Tools and Techniques

Check Sheet for My Master Degree Monthly Study Defects

Sr	Error- Deffect- Problem	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	%
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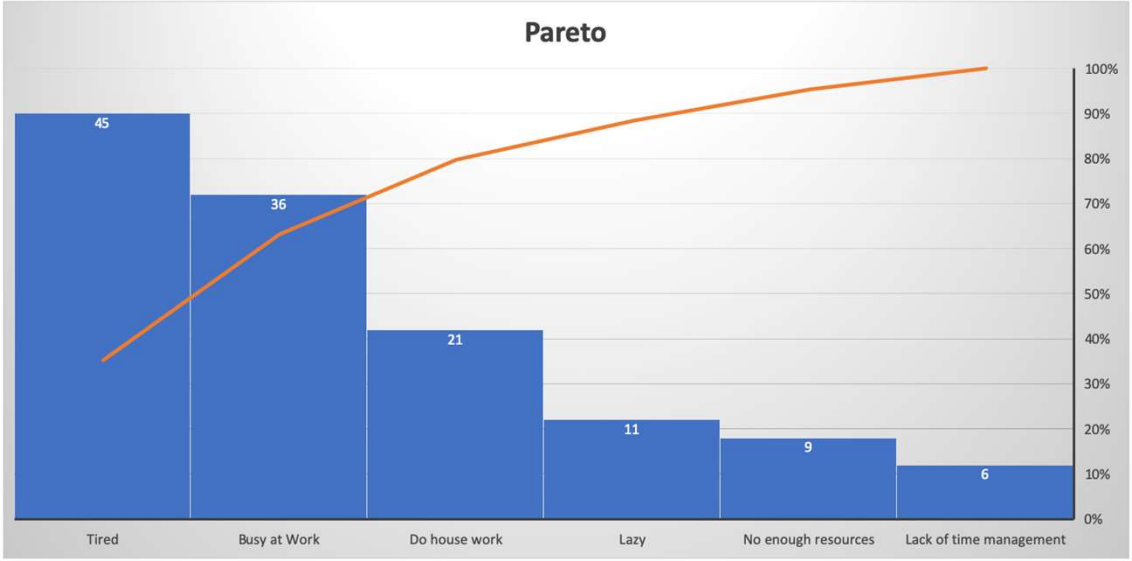


Measurement scales

- It helps in categorizing data into types so they can be collected and analyzed separately. Such as:
  - Nominal:
    - There is no ordering of data
    - Examples: (Male/Female), and religion
  - Ordinal:
    - Classified according to whether they have more or less of a characteristic
    - Measurement of degrees of difference
    - Very Good–5;Good–4;Average–3;Poor–2;VeryPoor–1;
  - Interval:
    - In Interval These types of scale permit the measurement of degrees of difference, and the specific amount of difference.
    - Averages, mode, median, mean etc. can be used for such scales.
    - Example: Dates- Temperature etc.
      - Very hot: 800 – 900 - Hot: 700 – 800 - Average: 600 – 700 - Cold: 500 – 600 - Very cold: 400 – 500

Measurement scales

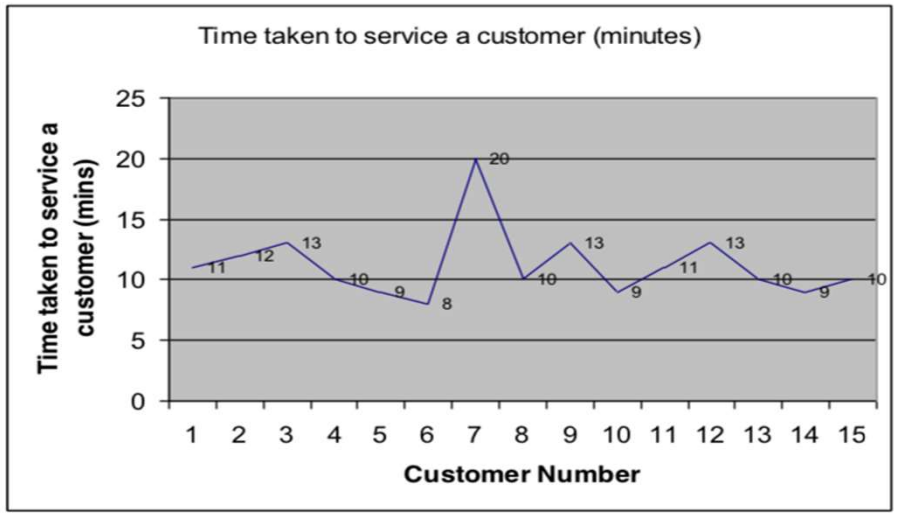
- Ratio measurement: Sales-profit-market share (ratio scale)
  - In ratio scale, the scale consists not only of equidistant points but also has a meaningful zero point.
  - Example: Sales, Profit, market share, age etc. are all expressed on a ratio scale.

Validation Techniques

- Validation Techniques (check the process and the measurements)
  - Ensure the received data is accepted
  - Variations in the systems are due to
    - Process variation
      - Expected by machine itself
      - Variation due to change in process
    - Measurement variation, due to
      - Different employee taking measurements
      - Change in procedure of data collection
    - Total variation=process variation+ measurement variation, so these variations should be minimizing or eliminating.
    - There are several tools to validate the data measurement system:
      - RR gauge
        - It determines the ability of measurements system
        - R: Repeatability, how measures system works on time
        - R: Reproducibility, if different people use the same machine, they will have the same result?
      - Statistical analysis ANOVA
  - Important characteristics of measurement systems;
    - Accuracy
    - Precision
      - Precision shows how the measurements are clustered around the center i.e. spread of the measurements.
    - Linearity
      - Linearity is a measure of how well the measurement system performs over a range of events.
    - Stability
      - Stability is a measure of how well does the measurement system performs over time.

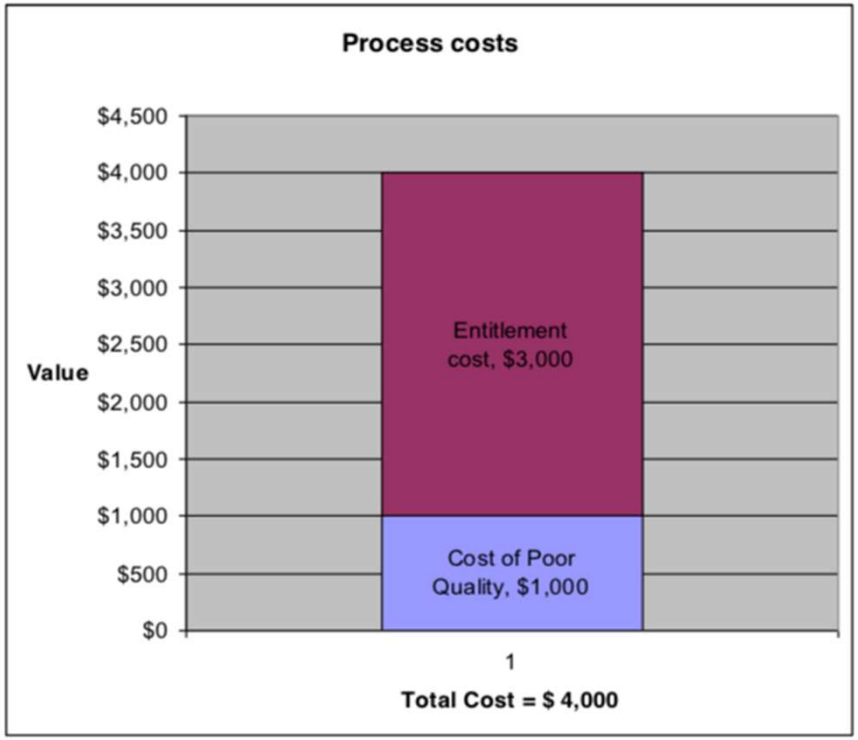
Probability Distributions

- Probability Distributions
  - Important distributions used include:
    - Binomial- Poisson- Normal- Chi Square- Student's
    - F distribution
- Data mining (Two crows)
  - It is information extraction activity in order to discover hidden facts contained in database.
  - Applied in market segmentation-customer profiling.
  - There is software (IBM-SAS).
- Run Chart
  - Use plotting of data arranged in time or order.
  - Help identifying whether the system is under control or not.
  - Help identifying the common cause and special cause
    - Common cause: there are inherent in the process and can be predicted.
    - Special cause: may be cause because of unexpected reasons.



Measure

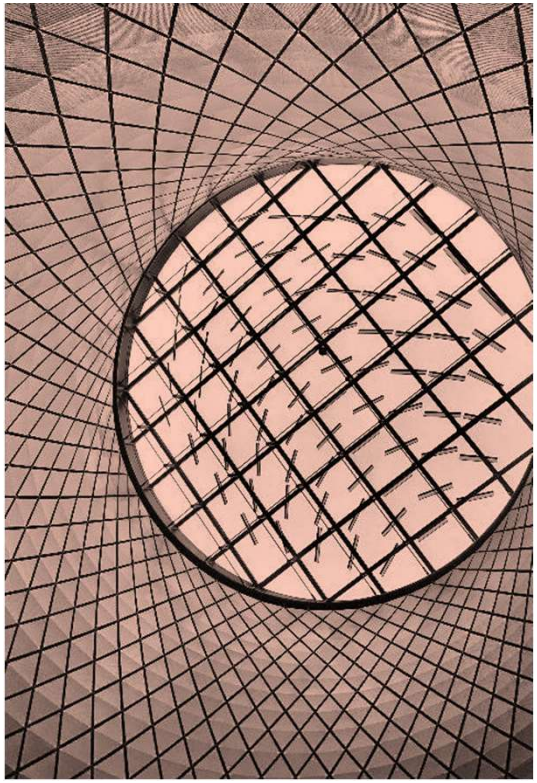
- Process Costs
  - Entitlement costs, these costs associated with producing goods correctly the first time (COC, cost of conformance).
  - Cost of poor quality (COPQ).
  - Total processes cost= entitlement cost+ COPQ.

