makeway
...enabling desired results

LEAN SIX SIGMA
GREEN BELT
(INCLUDES YELLOW BELT)

MakeWay Global is an accredited partner of the International Lean Six Sigma Institute (ILSSI)

About MakeWay Global

MakeWay Global is an international human capital development and management consultancy firm that is **focused on the management of change** for organisations.

Some of our accredited certification courses include:

Business Analysis Diploma	**Project/Programme Project Management**	**Others**
Foundation Certificate in Business Change	PRINCE2®	Lean Six Sigma – (White, Yellow, Green, Black Belts)
Business Analysis Practice	AgilePM®	Cyber Security Courses (inc. **GDPR, NDPR**)
Requirements Engineering	Scrum	Leadership and Management
Commercial Awareness	MSP®	Business Skills (inc Effective Communication)
Modelling Business Processes	MoP®	Business Applications

- **World Class Training**
- **Our Global Associates:** are passionate, real world experienced and knowledgeable trainers
- **Study at Your Pace**
- **Post Study Consultation**
- **Customised Training Solutions (inc specialist areas)**
- **Exceptional Standards (with Value for Money)**

SESSION LOGISTICS

Trainer Intro

Health and Safety (Fire…)

Conveniences

Days / Timings, including breaks

Mobile devices (telephones, tablets etc)

Delegate Introductions

Introductions

Name

Your current role

L6S awareness and/or experience

Expectations for the course

Green Belt Agenda

Day 1

- ☐ Introduction to L6S
- ☐ Project Selection and Establishment
- ☐ Some Improvement Methodologies
- ☐ DMAIC for Green Belt
  - ➢ Define Phase

Day 2

- ☐ DMAIC for Green Belt
  - ➢ Define Phase (contd.)

Day 3

- ☐ DMAIC for Green Belt
  - ➢ Measure Phase

Day 4

- ☐ DMAIC for Green Belt
  - ➢ Analyse Phase
  - ➢ Improve Phase

Day 5

- ☐ DMAIC for Green Belt
  - ➢ Control Phase
  - ➢ Yellow Belt Exam

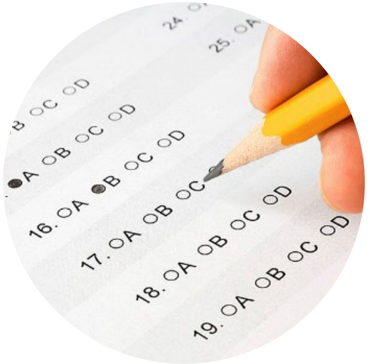
Objectives of the Yellow and Green Belt course

To give an understanding of what ***Lean Six Sigma (L6S)*** is and what it means to practitioners

To show the skills and tools that help to direct small groups of people in the L6S environment

Identify improvement opportunities in your organisation

Familiarise with the DMAIC cycle and learn to use the relevant tools and techniques for practical and statistical solutions



Understand the role of the Belts in continuous improvements and prepare you for the Green Belt certification

Examination & Certification Requirements

Complete the online exam (pass mark is 70%)

- 50 Questions (multiple choice) – *35/50 to pass*
- 60 minutes duration
- Open book
- Accredited by the International Lean Six Sigma Institute (ILSSI)

Complete a Lean Six Sigma GB improvement project in your organisation

- Send the ‘L6SJourneyBoard’ (signed of by the project Champion) to training@makewayglobal.com
- Complete the Green Belt project within 12 months
- Demonstrate effective application of tools and methods
- Present the ‘L6SJourneyBoard’ in PowerPoint or appropriate software

Agenda

Introduction and Housekeeping ☑

Introduction to Lean Six Sigma

- History and Introduction to Lean, Six Sigma and Lean Six Sigma
- Project Selection (1)

Some Problem Solving Methodologies

The DMAIC Cycle

What is Lean Six Sigma?

A fusion of two related disciplines

- ***Lean***
- ***Six Sigma***

Both consist of:

- Philosophies
- Methodologies
- Tools and techniques

Lean and Six Sigma are highly complementary

- So it makes great sense to combine them

Most practitioners merge the philosophies and combine a subset of the tools into the Six Sigma methodology ***(DMAIC)***

The Two Parts of Lean Six Sigma

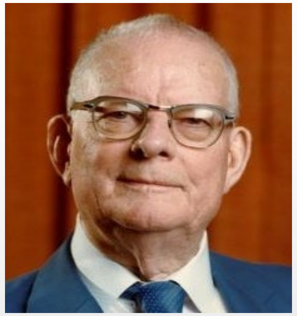
LEAN	SIX SIGMA
Originated from Toyota	Developed by Motorola
The Toyota Production System (TPS) is at the heart of Lean	Six Sigma equates to 3.4 defects for each million opportunities (DPMO)
The Lean methodology focuses on eliminating waste and smoothening the process flow	To improve processes by reducing variation and defects
Lean is not about cutting costs. It is about removing waste without sacrificing quality	Many (but not all) of the tools are statistical in nature and Six Sigma emphasises taking action based on fact rather than opinion or common belief
People tend to use the term Lean Thinking to describe the culture of Lean	The 'Sigma' (σ) rating of a process can be used as an indicator of how many defective parts a process produces

The Focus of Lean

Eighty-five percent of reasons for failure to meet customer expectations are related to deficiencies in systems and process rather than employees. The role of management is to change the process rather than badgering individuals to do better.

- **William Edwards Deming**

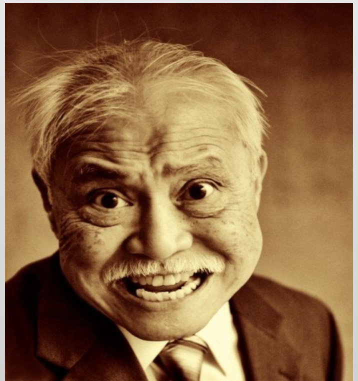
American engineer, statistician and professor



All we are trying to do is reduce the time from order to cash

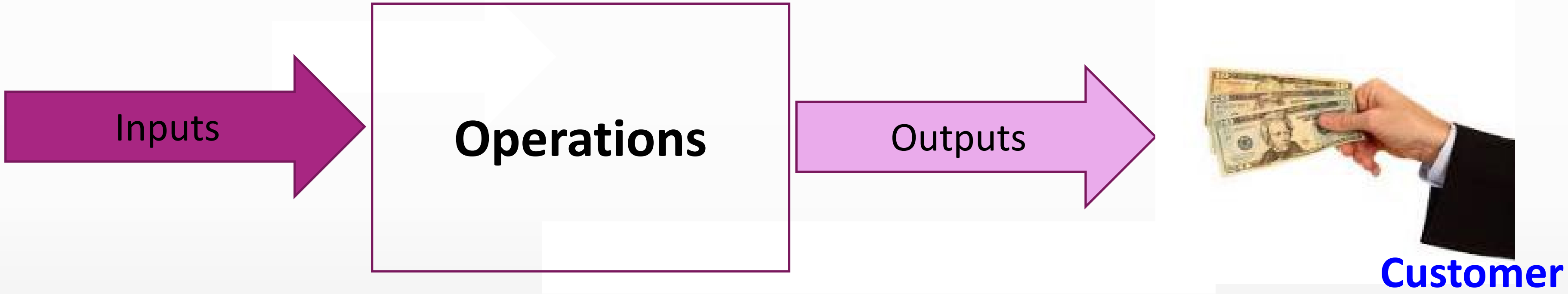
- **Taiichi Ohno**

Toyota Production System



The Focus of Lean

*There are four purposes of process improvement: **easier, better, faster, and cheaper.** These four goals appear in order of priority. Hence the first is to make the work easier for workers while improving the fruits of their labour.*



- **Easier** (for the workers)
- **Better Quality** (less defects and rework)
- **Faster** (on time delivery)
- **Cheaper** (lower Cost of production)

The Focus of Lean


Customer places order

Delivery process

TIME

Customer accepts order

Lean is **<u>NOT about cutting costs</u>** it is about removing waste without sacrificing quality.