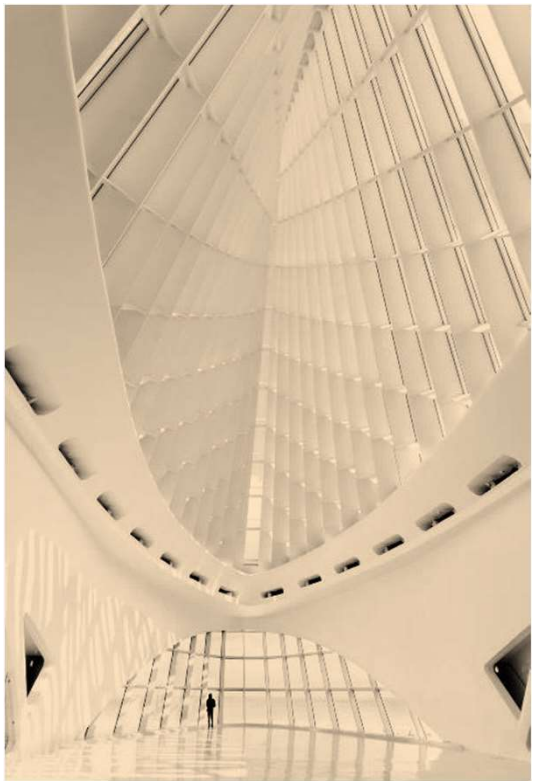


Measure

- Outputs

- Well defined processes
  - Better definition of the processes because of detailed process maps and Pareto charts.
- Use of validation techniques, gauge RR-data mining.
- Baseline process capability.
  - It means process limitation (like what we had in the Run chart)
  - Once we defined the baseline process capability, we can target to improve the process during Analyzing (next process).
- Process capabilities impacting CTO (Critical to Quality)
- Cost of Poor Quality (COPQ)



Chapter 6
Analyze

3. Analyze

- The Analyze phase is used to identify few vital causes from a list of potential causes obtained from the Measure phase, actually affecting project outcome using six sigma methodologies.
- The data collected in the Measure phase are examined to determine a prioritized list of the sources of variation.
- Doing analysis of present system
- Analyzing whether the present system can be further improved
- Determining major milestones and risks in successfully completing the project

Inputs

1. Well-defined Processes
2. Baseline Process Capabilities
3. Process parameters affecting CTQ
4. Cost of Poor Quality (COPQ)
5. Measurement Systems

Tools& Techniques

1. Ishikawa Diagrams
2. Failure Mode and Effects Analysis
3. Hypothesis Testing
4. Process capability study

Outputs

1. Important causes of defects
2. Performance gaps
3. Special and common causes of variation
4. Defects Per Million opportunities (DPMO) and Sigma level

2. Measure

Inputs

1. Project Charter
2. Roles and Responsibilities
3. Problem Statement
4. Stakeholder Requirements
5. Established metrics

Tools& Techniques

1. Data Collection Tools and Techniques
2. Measurement scales
3. Validation techniques
4. Statistical Distributions
5. Data Mining
6. Run charts
7. Detailed process maps and process charts
8. Stakeholder tools
9. Process Costs

Outputs

1. Well-defined Processes
2. Baseline Process Capabilities
3. Process parameters affecting CTQ
4. Cost of Poor Quality (COPQ)
5. Measurement Systems

3. Analyze

Inputs

1. Well-defined Processes
2. Baseline Process Capabilities
3. Process parameters affecting CTQ
4. Cost of Poor Quality (COPQ)
5. Measurement Systems

Tools& Techniques

1. Ishikawa Diagrams
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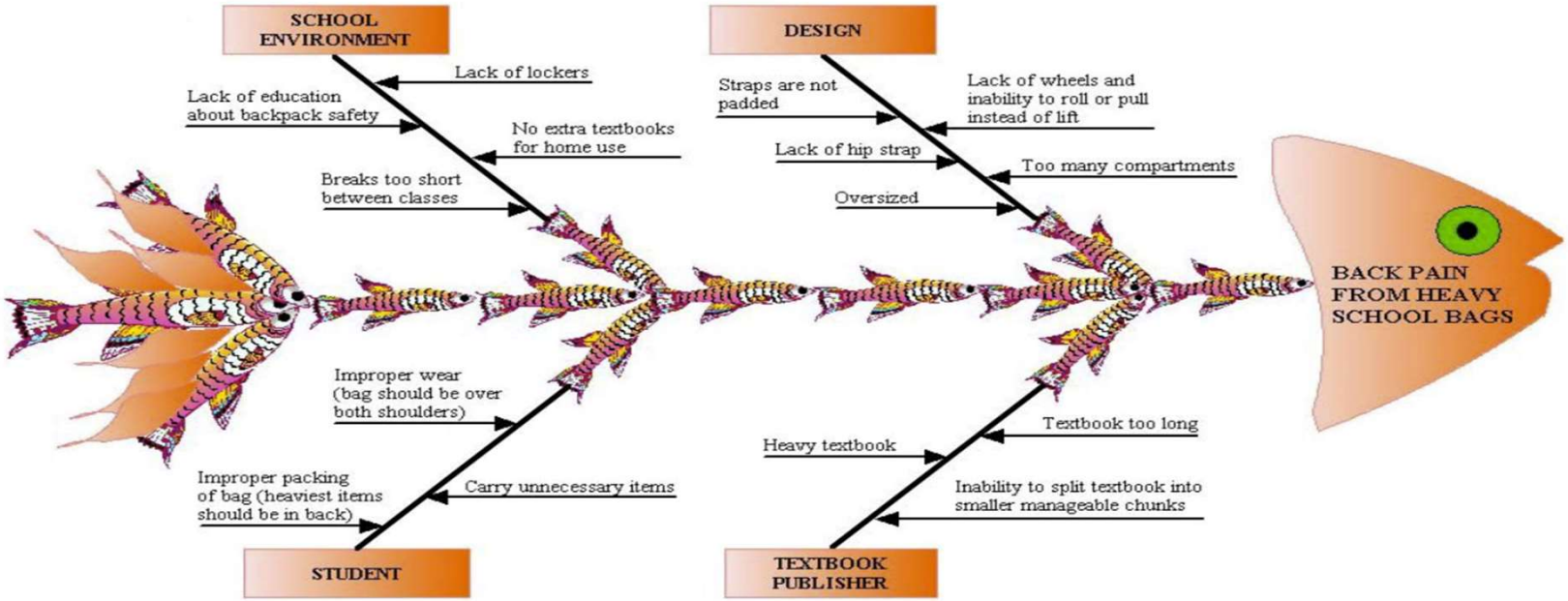
3. Hypothesis Testing
4. Process capability study

Outputs

1. Important causes of defects
2. Performance gaps
3. Special and common causes of variation
4. Defects Per Million opportunities (DPMO) and Sigma level

Analyze

- Ishikawa diagram= Cause-effect= Fishbone diagram
  - Steps
    - Create process map.
    - Define the problem (Y).
    - Collect the team who has knowledge about the process- focus group.
    - Conduct nominal group technique session, determine all the causes.
    - Use affinity diagram to categorize the causes.
    - Create Ishikawa diagram
      - Draw box on right, write the problem
      - Draw horizontal arrow which points to the box.
      - Write the names of categories above and below the line



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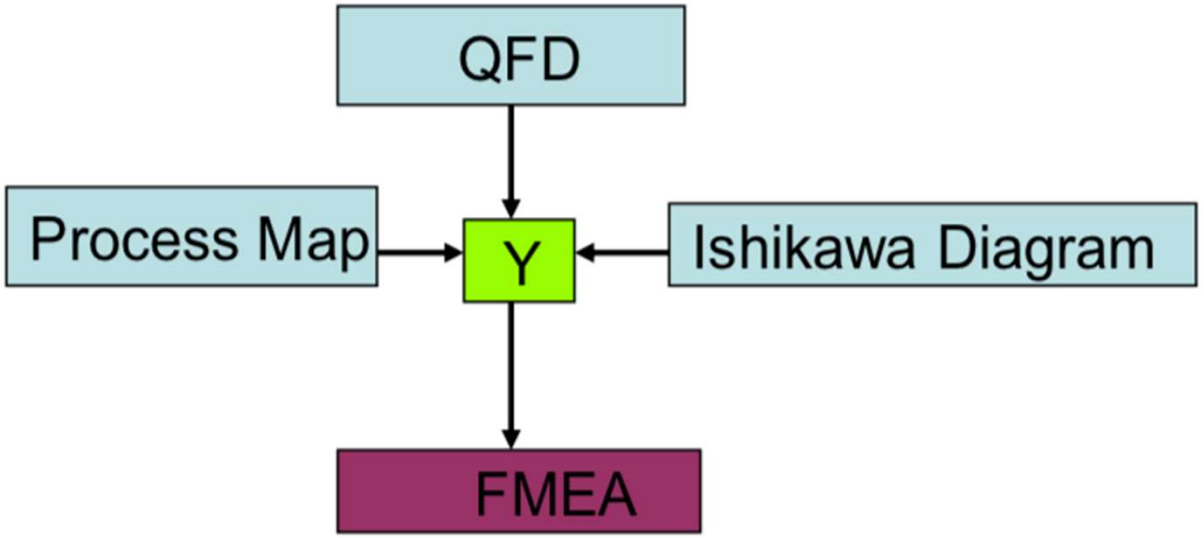
Analyze

- Failure Mode and Effects Analysis (FMEA) (like risk analysis)
  - It was used in the airlines then used in several industries.
  - It identifies consequences of a potential product/process failure.
  - It identifies methods to eliminate/reduce the change of failure occurring.
  - Failure modes are physical description of a failure
  - Example:

Let us consider a case study where you have daily long trip to your work, and you would like to enhance this process, one day in the morning you found your car is not working, how can you use the FMEA to manage this problem.



Analyze

- Steps
  - Identify potential failure mode
    - البروسيس متشتغلش
    - Ex The car is not working
  - Identify potential failure effects (Y Variable)
    - المترتب علي ان البروسيس مش هتشتغل
    - Ex I will be delayed on my work.
  - Determine the severity (i=impact) rating for the effect, the seriousness rate of this effect (1-10 rate)
    - حدد مستوي الخطورة المترتبة علي انها متشتغلش
    - Ex It will be big problem if I reached work late due to important meeting.

Process/ Operation	Potential Failure Mode	Potential Failure Effect	Severity S (1 to 10)	Potential Causes	Probability P (1 to 10)	Null Hypothesis	P Value PV (1 to 10)	Current Controls	Detection Rate D (1 to 10)	Risk Priority Number RPN= SxPxD	Recommendation/ Corrective Actions
Goin to work	The Car is not working	delay in my arrival	7	The battery is dead	7	There is no difference in car types	1	Get an external power connection	9	441	1- Go to Work by Taxi since the severity is high 2- Replace the battery of the car

Analyze

- Identify potential causes, this is the low-level bones of Ishikawa.
  - حدد جذر المشكلة
  - Ex The battery is not operating.
- Determine the occurrence rating (P=probability), rate that the failure effect (Y) will occur in the current system (1-10 rate, 10=sure will happen). probability
  - يعني ماهي احتمالية حدوث المشكلة والاثر التابع ليها
  - Ex If the battery is dead it means I will be delayed, so it take rate of 7.
- Perform Null Hypothesis (optional), is there any difference between the failure modes.
- Determine P-value (optional): it represents the probability of making an incorrect decision by rejecting a true null value.
  - احتمال ان الفرضية اللي اخذتها كانت غير صحيحة
  - I checked the car and the battery is not even running, so the P Value is very low, it will be = 1

Process/ Operation	Potential Failure Mode	Potential Failure Effect	Severity S (1 to 10)	Potential Causes	Probability P (1 to 10)	Null Hypothesis	P Value PV (1 to 10)	Current Controls	Detection Rate D (1 to 10)	Risk Priority Number RPN= SxPxD	Recommendation/ Corrective Actions
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Analyze

- Describe the current controls, make some controls on products before deliver to customer to ensure the failure mode does not occur.
  - حدد ازاي بتتحكم في الموضوع قبل ما يروح للعميل
  - Ex I will try to connect external power to run the car.
- Determine the Detection Rating "D" it is the probability that current controls would be able to detect potential failure modes before the product is released to the customer (1-10, 1= high=detect failure, 10= low detecting rating=not detect failure).
  - حدد هل طريقة التحكم اللي اخترتها قادرة تحدد الأخطاء ولا لا
  - If the car operates it means that the current control (connecting external battery) will detect the problem, so it will take rate of 9.