It is the ability to **<u>do more with less</u>** resources.

<u>WASTE</u> is whatever slows the delivery process down

The Toyota Production System (TPS)

MUDA (無駄)
[Waste]

Achieve efficiency

MURA (斑)
[Unevenness/ Irregularity]

Achieve flow

MURI (無理)
[Complexity]

Achieve standardised work for your tasks

The TPS was created by **Taiichi Ohno** based on the ideas taught by **W Edwards Deming**

Since the late 1980s, the term **LEAN**, which describes the TPS, has been introduced to the western world

Wastes of Lean [Muda] Wastes in Lean Services

Transportation
Inventory (Over)
Motion
Waiting
Over-production
Over-Processing
Defects (and Rework)
Skills (unutilised)

TIMWOOD(S)

1) **D**efects
2) **O**ver-production
3) **W**aiting
4) **N**on-Utilised talent (Skills)
5) **T**ransport
6) **I**nventory
7) **M**otion
8) **E**xtra Processing

DOWNTIME

Lean Wastes (Muda) in Services (2)

Defects

- Errors and Rework
- Missing information
- Work not meeting standards
- Ignoring customer requirements

Over-production

- Making more than is needed
- Too many reports, reviews or approvals
- Excessive documentation
- Documents carrying the same information
- Batching paperwork

Waiting

- Waiting for information or paperwork
- Waiting for approval
- Equipment downtime
- Waiting time between batch processing
- Delays

DOWNTIME

Lean Wastes (Muda) in Services (3)

Non-utilised Skills

- Not utilising the skills and the knowledge of those who work for the organisation
- Not listening to a good idea
- Unclear communication – such as leaving people to guess what is required

Transportation

- Paper-based rather than electronic
- Unnecessary electronic transfer – why are some people cc'd for every email discussion that they do not need to know about
- Data travels to multiple locations
- Inefficient inter-office mail system

DOWNTIME

Lean Wastes (Muda) in Services (4)

Inventory

- Excessive backlog or work in progress
- Creation of queues
- More than the absolute minimum being stored (paper and electronic)
- Partially completed work

Motion

- Walking to deliver paperwork
- Chasing needed information or paperwork
- Lack of *ergonomic workspace or design
- Task switching

Extra processing

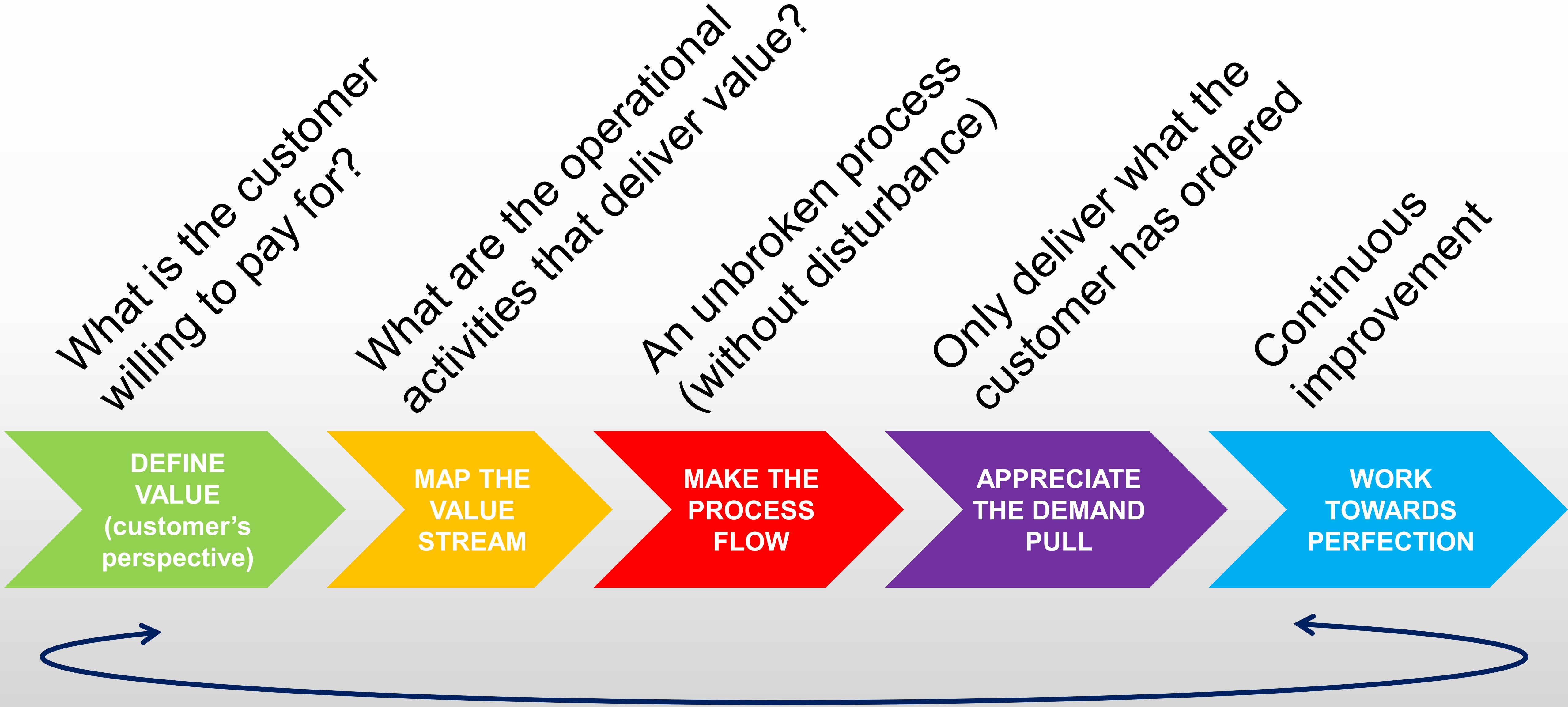
- Unnecessary steps
- Multiple handoffs
- Multiple documents
- Lack of standard procedure
- Excessive checking
- Re-learning
- Extra features and complexity

DOWNTIME

*Process of designing or arranging workplaces, products and systems so that they fit the people who use them

Introduction

The Five Principles of Lean



What is the customer willing to pay for?

What are the operational activities that deliver value?

An unbroken process (without disturbance)

Only deliver what the customer has ordered

Continuous improvement

DEFINE VALUE (customer's perspective)

MAP THE VALUE STREAM

MAKE THE PROCESS FLOW

APPRECIATE THE DEMAND PULL

WORK TOWARDS PERFECTION

Introduction

Single Piece Flow

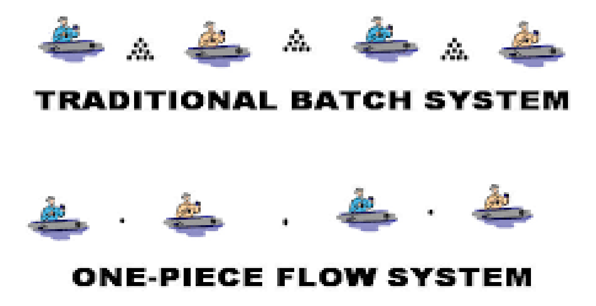
In *Single Piece Flow*, products or transactions are handled in batches of <u>**ONE**</u>

Each item is examined for defects before handing over (to next part of process)

Faulty units are **avoided** being passed downstream (i.e. towards the customer)

→Production halts until the problem is rectified)

In practice, it often means working to the smallest batch size possible



Pull

In *Pull* systems, material flow is triggered by downstream demand

Example:

- A user replaces the printer toner from the department's stationery cupboard (and leaves a Kanban for the store)
- The store replenishes the stationery cupboard (and leaves a Kanban for procurement)
- The procurement team places an order with the supplier to replenish the warehouse
- The supplier replaces the toner in the warehouse

So the flow is triggered by the customer placing an order – you can see how *Single Piece Flow* links in. This keeps stock holding to a minimum, thus reducing waste. Only that which is used is replaced!

Pull is the opposite of 'Push'

– where regular deliveries are driven by a schedule

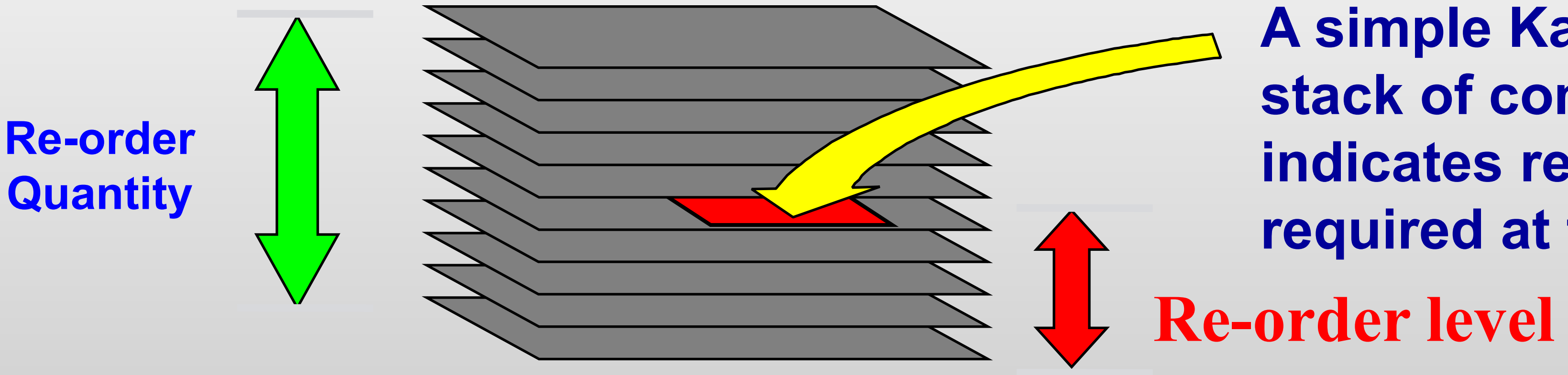
What are Kanbans?

A Kanban can be a whole host of things:

- a card
- a bin, container or pallet
- an empty square
- a ping pong ball or tennis ball
- a token etc.

→ **Visual Signals**

The Kanban has a particular purpose – it acts as an indicator for stock control and replenishment based on pre-set, fixed re-order levels and re-order quantities for materials. It is a short term execution tool



A simple Kanban card in a stack of components that indicates replenishment is required at that point

The Six Sigma Approach

Six Sigma is a management ideology, whereby business process improvements are based on statistical analyses and predictions.

What is the reason behind calculating the sigma value?

The value in making a sigma calculation is that it abstracts your level of quality enough so that you can compare levels of quality across different fields (and different distributions)

In other words, the sigma value (or even DPMO) is a universal metric that can help anyone with the industry benchmark/competitors

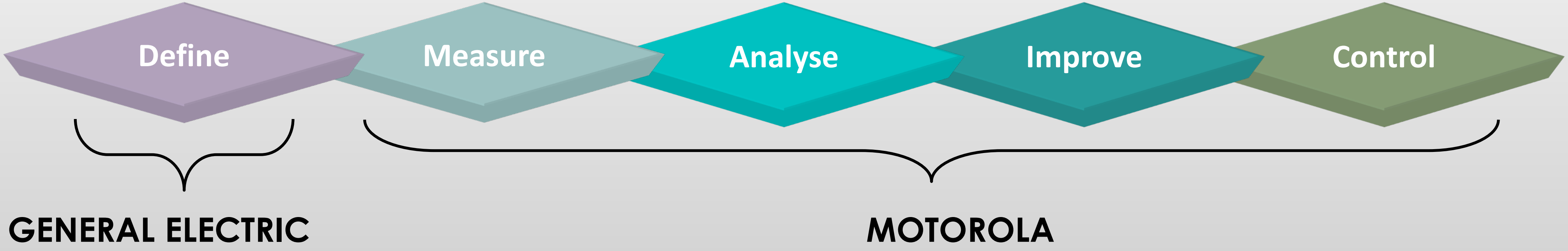
Basically, a business process that churns out less than 3.4 defects per million opportunities is considered to be six sigma efficient, and thereby determines QUALITY!

History of Six Sigma

Six Sigma created a realistic and quantifiable goal in terms of its target of **3.4 defects per million operations/steps** – this indicates that 99.99966% of its products or services are without flaws.