Process/ Operation	Potential Failure Mode	Potential Failure Effect	Severity S (1 to 10)	Potential Causes	Probability P (1 to 10)	Null Hypothesis	P Value PV (1 to 10)	Current Controls	Detection Rate D (1 to 10)	Risk Priority Number RPN= SxPxD	Recommendation/ Corrective Actions
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Analyze

- Calculate the Risk Priority Number RPN
  - RPN= Severity Rate (S) x Occurrence Rate (P) x Detecting Rate (D)= 7x7x9=441 (=S*P*D)

- Determine corrective action to be taken, action taken in the following cases:
  - Severity rate is very high, so failure has high impact on customer.
  - RPN is very high

Process/ Operation	Potential Failure Mode	Potential Failure Effect	Severity S (1 to 10)	Potential Causes	Probability P (1 to 10)	Null Hypothesis	P Value PV (1 to 10)	Current Controls	Detection Rate D (1 to 10)	Risk Priority Number RPN= SxPxD	Recommendation/ Corrective Actions
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Analyze

- Hypothesis testing (sampling test)

It is required when decisions are made about a population using sample data.

It helps quantify the risks associated assigned to making specific decisions.

It helps determine confidence level that the decision we are making about small sample would apply to the whole population.

Ho is null hypothesis; this is something we assume true.

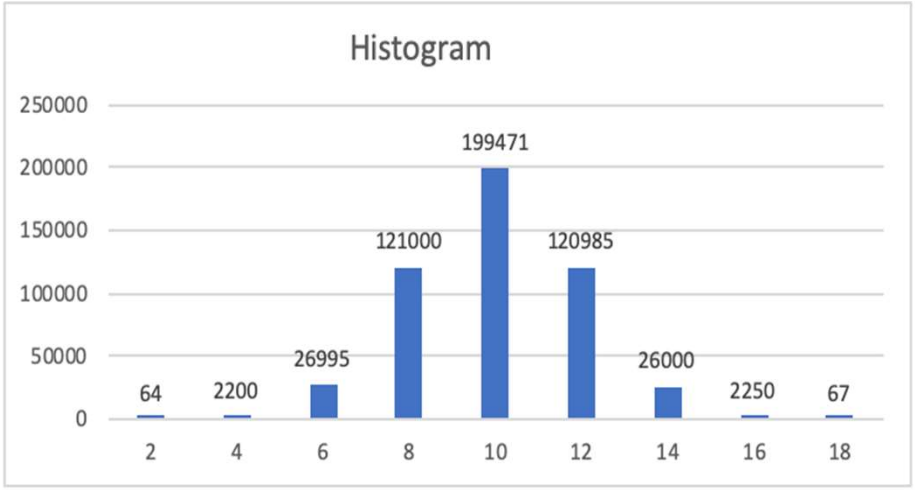
Ha is alternate hypothesis it is opposite to the null hypothesis.

Analyze

- Process capability study (determine what sigma level)تحديد المستوي الحالي من السيجما
  - It is the extent to which any stable process is able to meet specifications.
  - In this tool, we use :Run chart -Process data -Voice of customer U&L SL

Process Capability

Range of ball bearing size		Mean of	Number of
From	To	Range	observations
1	3	2	64
3	5	4	2200
5	7	6	26995
7	9	8	121000
9	11	10	199471
11	13	12	120985
13	15	14	26000
15	17	16	2250
17	19	18	67



Analyze

Process Capability

Range of ball bearing size		Mean of	Number of
From	To	Range	observations
1	3	2	64
3	5	4	2200
5	7	6	26995
7	9	8	121000
9	11	10	199471
11	13	12	120985
13	15	14	26000
15	17	16	2250
17	19	18	67

	LSL, Lower Specification Limit	<5	*input from customer*
	USL, Upper Specification Limit	>15	*input from customer*
A	Total Observation	499032	
B	Defects, outlite the LSL and USL	4581	
C	Defect Per Million, C=B/A * 1,000,000	9180	

Analyze

Six Sigma Table

For	1,000,000	Opportunities
Sigma Level	Defect Rate	Yield
2	308,770	69.1230%
3	66,811	93.3189%
4	6,210	99.3790%
5	233	99.9767%
6	3.44	99.99966%

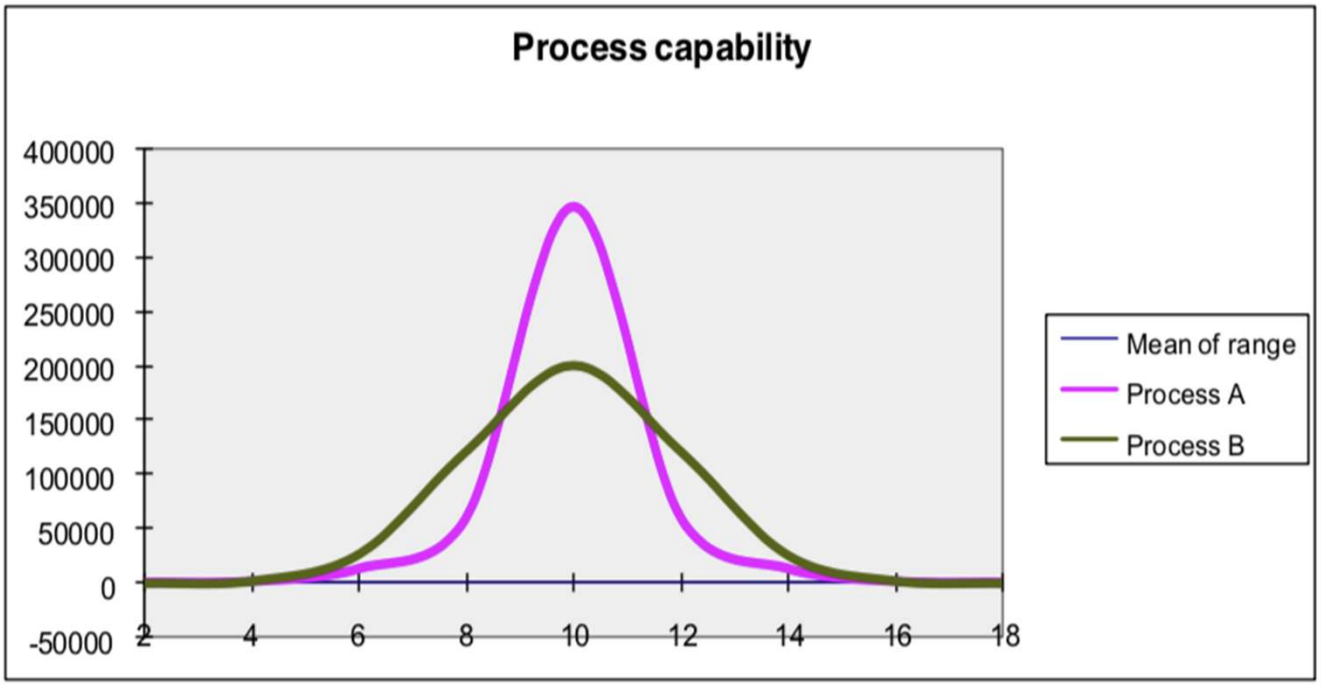
Sigma Level Range

Sigma Level	From	To	
1	308,770	Open	
2	66,811	308,770	
3	6,210	66,811	9180 is in 3 Sigma
4	233	6,210	
5	3.44	233	
6	0.00	3.44	

- Since the process has a DPMO of 9180, we know that the sigma level for the process is less accuracy than 4 sigma which mean it is 3 SIGMA

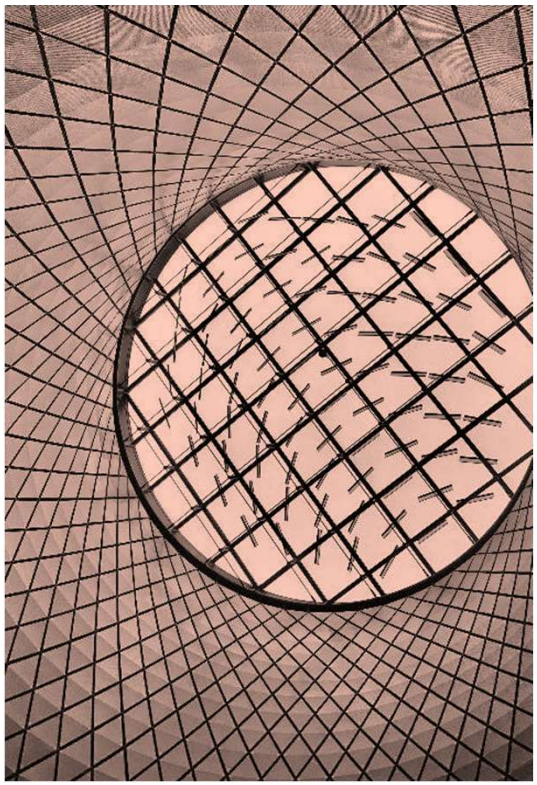
Analyze

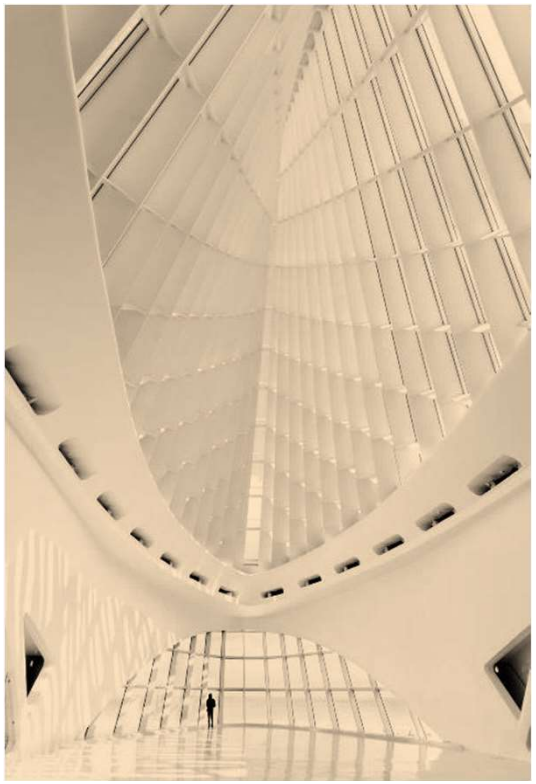
- Improve Process capability (improve or increase sigma level) زيادة ليفل السيجما
  - Spread is less, more measurements are closer to target, and fewer are out of specification (Process A).
  - We say that the pink process is more capable than the green process which indicate higher sigma level and lower DPMO level.