It was also accompanied by problem-solving strategy made up of four steps:
Measure, **Analyse**, **Improve** and **Control**

When GE launched Six Sigma, they improved the methodology to include the **Define** phase



Define Measure Analyse Improve Control

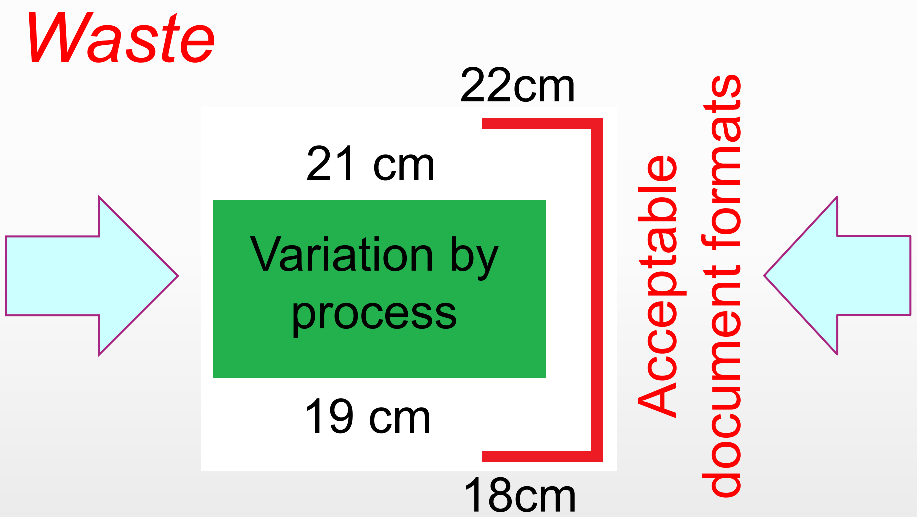
GENERAL ELECTRIC **MOTOROLA**

The Focus of Six Sigma

To reduce variation and avoid giving the customer defective products

All processes and systems give out variation

This process formats documents between 19cm and 21cm (as represented by the vertical height of the green block)



Customers will only accept a certain rage of variation

This customer wants the documents delivered at 20cm but will accept between 18cm and 22cm

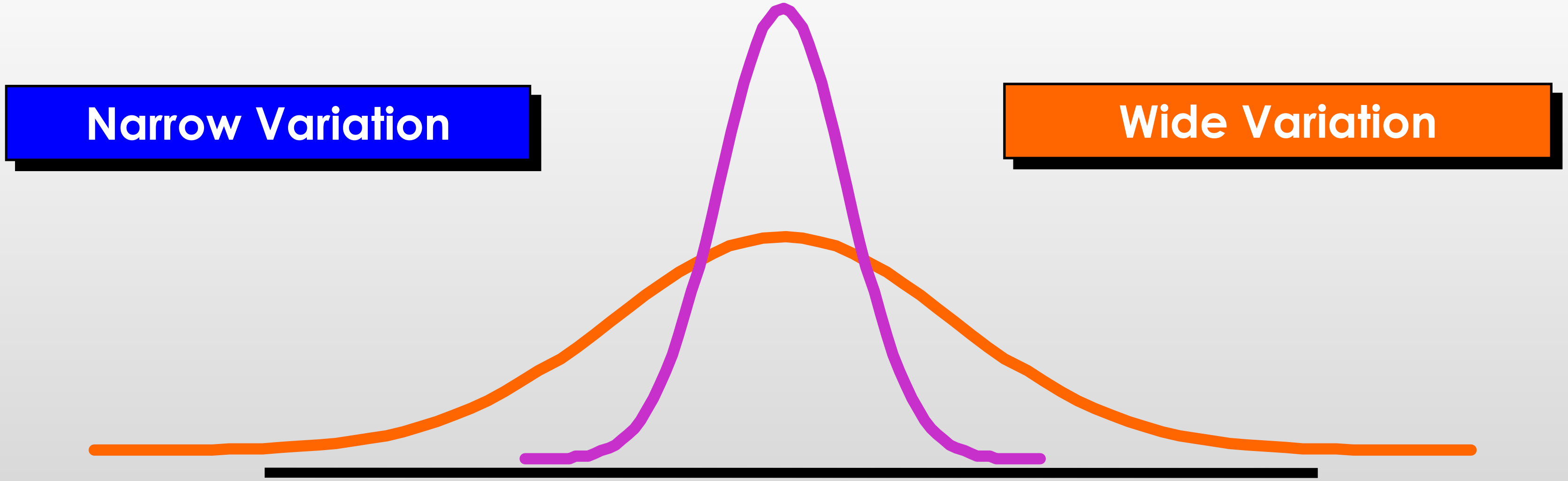
Waste is whatever gives rise to unacceptable deviation (defects)

What is the Six Sigma Symbol?

σ, Sigma, is the 18th letter of the Greek alphabet

Mathematicians use this symbol to signify Standard Deviation, an important measure of variation

Variation designates the distribution or spread about the average of any process



The 6 Principles of Six Sigma

Reduce Variation and you will reduce Defects / Errors

Conduct Root Cause Analysis (RCA) of problems

Use Data for Decision making (Not guessing)

Use of Statistical Analysis tools and charts

Process Optimisation using relevant techniques (e.g. DoE, Regression Analysis, Hypothesis testing)

Improvement projects with DMAIC Framework

REDUCE VARIATION

ROOT CAUSE ANALYSIS

USE DATA

STATISTICAL ANALYSIS

PROCESS OPTIMISATION

USE DMAIC

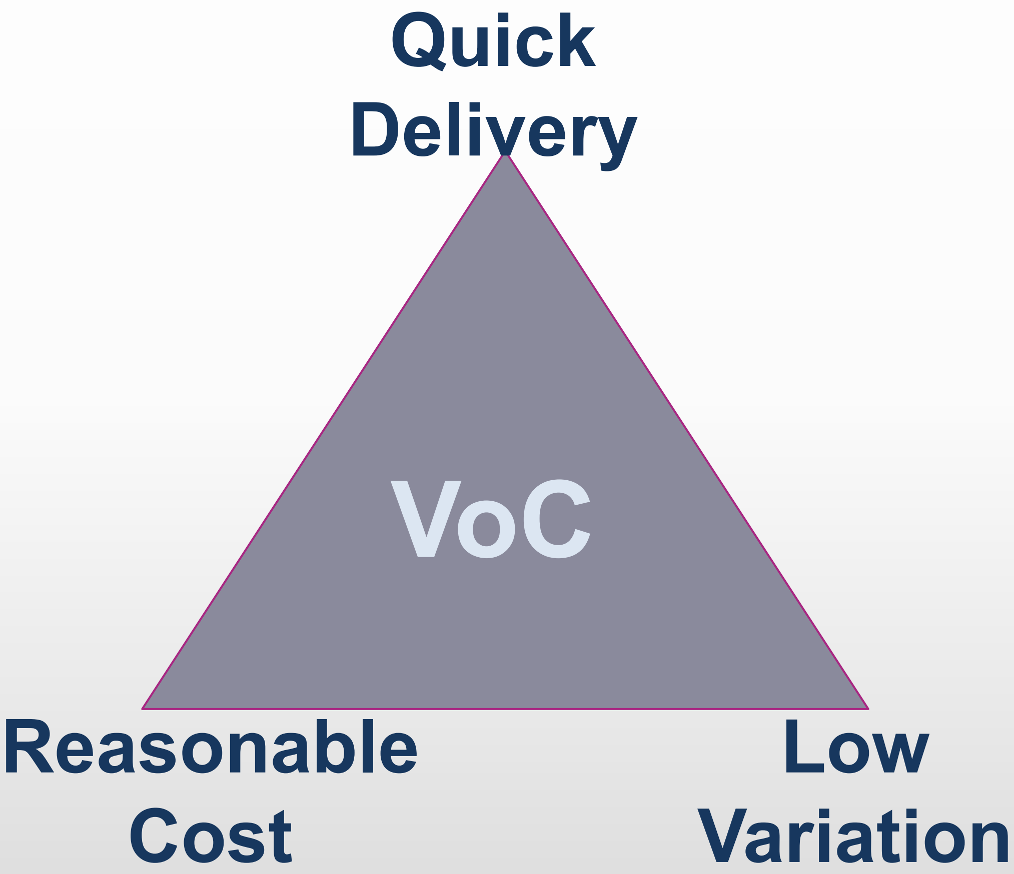
Making Customers Happy

Customers want three things from a product or service:

- Minimum variation
- Quick delivery (short lead time)
- Reasonable Cost

These three requirements are linked together and need to be balanced out.

The Voice of the Customer (VoC) tells us what this balance should be.



How they Complement Each Other

Six Sigma helps Lean because…	Lean helps Six Sigma because…
Lean does not really have a formal project methodology, whereas Six Sigma has DMAIC. DMAIC allows the improvement team to have a clear set of activities for the **Measurement** and **Analyse** phases.	Lean provides alternatives to DMAIC for less complex improvement areas. For example Kaizen events can be performed frequently by everyone.
Lean does not consider the problems with variation; however, Six Sigma adds statistical modelling tools to track down and investigate variation.	Lean focuses on waste and end-to-end flow. Lean defines waste from the customer's perspective. By itself, Six Sigma may take an insular view, optimising a process to meet a local target. Process sigma levels are reached more rapidly by also considering waste

Key Principles of Lean Six Sigma

1 – Customer focus

Focus on the Customer (VoC) first; not the business process

2 – Know the value stream

Identify and understand how the work gets done (the value stream)

3 – Business Process

Manage, improve and smoothen the process flow

→Identify and eradicate waste wherever possible

4 – Manage by facts and data

→Not by opinion

→Identify and understand how the work gets done and not how you think it gets done

→Reduce variation

5 – Trust and empower people

→Those closest to the work are usually the true Subject Matter Experts (SMEs)

→Empowerment must be resourced

→Transparency (is two-way)

6 – Drive for perfection

Improve processes systematically

The Costs of Lean Six Sigma

Both Lean and Six Sigma are license and royalty free

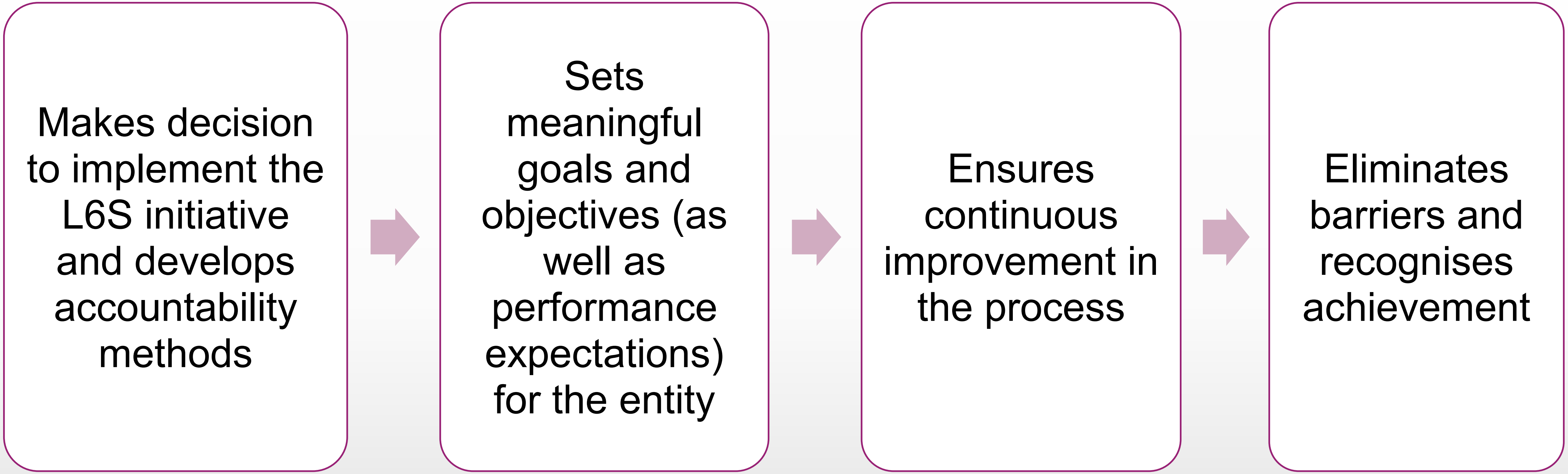
But there are **costs**:

- Training
- Co-ordination and culture change
- Also, if people are spending time improving a process they are not serving customers etc

Introduction to Lean Six Sigma

- History and Introduction to Lean, Six Sigma and Lean Six Sigma
  - ***Project Selection (1)***
- Some Problem Solving Methodologies
- The DMAIC Cycle

Board Level / Senior Management



Makes decision to implement the L6S initiative and develops accountability methods

Sets meaningful goals and objectives (as well as performance expectations) for the entity

Ensures continuous improvement in the process

Eliminates barriers and recognises achievement

Not all Lean Six Sigma deployments are driven from the top by Executive Leadership. It has been proven, however, that those deployments driven by executive management are much more successful than those that are not.

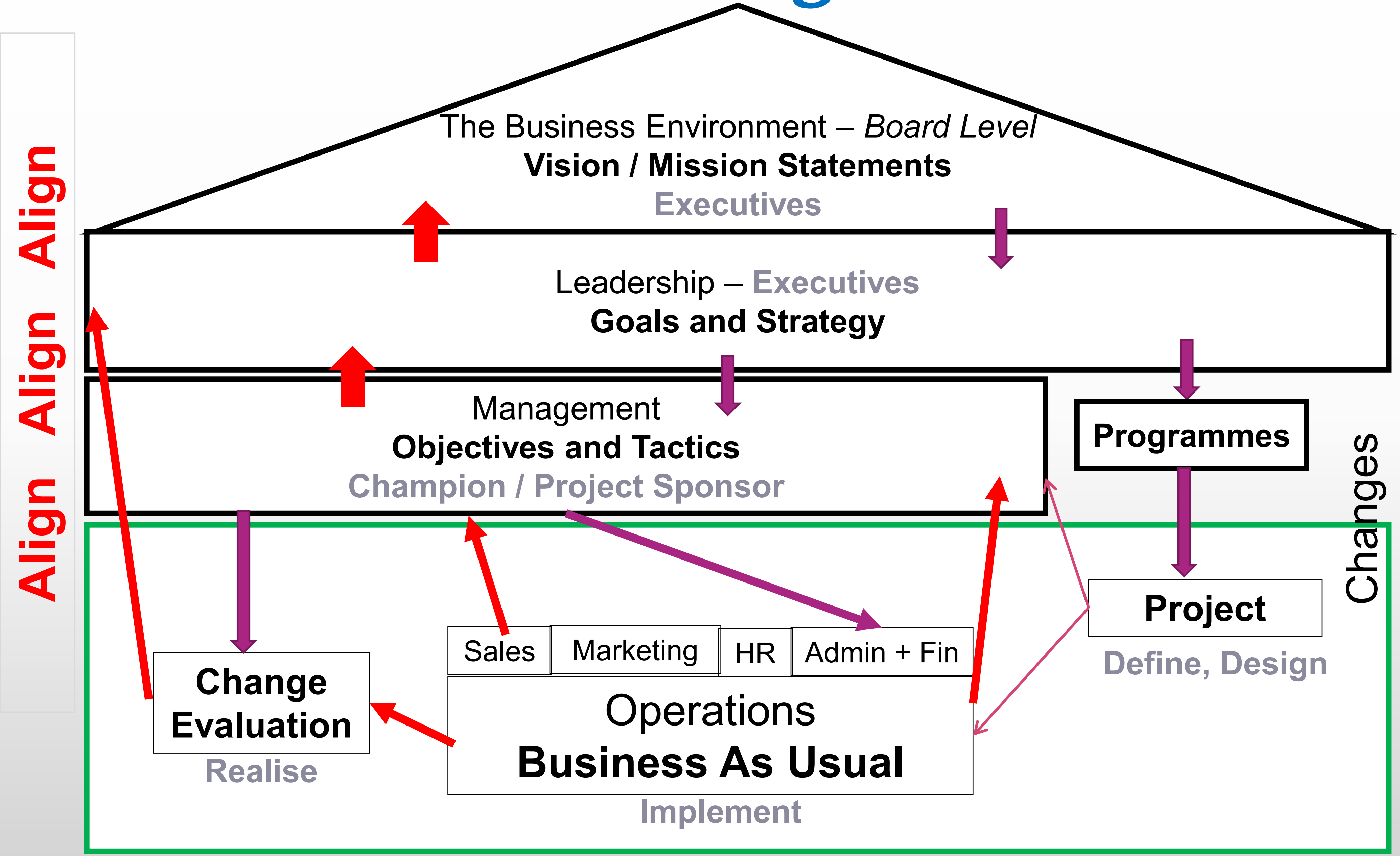
Hoshin Kanri (Policy Deployment)