Analyze

- Outputs
  - Important causes of defects
    - By using FMEA and Ishikawa
    - RPN is used as input to improve phase
  - Special and common causes of variation
    - Using Run chart
      - Common cause
      - Special cause
    - In Six Sigma, we should target to eliminate the special cause and minimize the common cause
  - DPMO and sigma level



Chapter 7
Improve

4. Improve

- The improve phase of Six Sigma is used to improve the system to do things better, cheaper or more rapidly by finding optimum solution for Y, implement the new approach and validate using statistical methods.
- The main objective of the improve phase is to improve the process by eliminating defects.
- Determine which project would be selected that maximizes the Return on Investment (ROI)
- Find out cause and effect relationships using tools like Design of Experiments (DOE) and Solutions Matrix. This helps in comparison and verification of alternate solutions.
- Creating work breakdown structures and detailed implementation plan for the project.

Inputs

1. Important causes of defects
2. Special and common causes of variation
3. Defects Per Million opportunities (DPMO) and Sigma level

Tools& Techniques

1. Return on Investment (ROI)
2. Solution Design Matrix
3. Design of Experiments
4. Taguchi Robustness concepts
5. Response Surface Methodology
6. Project planning and management tools
7. Prototypes

Outputs

1. Costs and Benefits of different solutions
2. Selection of solutions for implementation
3. Implementation Plan

3. Analyze

Inputs
1. Well-defined Processes
2. Baseline Process Capabilities
3. Process parameters affecting CTQ
4. Cost of Poor Quality (COPQ)
5. Measurement Systems

Tools& Techniques
1. Ishikawa Diagrams
2. Failure Mode and Effects Analysis
3. Hypothesis Testing
4. Process capability study

Outputs
1. Important causes of defects
2. Special and common causes of variation
3. Defects Per Million opportunities (DPMO) and Sigma level

4. Improve

Inputs
1. Important causes of defects
2. Special and common causes of variation
3. Defects Per Million opportunities (DPMO) and Sigma level

Tools& Techniques
1. Return on Investment (ROI)
2. Solution Design Matrix
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4. Taguchi Robustness concepts
5. Response Surface Methodology
6. Project planning and management tools
7. Prototypes

Outputs
1. Costs and Benefits of different solutions
2. Selection of solutions for implementation
3. Implementation Plan

Improve

- Return on Investment

Return on Investment (ROI) is a performance measure used to evaluate the efficiency of an investment or compare the efficiency of a number of different investments.

ROI tries to directly measure the amount of return on a particular investment, relative to the investment's cost.

To calculate ROI, the benefit (or return) of an investment is divided by the cost of the investment. The result is expressed as a percentage or a ratio.

Costs are such as: human resources- infrastructure- raw material.

Profits are such as increased revenue- reduction in costs- improved productivity- improved customer satisfaction.

Objective of any company is to maximize ROI

$$ROI\ \% = \frac{Profit}{Investment\ Cost} \times 100$$

Improve

- Solution Design Matrix
  - It compares alternative solutions based on information available.
  - Steps to implement the Solution Design Matrix:
    - Determine the project success criteria, you get it from the Project Charter- Kano Model - QFD…
    - Form a team who have knowledge of the processes.
    - Determine the importance rating of each criteria (scale 1-5, 1 means not important- 5 means very important).
    - Determine benefit rating for each criteria from the members
      - For existing design, set rate as 0
      - For new design, here we have to add either -1, 0, or +1. when the new design is worse than existing design add -1, when the new design is the same as existing design, add 0, when the new design is better than existing design, add +1.
    - Determine the Sum of Positives, Sum of Negatives, Sum of Zeros, Weighted Sum of Positives, Weighted Sum of Negatives.
    - Then we select the solution which has highest value of (Weighted Sum of Positives – Weighted Sum of Negatives).

Improve

Example

➢ Jim is preparing for the Project Management Professional (PMP) exam, and he would like to improve the study process to obtain better quality and ensure his success in the exam. A six sigma project was initiated, and a six sigma expert was assigned to the project. Analysis phase for the project is complete and two study techniques were proposed, and we would like to decide between two available alternatives (Option A and option B). The six sigma expert suggests doing a Solution Design Matrix to compare the available alternatives.

➢ Steps followed:

➢ A project team is selected which has good understanding of the PMP study techniques process and the pros/cons of the suggested processes.

➢ The key criteria for the solution matrix are determined. They are:

1. Time to finish the study.
2. Quality of understanding.
3. Getting high score in the simulation exams.
4. Cost of study materials.
5. Complexity of studying process.

Improve

Solution Design Matrix

Key Criteria		Importance Rating of IR	Criteria Rating Existing Process CREP	Option A CRa	Option B CRb
1.Time to finish the study.		4	0	1	0
2.Quality of understanding.		3	0	0	-1
3.Getting high score in the simulation exams.		5	0	-1	1
4.Cost of study materials.		3	0	1	1
5.Complexity of studying process.		2	0	1	-1
Sum of +ve (how many +1 we have)			0	3	2
Sum of -ve (how many -1 we have)			0	1	2
Sum of Zeros (how many Zeros we have)			5	1	1
Weighted Sum of +ve	Sum of (IR x CRa) of +1 for each criteria			9	8
Weighted Sum of -ve	Sum of (IR x CRa) of -1 for each criteria			-5	-5
Overall Weightage	(Weighted Sum of +ve) + (Weighted Sum of -ve)			**4**	**3**

Therefore, the selected project which has the more Criteria Rating 4 which is Option A

Improve

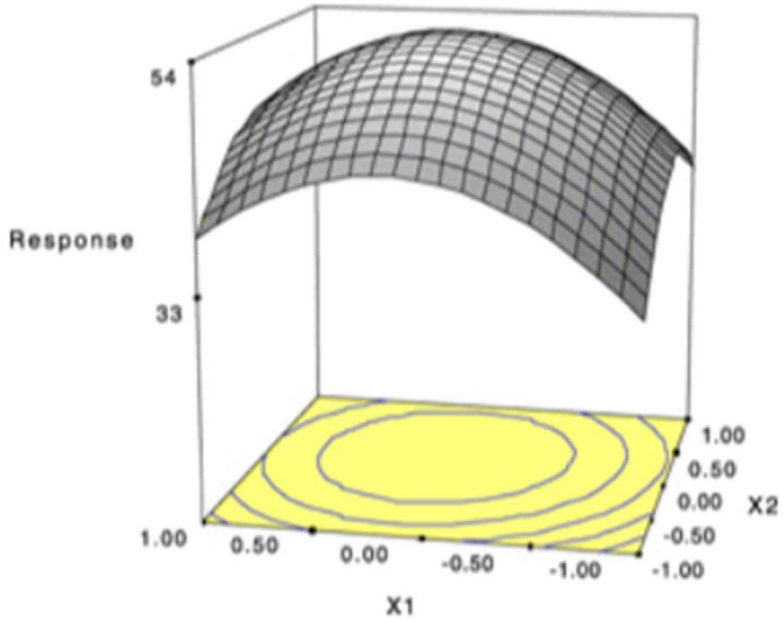
- Design of Experiments
  - It is useful tool to determine the cause and effect relationship.
  - If there is Y and there are more Xs, design of experiments will enable the team to determine the most appropriate combination of input factors X which max the Y.
  - Benefits:
    - Better quality
    - Lower cycle time
    - COPQ decreases
    - ROI increases
  - Important Terms:
    - Factor, any variable that may influence a process.
    - Levels, setting or category that a variable may take.
    - Trial, one run during experiment.
    - Response variable, specific parameter used to decide if the process is improving.
    - Interaction between factors, when experiment is being run, two or more factors may interact and influence the response variable.
    - One-factor-at-a-time, level of the first factor is changed while other stay the same.
    - Factorial design, allows experimentation on many factors simultaneously, ex
      - Two-factorial design, 2 factors are changed together.
      - Fractional factorial experiment
      - Full factorial experiment

Improve

- Taguchi Robustness concepts
  - Taguchi revolutionized the concept of improving quality of goods produced while simultaneously reducing costs.
  - He theorized that manufacturing processes are impacted by the external disturbance i.e. noise which impacts quality of goods produced. The noise should be minimized wherever possible but some noise (e.g. bad weather) cannot be avoided.
  - Taguchi divided variables that have impact on the processes into two types:
    - Controllable variable
    - Uncontrollable variables (weather- natural calamities)

Improve

- Response Surface Methodology- RSM
  - It is statistical tool that uses quantitative data from experiments.
  - After DOE are conducted, the response need to be studied to determine the best solutions.
  - It provides means to study the response either in form of contours or 3d rendering.
  - Steps:
    - At the start, the project may have several factors and levels that are being studied. All these factors don't need to have an impact on the response variable. In order to determine initially which of these has an impact on the response variable, a screening design is often performed. [L SEP]
    - Screening Design will potentially reduce the number of factors that need to be investigated in detailed experiments: this eliminates unimportant factors before investing time and money in a more elaborate experiment (i.e., second-order design). [L SEP]
    - After screening design, RSM experts use a concept referred to as "Method of steepest ascent" to determine which combination of factors maximizes the response variable [L SEP] focus



Improve

- Project Planning and Management Tools

ID	Knowledge Areas	2	24	10	12	1
		Initiation PG	Planning PG	Execution PG	Monitoring & Controlling PG	Closing PG
4	Project Integration Management	1- Develop project charter	2- Develop project management plan	3- Direct and manage project execution 4- Manage project knowledge	5- Monitor and control project work 6- Perform integrated change control	7- Close project or phase
5	Project Scope Management		1- Plan scope management 2- Collect requirements 3- Define scope 4- Create WBS		5- Validate scope 6- Control scope	
6	Project Schedule Management		1- Plan schedule management 2- Define activities 3- Sequence activies 4- Estimate activity duration 5- Develop schedule		6- Control schedule	
7	Project Cost Management		1- Plan cost management 2- Estimate cost 3- Determine budget		4- Control cost	
8	Project Quality Management		1- Plan quality management	2- Manage quality	3- Control quality	

Improve

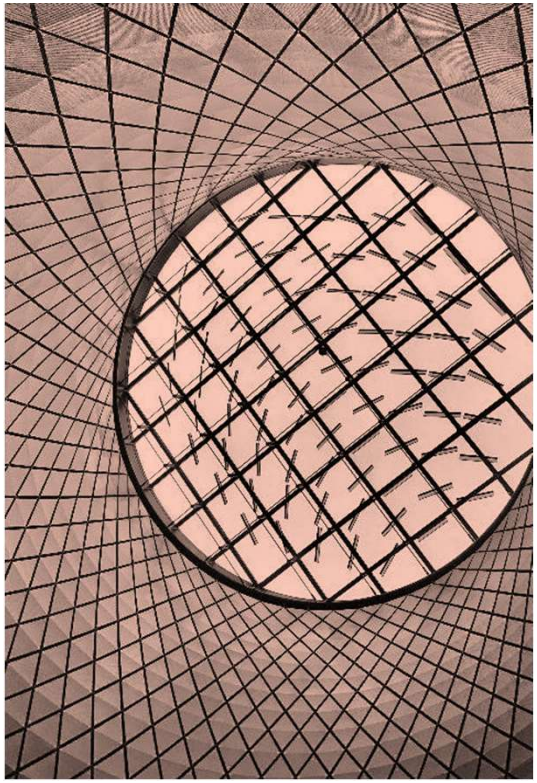
- Project Planning and Management Tools

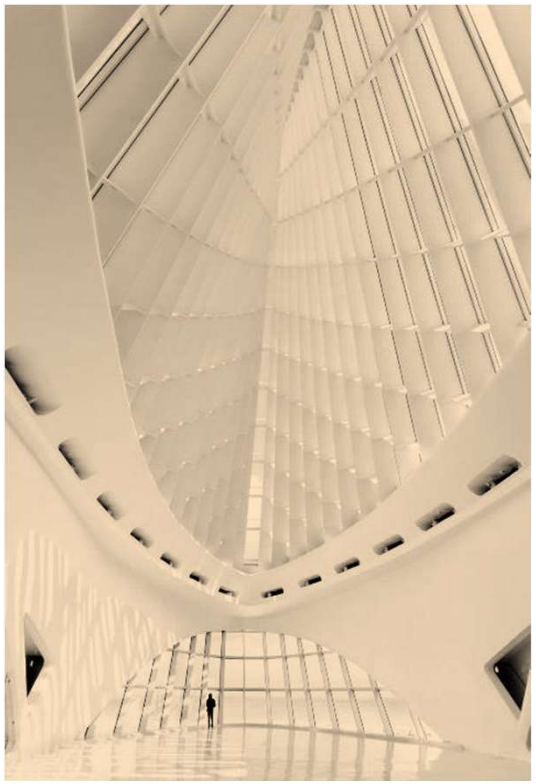
9	Project Recourses Management		1- Plan resource management 2- Estimate activity resources	3- Acquire resources 4- Develop team 5- Manage team	6- Control resources	
10	Project Communications Management		1- Plan communications	2- Manage communications	3- Monitor communications	
11	Project Risk Management		1- Plan risk management 2- Identify risks 3- Perform quanlitative risk analysis 4- Perform quantitative risk 5- Plan risk responces	2- implement risk respones	3- Monitor risks	
12	Project Procurement		1- Plan procurement management	2- Conduct procurements	3- Control procurements	
13	Project Stakeholder Management	1- Identify stakeholders	2- Plan stakeholder engagement	3- Manage stakeholder engagement	4- Monitor stakeholder engagement	

Improve

- Prototypes
  - It is an original or model after which anything is copied.
  - It is a small scale working model which provides idea of the final product/process/service
  - prototyping is a commonly used tool in the construction industry where small-scale prototypes of buildings, highways etc. are created and approved by relevant stakeholders before the final project implementation is done.

- Outputs
  - Cost/benefit of different solutions
    - We should have ROI
    - We should have clear idea of the costs and benefits with all suggested options
  - Selecting of solutions of implementation
    - Management will be able to make decision about which solution should be implemented to max the ROI
  - Implementation Plan
    - Six sigma experts work with the PMs to create implementation plan using the PMP tools.



Chapter 8
Control

5. Control

- The control phase of Six Sigma is used to develop and implement process control plan to ensure sustenance of the improved process.
- The major activities in the control phase are to validate measurement system, verify process improvement and develop control mechanism. So far we have identified the best settings for each of the vital 'X'. The key now is to ensure that the X's don't fluctuate away from the targeted setting.
- Process control is an important tool to ensure that the Six Sigma project delivers lasting benefits.
- Control project management parameters including risk, cost, scope, schedule, quality, changes etc
- Measure the gains made by the project through Statistical Process Control, Control charts etc.
- Ensure that the targets set by the project are achieved.
- Ensure that gains made by the project are sustained.

Inputs

1. Costs and Benefits of different solutions
2. Selection of solutions for implementation
3. Implementation Plan

Tools& Techniques

1. Control Plan
2. Statistical process control
3. Learn Enterprise
4. 5S
5. Kaizen
6. Kanban
7. Total productive maintenance
8. Measurement system reanalysis

Outputs

1. Implemented Solutions
2. Revised Measurement Systems
3. Control Plans for Sustaining benefits
4. Improved Process capabilities
5. Lessons Learned

4. Improve

Inputs
1. Important causes of defects
2. Special and common causes of variation
3. Defects Per Million opportunities (DPMO) and Sigma level

Tools& Techniques
1. Return on Investment (ROI)
2. Solution Design Matrix
3. Design of Experiments
4. Taguchi Robustness concepts
5. Response Surface Methodology
6. Project planning and management tools
7. Prototypes

Outputs
1. Costs and Benefits of different solutions
2. Selection of solutions for implementation
3. Implementation Plan

5. Control

Inputs
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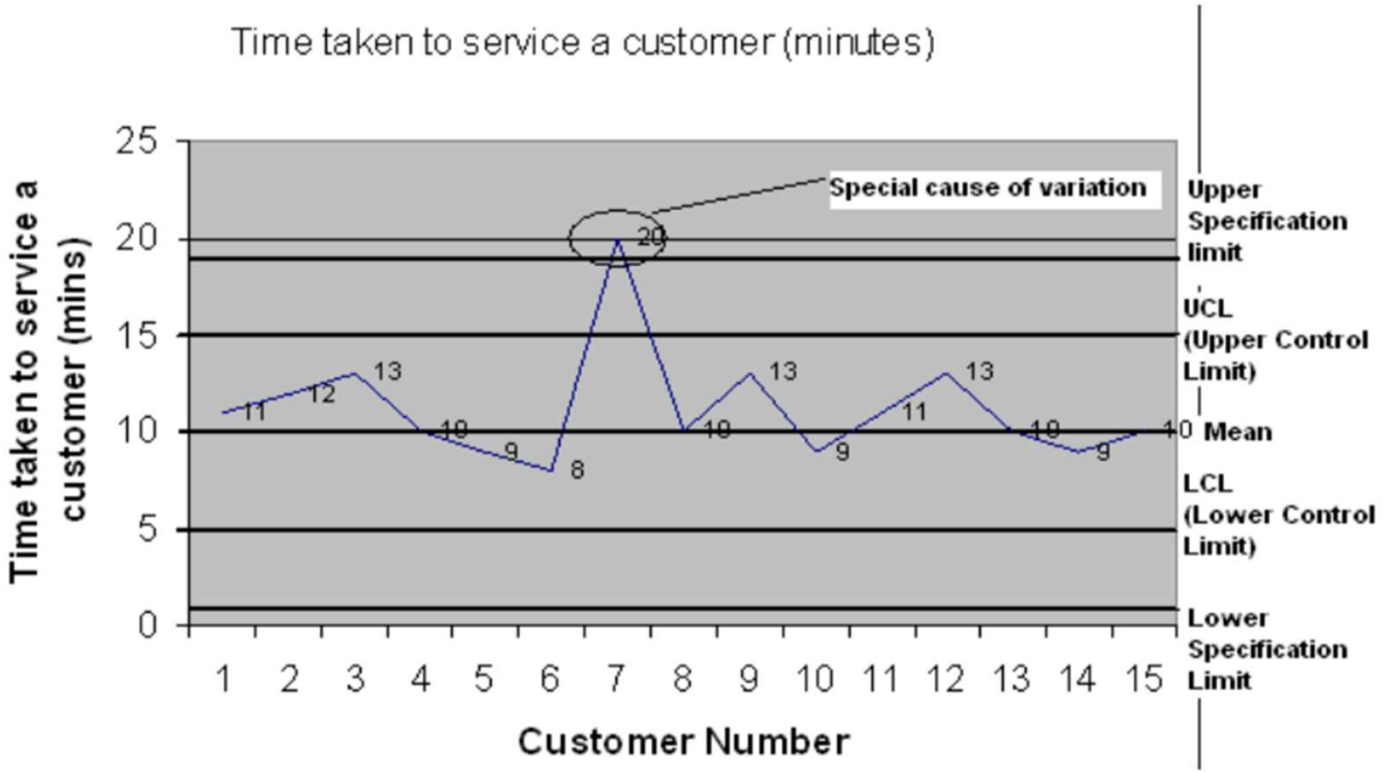
2. Revised Measurement Systems
3. Control Plans for Sustaining benefits
4. Improved Process capabilities
5. Lessons Learned

Control

- Control Plan
  - You collect data during the control phase to ensure it sustains its DPMO and sigma level.
  - Benefits
    - Record data from the process to proactively determine that process is under control.
    - Use preventive maintenance to reduce the errors.
    - Get buy-in from all team members to suggest improvement.
    - Provide inputs on the CTQ (critical to quality) parameters.
  - Control plan must have 3 sections:
    - Header (strategy). Who will create the plan- who will take the measurement-..
    - Process section, describes the process and its characteristics which would be measured.
    - Control methods, describe the data that should be collected for the process (it include: measure type- level of verification…)

Control

- Statistical process control- SPC
  - After collecting the data, SPC to detect and rectify the errors.
  - Control chart is one of the important tools to be used.
    - Out of control
    - Rule of 7



Control

- Lean Enterprise
  - Lean is a methodology to (less time- less cost)
    - Accelerate the velocity and educe the cost of/from any process by removing wastes.
  - According to Little's low, Lead time of any process = amount of time from entry to exit from process= Q/T= (quality of things in process)/(average completion rate/unit of time).
  - Some tools are used to increase quality- reduce the time – reduce cost such as
    - 5S
    - Kaizen
    - Kanban
    - Total production maintenance

Control

- 5S
  - Sort-Straighten-Shine-Standardize-Sustain
  - 5 pillars of visual workplace
  - 5S is to have only what you need available in the workplace.
  - It is designated way of doing things
  - 5S
    - Sort (seiri), put things in order (remove what is not needed and keep what is needed).
    - Straighten (seiton), proper arrangement (place things in such a way that they can be easily reached whenever they are needed)
    - Shine (seiso), clean (keep things clean and polished, no trash no dirt in the workplace)
    - Standardize (seiketsu), purity (maintain cleanliness after cleaning- perpetual cleaning)
    - Sustain (shitsuke), commitment (typical teaching and attitude toward any undertaking to inspire and keep the four compnents)
- Kaizen
  - It means continuous improvement taken from KAI=continuous& ZEN=improvement
  - Focus on small and continuous improvements to the existing process
  - All people should be involved in Kaizen efforts.