All too often, the strategic direction of an organisation set by a company’s leaders (strategic) is distorted as it flows through middle management (tactical) down to the shop floor (delivery)

The ***Hoshin Kanri*** philosophy is about bringing all three levels into alignment

The approach helps to reduce the waste that comes from poor communication and inconsistent direction

The Lean Six Sigma Framework



Align Align Align

The Business Environment – *Board Level*
Vision / Mission Statements
Executives

Leadership – **Executives**
Goals and Strategy

Management
Objectives and Tactics
Champion / Project Sponsor

Programmes

Project
Define, Design

Sales | Marketing | HR | Admin + Fin

Operations
Business As Usual
Implement

Change Evaluation
Realise

Changes

Master Black Belt

- **Full time expert as a strategic consultant and adviser to the Executives**
- **Coach Black Belt**

Black Belt

- Full time and leading various programmes and projects
- Advise Champion
- Coach Green Belt

Green Belt

- **Lead projects in their area**
- **Report to Champion & BB**
- **Coach Yellow Belt**

Green Belt Agenda

Introduction to Lean Six Sigma ☑

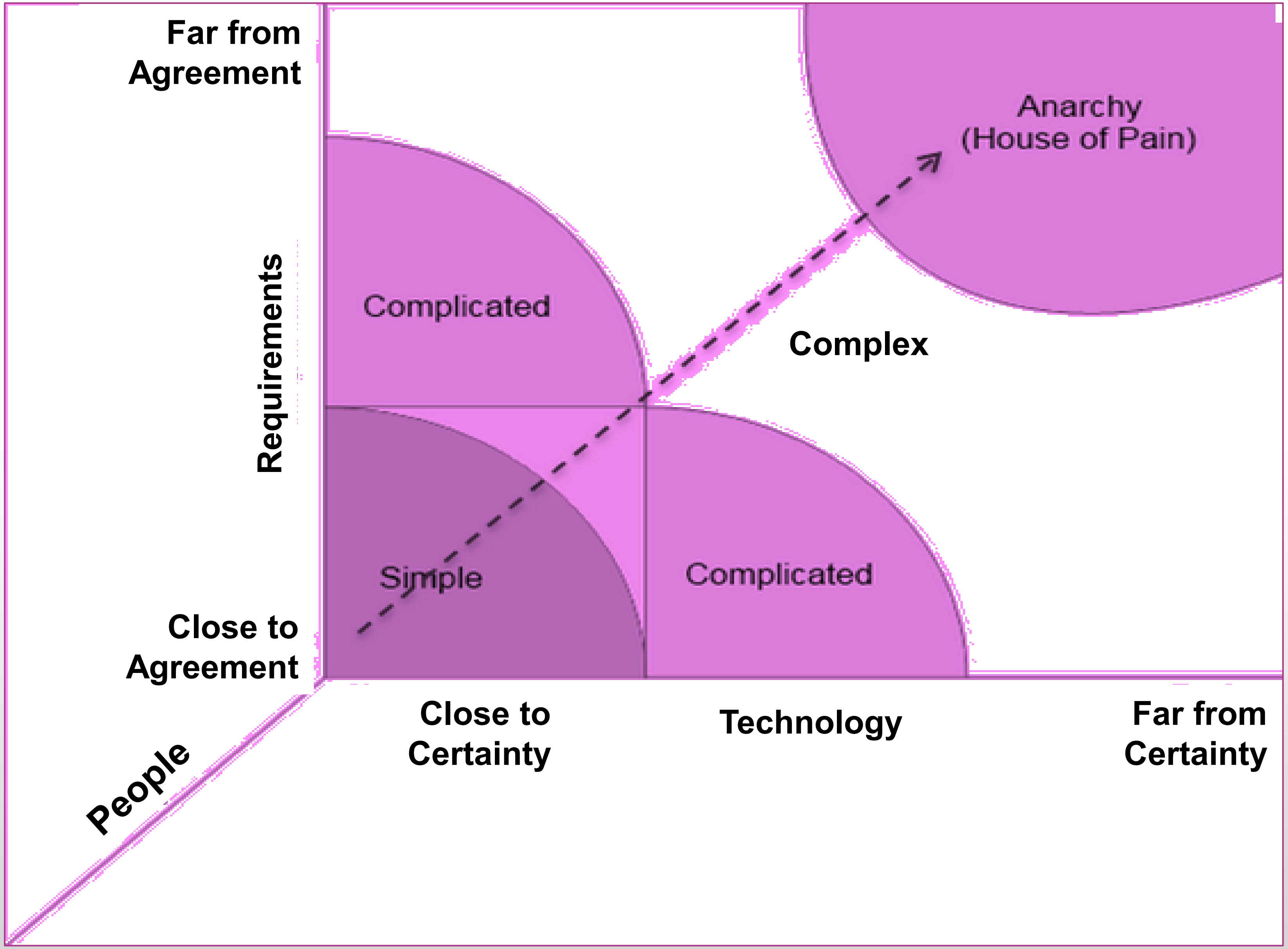
Some Problem Solving Methodologies

- Introduction
- 3 Cs
- 8 Ds
- Plan Do Check Act
- Kaizen
- DMAIC
- DFSS (using DMADV)

Project Selection (2)

DMAIC for Green Belts

Introduction to Problem Solving Methodologies



Project Prioritisation

- Impact on Customer
- Value to the business
- Resource availability
- Time to complete
- Current capability of the process
- A change in regulation
- Connection to key business priorities
- Current cost of dealing with failure