Control

- Kanban
  - Used in high volume production lines.
  - Aims to reduce the costs.
  - Used to balance and smooth material flow by controlling the inventories.
  - Cards
    - WIP, work in progress
    - JIT, Just in time
  - Objectives
    - Reduce cost by eliminating waste/scrap
    - Create work sites that can respond to changes quickly.
    - Facilitate the methods of achieving the quality control.
    - Design work sites according to human dignity, mutual trust.
  - Types of Kanbans used today:
    - Withdrawal Kanban
    - Production Kanban
  - Kanban rules
    - No withdrawal of parts without Kanban
    - The subsequent process comes to withdraw only what is needed
    - Don’t send the defective part to subsequent process
    - The preceding process should produt only the exact quantity of parts withdrawn by subsequent process.
    - Smoothing of production
    - Fine tuning of production using Kanban

Control

- Total productive maintenance
  - Total productive maintenance (TPM) is the systematic execution of maintenance by all employees through small group activities
  - It is presented as a key part of an overall manufacturing philosophy.
  - In essence, TPM seeks to reshape the organization to liberate its own potential.
  - TPM is concerned with the fundamental rethink of business processes to achieve improvements in cost, quality, speed etc.
  - It encourages radical changes, such as;
    - Flatter organizational structures- fewer managers, empowered teams
    - multi-skilled workforce
    - rigorous reappraisal of the way things are done - often with the goal of simplification.
  - The principal measure is known as the Overall Equipment Effectiveness (OEE):
    - This figure ties the 'six big losses' to three measurements i.e. Availability (Time), Performance (Speed) & Yield (Quality).
    - Six big losses include
      - 1. Equipment Downtime
      - 2. Engineering Adjustment
      - 3. Minor Stoppages
      - 4. Unplanned Breaks
      - 5. Time spent making reject product
      - 6. Waste

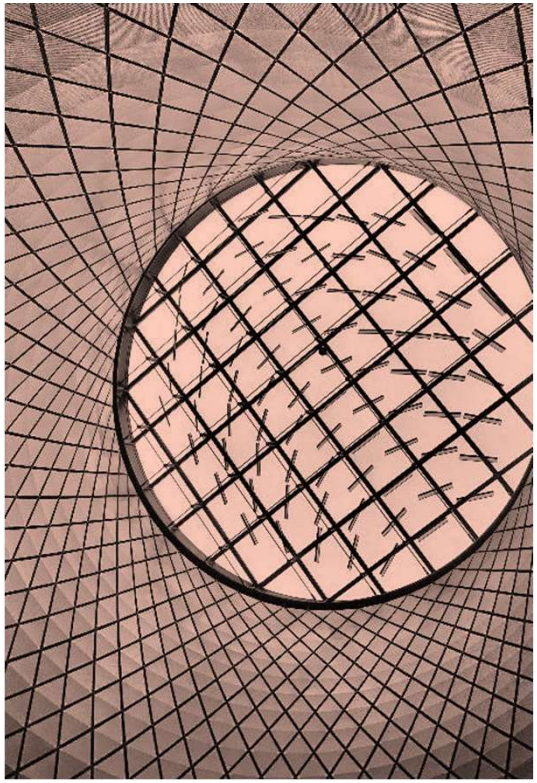
Control

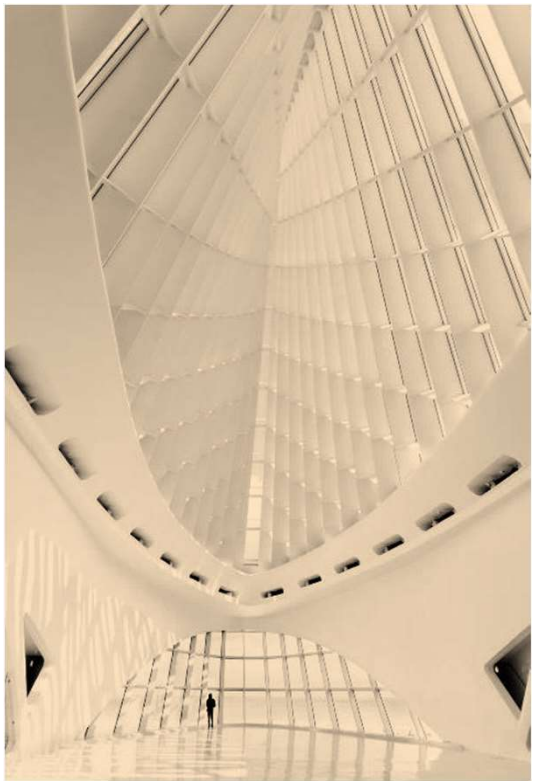
- Total productive maintenance
  - When the losses from Time X Speed X Quality are multiplied together, the resulting OEE figure shows the performance of any equipment or product line.
  - TPM benefits: it include:
  - better understanding of the performance of their equipment.
  - better understanding of equipment criticality and where it is worth deploying improvement effort and potential benefits.
  - improved teamwork and a less adversarial approach between Production and Maintenance
  - improved procedures for changeovers and set-ups, carrying out frequent maintenance tasks, better training of operators and maintainers, which all lead to reduced costs and better service,
  - General increased enthusiasm from involvement of the workforce.

- Measurement system reanalysis
  - After doing Statistical Process Control, we may need to do a periodical reanalysis of the measurement system to ensure that it is functioning as was earlier planned.

Control

- Outputs
  - Implemented Solutions
    - At the end of the Improve phase, six sigma solutions are completely implemented.
    - Then, there is an analysis performed to ensure that the gains from the six sigma project were realized as had been forecast earlier.
  - Revised Measurement System
    - The measurement system is analyzed and recalibrated if required to ensure that it continues to be accurate and can provide appropriate information required for SPC and other control activities.
  - Control plan for sustaining benefits.
    - A control plan for sustaining benefits is created as was discussed earlier in the chapter
  - Improved process capability
    - Once the six sigma project is implemented, the process capability improves.
  - Lessons learned
    - Not all six sigma projects are successful i.e. they may not get the benefits as was earlier planned.
    - Lessons learned from the six sigma project (including successes and failures) should be well documented and shared across the organization. This will help other six sigma projects in the organization leverage the knowledge to improve their process.
    - Benefits from lessons learned
      - Reduced overall costs
      - Increased efficiency
      - Improved customer service
      - Better morale increased the ROI of Six Sigma



Chapter 9
Lean Essentials

About Lean

- Lean was developed in Toyota as part of the Toyota Production System.
- The fundamental driver of Lean is the elimination of waste.
- In fact, a good description of the Lean approach is, "a set of tools that assist in the identification and the steady elimination of waste".
- It aims to reduce or eliminate wastage of time (resources idle time), efforts, and material - Provide customers with make-to-order products.
- The materials are kept 95% of time idle because of delays caused by less than 20% of the work stations called (time traps).
- MRP (material requirement planning) data can be used to prioritize time traps and then apply lean six sigma improvement to eliminate them.

Five principles of lean manufacturing

1. **Value**
   Value is determined by what the customer considers to be important within a product or service, rather than what the individuals developing or delivering the product or service consider important.

2. **Value Stream**
   The set of business activities and steps involved in creating and delivering products and services to the customer; it is the connection of the steps together rather than considering each step-in isolation.

3. **Flow**
   The degree to which there is smooth uninterrupted flow of activities that add value to the customer, rather than waste and inefficiency that impedes the flow through the value stream.

4. **Pull**
   The degree to which the value stream is only processing products and services for which there is a customer demand, rather than creating something and hoping someone wants it.

5. **Perfection**
   The continuous assessment of value stream performance to identify and improve the value created and delivered to the customer, rather than resisting changes that improve the process of creating and delivering customer value.

Three types of waste

Muda
Non-value added work- Pure waste.

Mura
Unevenness in flow – unpredictable variation requires compensation elsewhere in the system.

Muri
Over-burdening resources beyond their normal rated capability – stresses and damages resources so that they are unable to do a normal workload.

Similarities of Lean and Six Sigma

1. Both rely on a definition of value that is based upon the customer experience. The customer is king (or queen).
2. Both use a process flow mapping approach to understand the process.
3. Both rely on data for determining current performance and for determining the impact of future performance. The data collected in a Lean Six Sigma project can often be used to support both Lean analysis and Six Sigma analysis.
4. Both are applied using improvement projects that typically will be implemented by a small cross-functional team. The duration of the project and the size of the team will depend upon the scope and scale of the process, product or service being analyzed for improvement.
5. Both have migrated beyond the manufacturing operation and are now used for all functions and for all internally facing and externally facing processes. They are also used in all industries including industrial, consumer, government, education, and non-profits.
6. Improvements based upon using either approach will normally both reduce waste and reduce variation. Removing wasted steps and activities (muda) eliminates sources of variation, and removing variation eliminates wasted process capacity and steps associated with accommodating the variation (mura and muri).

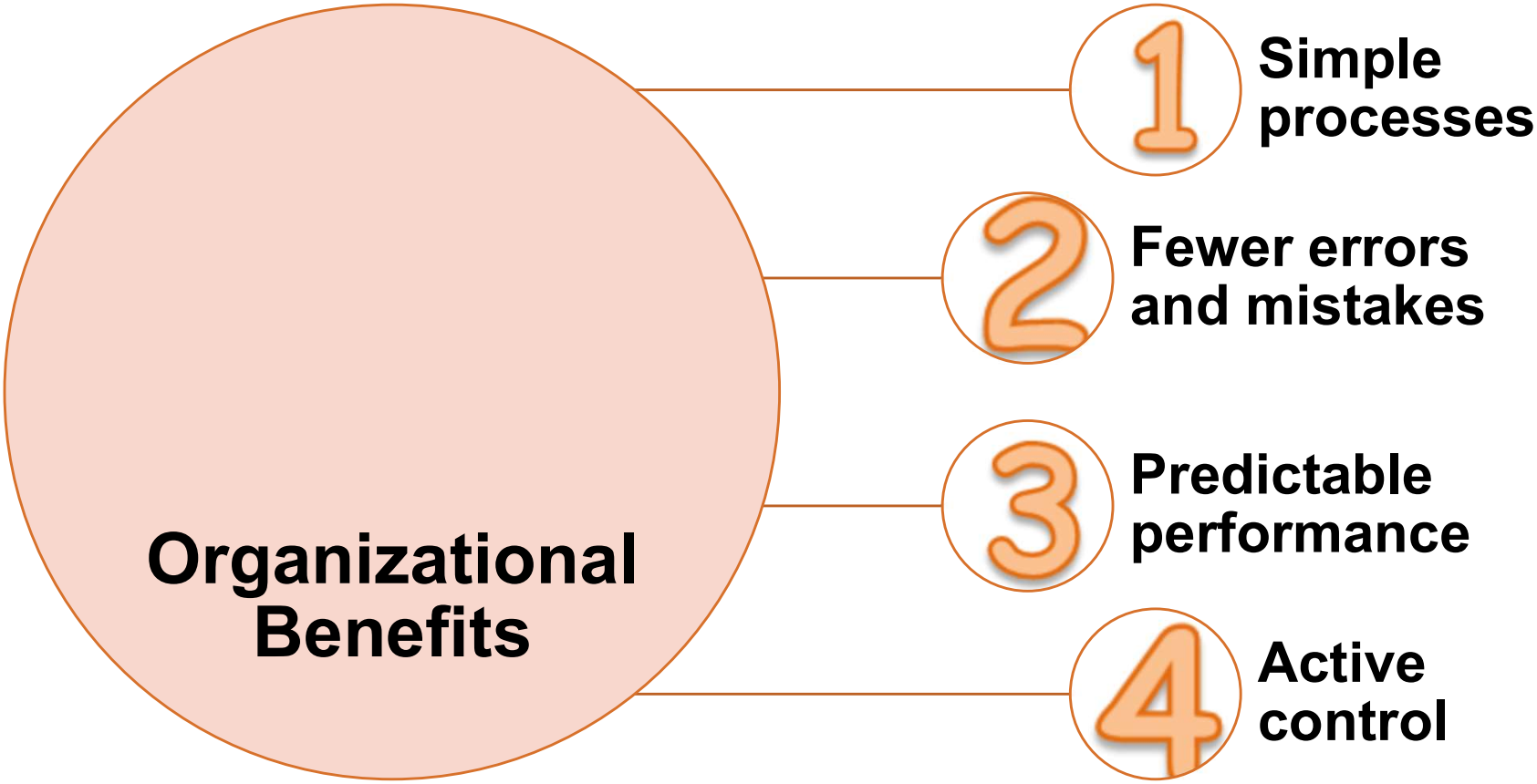
Differences between Lean and Six Sigma

Different focus for problem identification – Lean is focused on waste (muda, mura, muri) and Six Sigma is focused on variation, any deviation from the target performance.

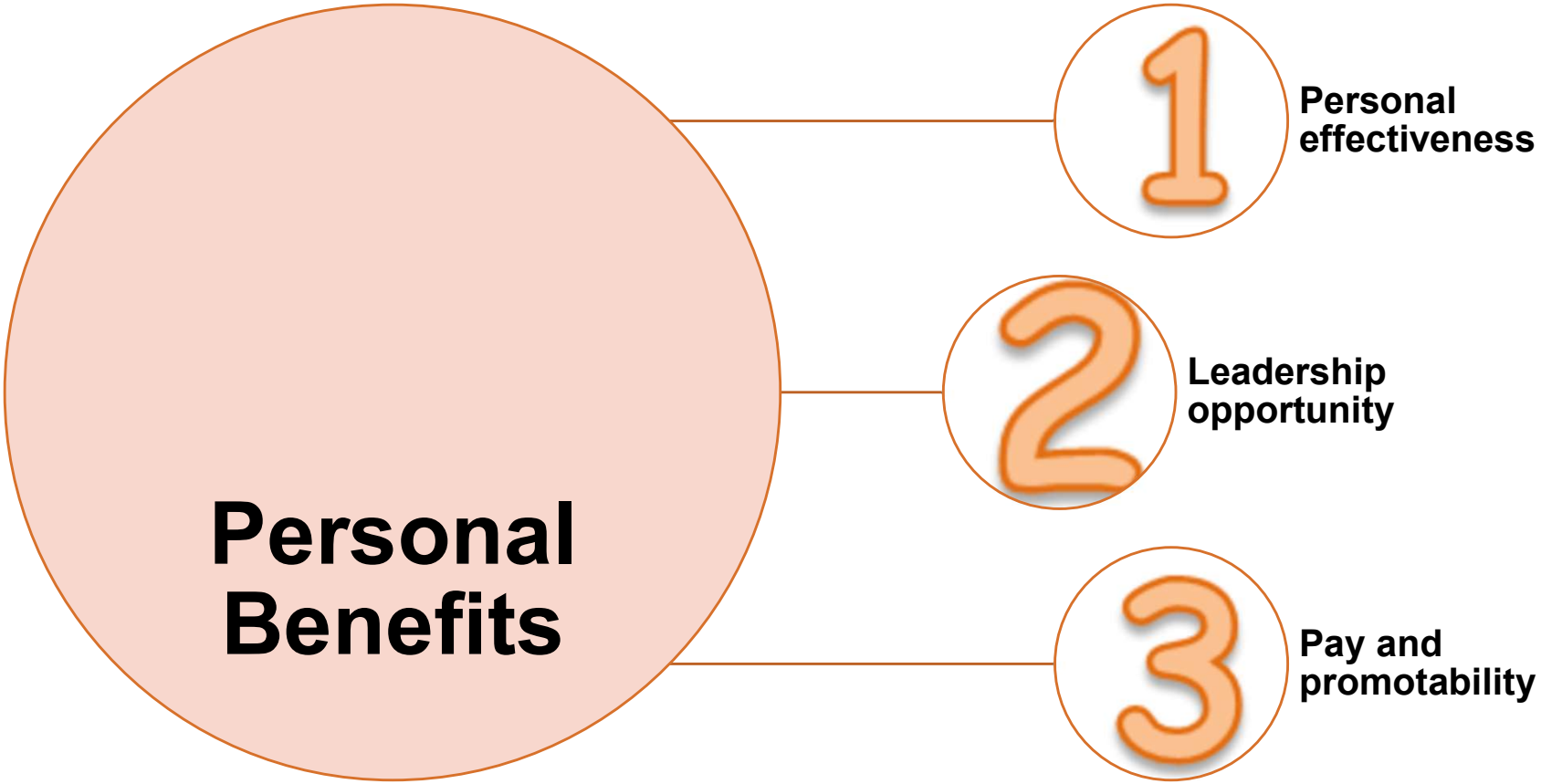
Different types of techniques – Lean primarily uses visual techniques for both analysis and solution creation that are supported with data analysis. Six Sigma primarily uses statistical techniques for analysis and solution creation that are supported with data visualization. This leads to a myth that Lean is easier than Six Sigma, because the visual analysis of Lean is easy to understand, while many people are intimidated by Six Sigma's numerical analysis. The reality is that both types of analysis are easy to perform with today's statistical support tools.

Different types of documentation for the solution – the Lean solution is documented with a revised value stream map that leads to changes in workflows and often changes in work instructions at many of the steps in the process. The Six Sigma solution is documented with changes in setup procedures and the control plan for monitoring the process and responding to variation. It will also impact work instructions and frequently leads to changes in the measurement approach or systems.