Introduction to Problem Solving Methodologies

Context	No problem, but an idea	Immediate problem	Simple problem requiring agreement	Problem requiring some analysis	Complex issues	Problem requires a new process and may involve strategic investment
Action	I have an idea	I know what I need to do quickly with little cost or changes	A simple problem for which an improvement is proposed	Jointly with people who work within the department or process	This is a project that requires a tooled methodology	This issue requires investment in a new product, service or process
Execution: Duration / No. of People	1 hour - 1 week	1 hour - 1 week	1 - 4 weeks	1 - 3 months	3 - 6 months	6 months - 3 years
	1 person	1 person	The team	3 - 7 people	4 - 10 people	> 20 people
Tools	Idea Management System	3C	8D / Kaizen / PDCA/PDSA	Kaizen	DMAIC	DMADV (DFSS)

Lean

Six Sigma & Lean Six Sigma

Problem Solving

3 Cs

Concern

- Identify and articulate what the problem is
- What needs to be addressed?
- e.g. Why are hotel bookings for missions delayed as at the time of arrival of staff?

Cause

- Identify what the root cause is
- Identify the best solution
- e.g. Staff do not submit required data with the requests to protocol

Correct (counter-measure)

- Implement the selected solution
- Maintain the implementation
- e.g. Design and enforce automated forms that ensures accurate data are collected

The 8 D's (*Eight Disciplines*)

D0
Prepare to solve the problem

D1
Establish the Team

D2
Describe the problem

D3
Develop an Interim Containment Action (band aid)

D4
Define/ Verify Root Cause

D5
Choose / Verify Permanent Corrective Action

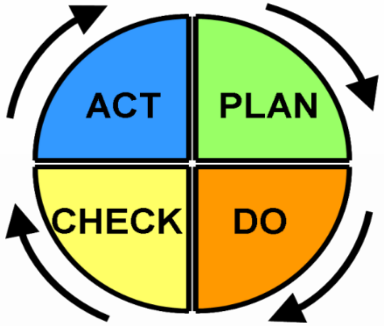
D6
Implement / Validate Permanent Corrective Action

D7
Prevent Recurrence

D8
Recognise and praise the Team

Developed at the Ford Motor Company, its purpose is to identify, correct and eliminate recurring problems so as to get a permanent resolution. These disciplines are performed within a control structure (for example you may perform D5 within the DMAIC Improve phase)

The PDCA Steps



Plan

- Develop a plan to address a problem or hypotheses
- Identify control points and control parameters
- The plan is reviewed and agreed

Act

- The results are analysed
- The causes of any differences between expected and actual results are identified, discussed and agreed
- If necessary, corrective action is identified which triggers another cycle (Plan)

Do

- The plan is carried out

Check (or Study)

- Information is collected on the control parameters
- The actual results are compared to what was expected

CHECK – did we achieve what was expected?

STUDY – what can be learnt from what was achieved to provide further help?

PDSA

Plan
Do
Study
Act

Kaizen

Kai + Zen (Continuous Improvement)

"Kaizen is...
Everyday
Everybody
Everywhere"

Masaaki Imai
1986

A philosophy of small improvements that involves any level of employees from top management to the lower cadre. The culture is driven so that area or people can be considered.

Individual philosophy:

Everyone is encouraged to come up with small improvement suggestions on a regular basis

Kaizen is based on making little changes on a regular basis and not major changes.
The emphasis is to always improve productivity, safety and effectiveness while reducing waste

An umbrella term covering several areas typically:

- An individual philosophy
- A team based improvement methodology (Kaizen Event / Kaizen Blitz)

Creating a Kaizen

1 month

Preparation

- Management team identify areas of waste in the process, identify resources needed to fix them and prioritise remedial actions (Kaizen Bursts)

0 – 2 days

Pre Kaizen

- Optional – only used in longer Kaizen Bursts

2 – 5 days

Implementation

- This is the Kaizen Event
- Solution Team work full-time on the problem

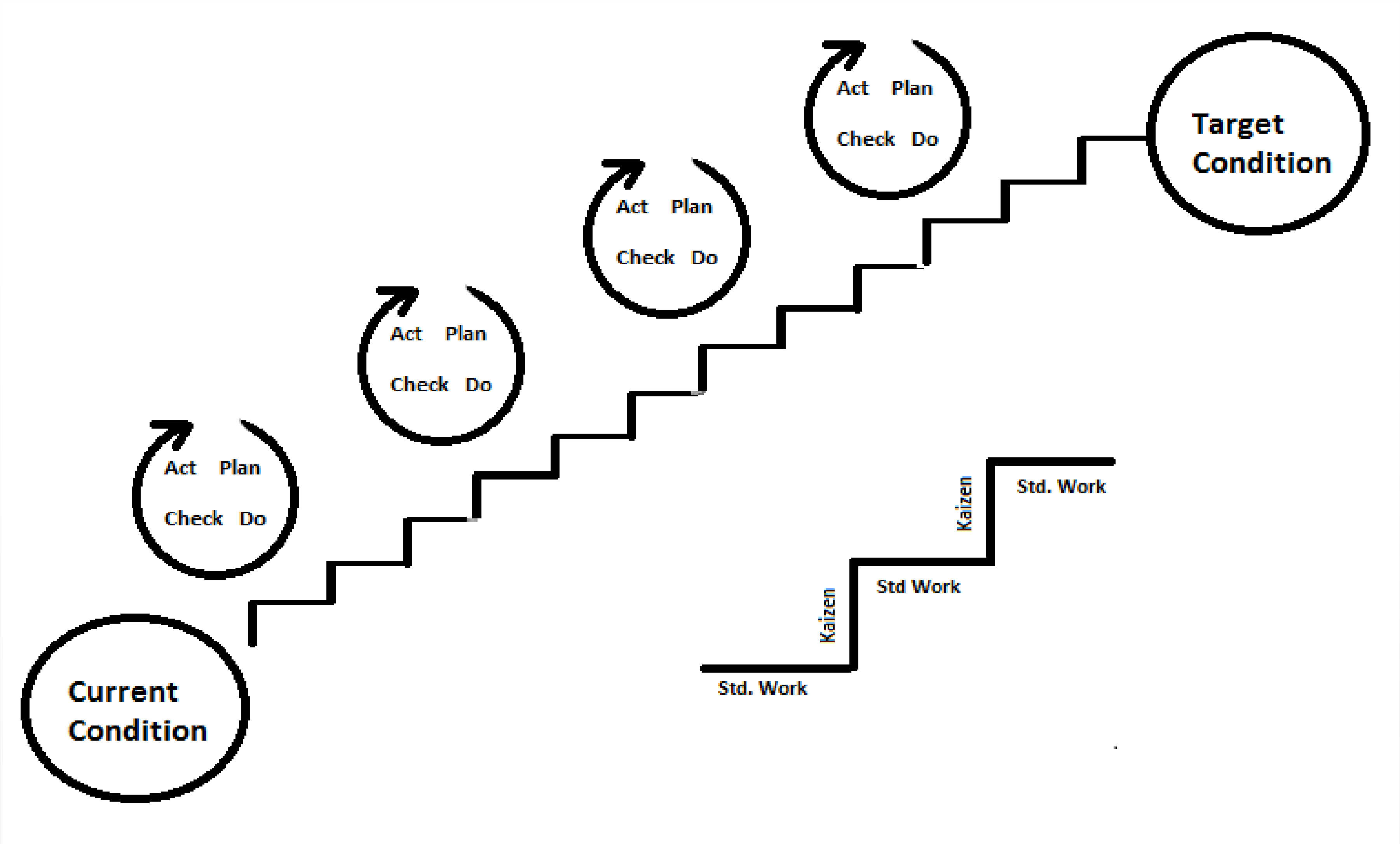
1 month

Follow-up

- Optional – used in longer Kaizens or where the solution cannot be completed within the timeframe of the Kaizen Burst