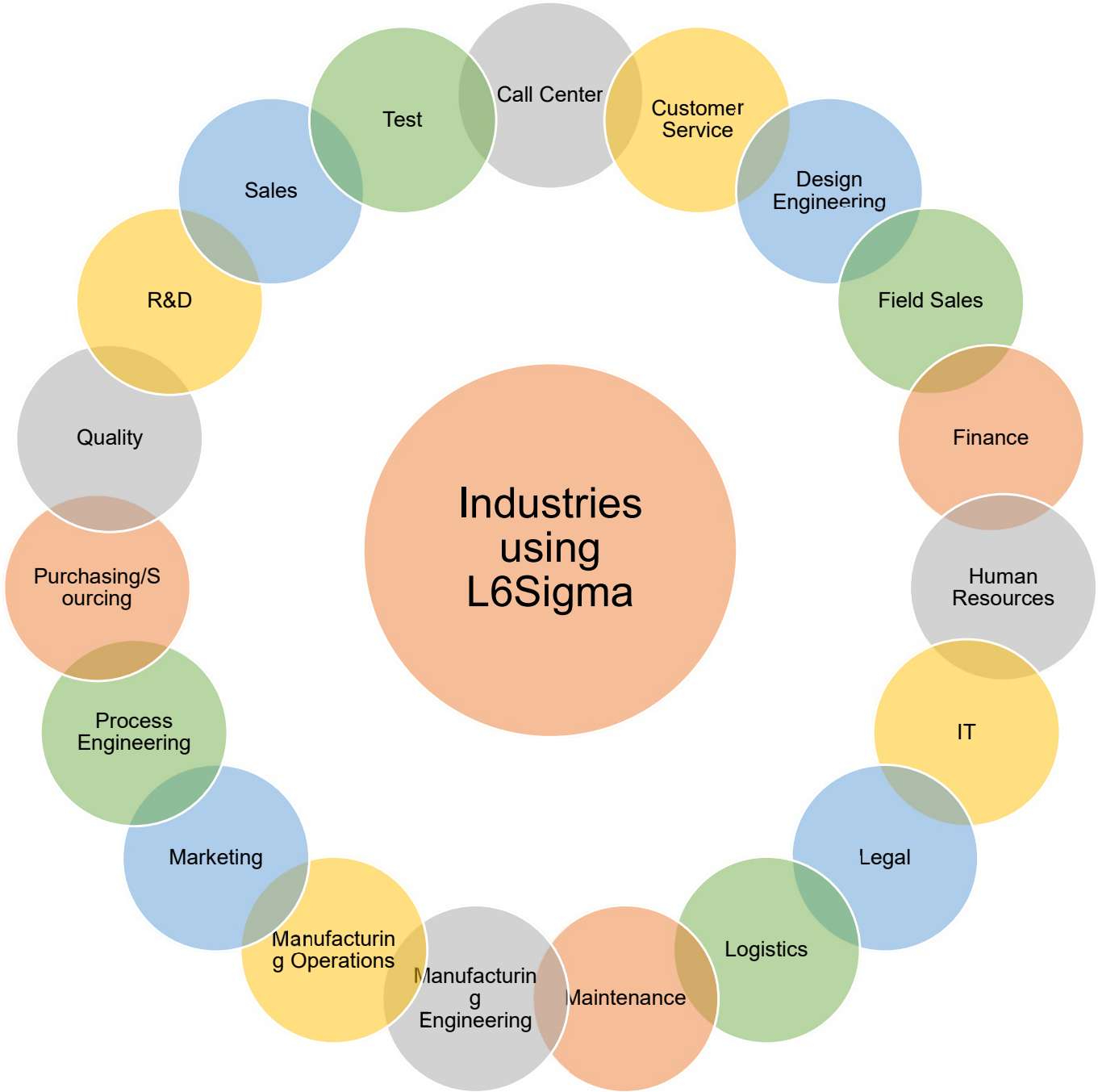
Benefits of Lean Six Sigma



Benefits of Lean Six Sigma



Industries and functions using Lean Six Sigma

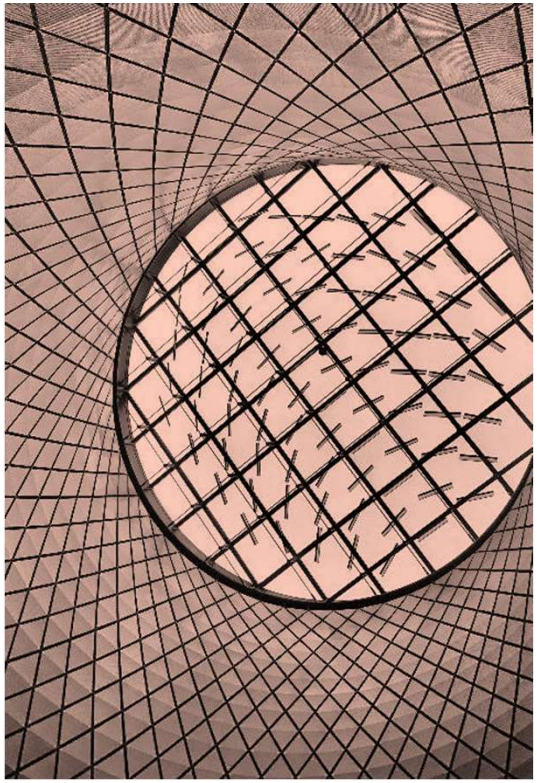


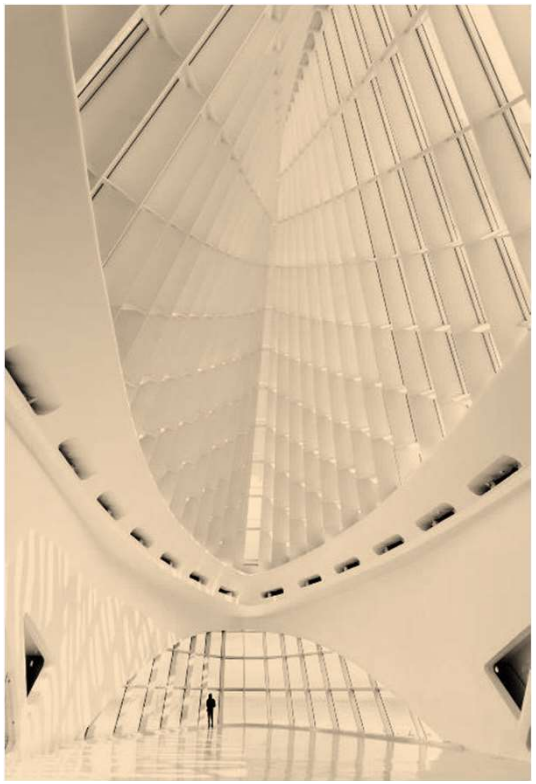
Lean Essentials

- Metric cycle efficiency
  - It will answer the question, since lean is to achieve the speed, so “how fast is fast?” and “how slow is slow?” - Therefore, process Cycle efficiency= value added time / total lead time
    - Value-added time (required work to create the product or service as acceptable to the customer).
    - Total lead time (duration of the process from its start to finish).
  - Process cycle efficiency determines if the process is lean or not - 20% of workstations cause 80% of delays.
- Importance of finding and eliminating time traps
  - The 1st law of lean 6 sigma for supply chain acceleration is through this law
    - Customer demand rate = batch size / workstation turnover time
    - , delay time= workstation turnover time / 2
    - hence, customer demand rate= batch size / 2 x delay time.

Lean Essentials

- Source of cost reduction
  - Lean discovers and eliminates the various elements of hidden factory (it is the items that consumes resources& people and produce nothing as value to the customer) such as: 1) scrap- 2) rework – 3) manufacturing overheads- 4) money tied up in inventory. (if you reduce all of those you therefore eliminate the hidden factory and increase the cycle efficiency).
- Where to use lean system
  - The 3rd law of lean six sigma for supply chain acceleration states that, (velocity): “The average velocity of flow through any process is inversely proportional to both the number of things in process and the average variation in supply and demand.
    - Process velocity= number of activities in process / process lead time = (completions / hour) x (number of activities) / number of things in process.
    - Reduce the work in progress WIP
- 80/20 Rule
  - 80/20 rule is also called the 2nd law of Lean Six Sigma for supply chain acceleration.



Chapter 10
Lean Tools and Features

Lean Tools and Features

- Value stream mapping (catch the hidden rats)
  - It is a technique which used to understand the flow of materials and information required to produce the deliverables.
  - Value Stream Mapping' (VSM) is a lean manufacturing tool used to improve the production process.
  - It is known as value chain diagram, it is paper and pencil sketch of the entire process (material and information) flow,
  - The objective of value stream mapping is to find out and reduce the non-value-added activities (wastes) in a process.
  - It shows all the process steps that are involved in turning a customer need into deliverables. It also captures the value added by each step in the process to the product or service.
  - Steps of value stream map:
    - A value stream map is a paper-and-pencil representation which shows the flow of information and materials required to produce a product or service - It begins with customer requirements. Here the map depicts how and when information is obtained - The end point is the product or service delivery to the customer - Here the map depicts how the entire flow is influenced by decision-making and communication processes.

Lean Tools and Features

- Value stream mapping (catch the hidden rats)
  - Uses of the value stream map:
    - Identify and differentiate the value-adding activities from non-value adding activities in the process.
    - Manage decision points related to process improvement.
    - Identify key areas for data gathering and process improvement
  - Types of wastes to be removed (non-value-added wastes)
    - overproduction- waiting times- transportation- useless and excess inventories- inappropriate production processing- ineffective motions- defect correction.
  - 7 value stream map (VSM) Tools:
    - Process activity mapping - Supply chain response matrix - Production variety funnel - Quality filter mapping - Demand amplification mapping - Decision points analysis - physical structure mapping.
  - Benefits of VSM
    - More efficient process - Develop future guidelines for designing more efficient processes - Identify waste and sources of waste - Identify areas where there is scope for improvement in lead time (a lead time is the period between the start of a production process and its completion) - Can be implemented not only in the manufacturing industries, but also in supply chain, service related industries, logistics, healthcare, and software.

Lean Tools and Features

- Total Supply Chain
  - Supply chain is an organization is said to be a network that carries out the activities of procuring and converting material into intermediate/final products and distributing to the customer.
  - Accelerating the internal supply chain: Reduce the lead time - apply 3rd law of lean six sigma and reduce WIP (=activities/lead time) قلل المقام
- Kanban- pull system
  - It is the 'produce-to-demand' concept, which ensure every process pulls from the previous process only the required components at the right time.
  - Kanban means card.
  - Org should keep strategic buffer of components.
  - How to determine strategic buffer, there are 5 components:
    - 1- Manufacturing lead time buffer, = lead time x demand
    - 2- Cycle time interval, cycle time=CTI x avg demand/day
    - 3- Transport time buffer,
    - 4- Safety stock,
    - 5- Seasonality or promotions,
  - Kanban (strategic buffer) is SUM of those 5 buffers= (manufacturing lead time x demand) + (cycle time interval x demand) + (safety stock) + seasonality + (transport time x demand).
  - Synchronous and Asynchronous Pull System
    - Asynchronous pull systems do not have 'preset timing', i.e., if and when there is a demand for a part, the pull system supplies that part and refills the stock.
    - Whereas a Synchronous pull system is used for operations in which manufacturing is done in numerous stages to meet the final customer lead time demand. Synchronous pull systems carry forward materials in a predetermined velocity or rhythm which is called 'Takt time'. L SEP
  - The rise of pull system
  - Pull formula for supplier parts
  - Down steam pull system

Lean Tools and Features

- Lean six sigma logistics (ch9-4)
  - Introduction,
    - Logistics: minimize the cost of the inventories through the following drivers: Demanding forecasting - Inventory control - Material handling- Packaging – Transportation – Quality.
    - The following are obtained by the logistics: Bring raw material to factory when the facility is running out of them - Reduce the level of inventories, thus reduce wastes.
  - Importance: An organization will hold inventories for any or all of the following reasons (Why to held logistics):
    - Safety stock (stock need to be removed): The inventory stocked to avoid stock shortages due to varying production schedules, lengthy lead times, and failure of future supplies
    - Cycle stock (stock need to be min): The stock held in line with an organization's strategy on production batch sizes, raw material lot sizes, and workstations having long time delay within a production process.
    - In-transit inventory: The stock stored to cover transportation lead times from suppliers.
    - Work in process stock: The stock used in the production process, both by the manufacturer and the suppliers.
    - Speculative stock (stock need to be removed): The stock held to assist business operations such as marketing promotions, potential raw material shortages in future, purchasing discounts etc.

Lean Tools and Features

- Lean six sigma logistics (ch9-4)
  - Goals
    - Remove safety and speculative stocks.
    - Min WIP, lead times, and cycle stock.
    - Ensure the org profitability is not affected.
  - Implementation
    - Transportation: Lowering interplant transfer - Reduce trailers - Raise delivery frequency
    - Decrease Lot sizes
    - Leveled flow, Min material handling- optimize space
    - Returnable packaging
    - Pipeline visibility and contingency planning
    - Logistics measurements: Delivery frequency per supplier - On-time delivery by supplier - Lot size by supplier
  - Role of six sigma logistics
    - Explicit costs are the actual payment.
    - Implicit costs are the lost or missed opportunities (6 sigma focuses on the implicit costs), such as: Capital costs - Inventory service costs - Storage space costs - Inventory risk costs.

Lean Tools and Features

- Standard Operations
  - Introduction
    - It refers to the standardization of all process stages.
    - Those resources can be used: Man-material-methods-machines
    - Using charts- posters- color codes
  - Benefits
    - Produce more consistent products
    - Simplifies down stream activities
    - Min variations in cycle time.
- Operator work instructions
  - Introduction: It is details of the tasks involved in a process to be performed by the employees.
  - Importance: Using of visual aids - Set up work place with signs, labels, color codes.

Lean Tools and Features

- Cycle Time Reduction and Takt Time
  - Cycle time
    - It is the time required to complete a task or activity related to a product or service - It can be reduced by breaking down an activity into sub activities - Analyze these sub activities, then you can find the sub activities that increase the cycle time and add no value to the process.
    - Technique of cycle time reduction: Such as SMED-CFM-Kaizen - The most important is Kaizen (it is called kaizen blitz- kaizen methods- rapid continuous- improvement RCI.
  - Takt time
    - Takt time= metronome= It is used to indicate the desired rhythm of the process (whether the production according to customer demand).
    - Takt time allows org to fine tune and control its rate of production according to customer demand.
    - Takt time= hours/demand
    - Ex. demand=64peices/day, the work is 2 shifts, 8hrs each, the takt time= hrs/pieces= 16/64= 0.25hr=15min الحتة هتاخد اد ايه وقت
    - Total cycle time= or less than takt time.المفروض تطلع الشغل في الوقت المطلوب او اقل من الوقت المطلوب
  - Cycle time vs Takt time
    - Both are related to production cycle.
    - Both aim to min the non productive time and max the productive time.
    - Takt time: aims to achieve the desired rhythm.
    - Cycle time: aims to keep only the value adding activities.
    - Takt time is rate of production
    - Cycle time is period of time taken to complete the task.
    - Takt time is determined by demand of customer
    - Cycle time is determined by eliminating the effect of non added value.

Six Sigma Green Belt Certification

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