Kaizen is not suitable
when rigorous statistical analysis and data gathering needed

Continuous Improvement (Kaizen)



5-Day Kaizen Burst: An Example

Day 1 and 2 (Plan)	Kick-off (executive presence) Analyse current state Perform root cause analysis Design future state Interim briefing
Day 3 and 4 (Do, Check)	Design and test improvements Obtain buy-in Interim briefing
Day 5 (Check, Act)	Finalise improvements Train process workers and stakeholders Present results CELEBRATE!

Situations when you could consider deploying Kaizen Events

Need for solution is urgent

- *Competitive crisis*
- *High customer dissatisfaction*

Big impact projects

- *Significant impact on sales or profits*

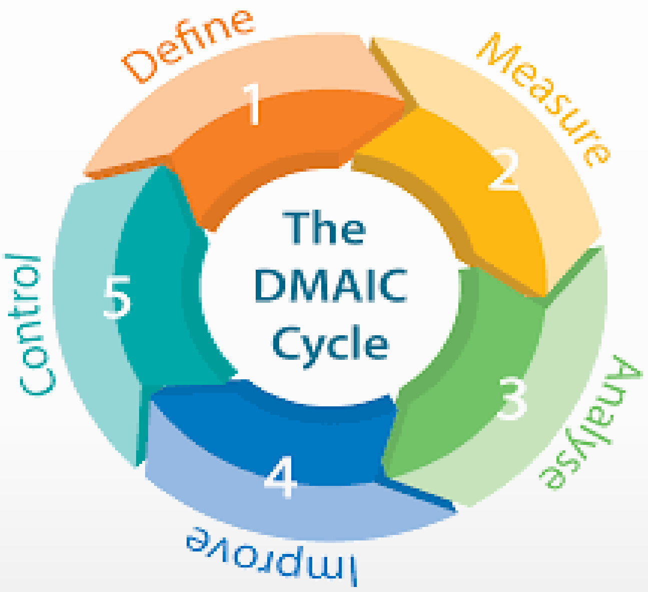
Bottlenecks

Relevant staff can be assigned full time for the event

The solution is capable of being generated by staff members and at least piloted within 5 days

- *Fully implemented within 30 days following*

DMAIC – a logical flow to problem solving



A 5-step methodology that provides a structured framework to improve an **existing** process

The DMAIC framework helps ensure that improvement projects:

- Are clearly defined
- Are clearly implemented
- Have their results embedded in standard operations

Lots of waste!

Less waste!

A View of the DMAIC Phases

DEFINE

- Establish the project (get the team together and agree governance)
- Define the problem (Set the scope of the project)
- Talk to Customers and seek to understand their needs from the processes under investigation

MEASURE

- Collect data about the process being investigated
  - Create a Data Collection Plan and Data Collection Forms
- Illustrate how the process is now (‘As Is’)

ANALYSE

- Analyse the data (probably using statistical tools)
- Determine genuine areas of waste and their root causes
- Illustrate how an improved process would look (‘To Be’)

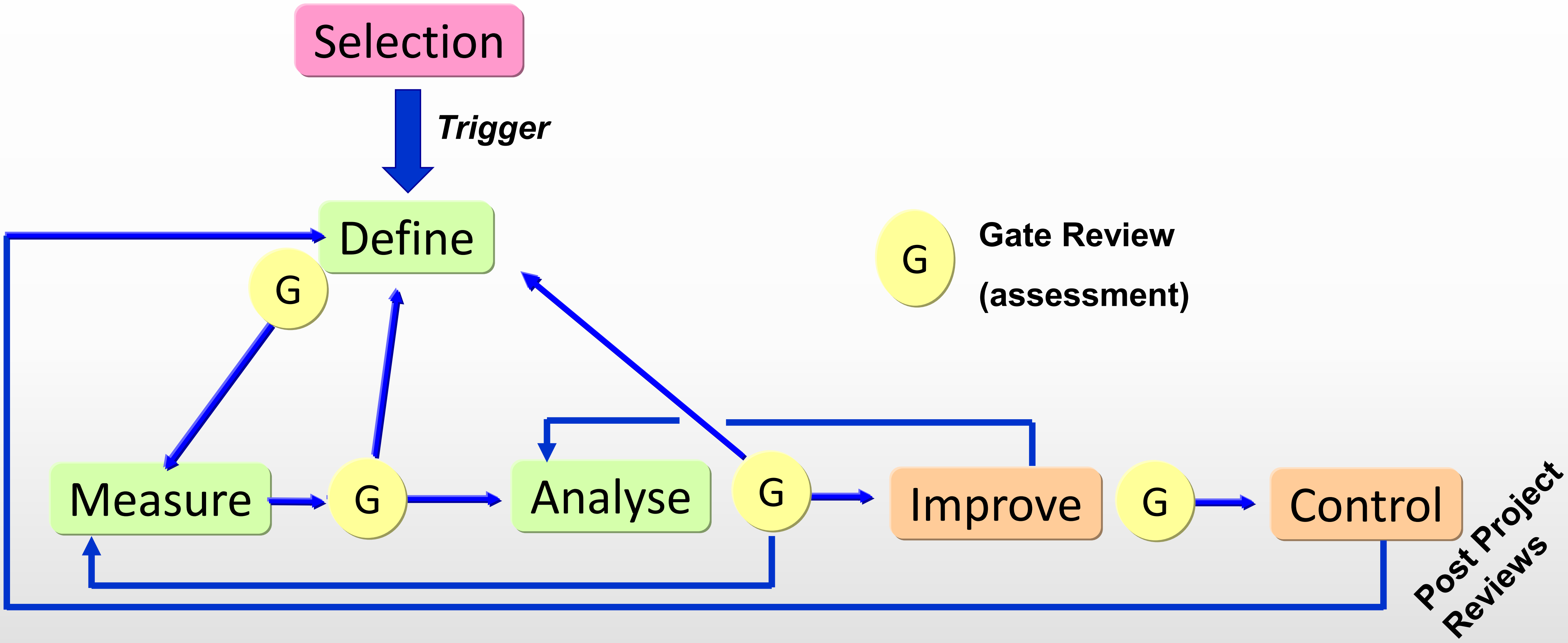
IMPROVE

- Select, trial and implement solutions
- Create a Control Plan

CONTROL

- Close the improvement project
- ‘Sustain the change’ – monitor the improved process (if performance degrades, this triggers corrective action)

DMAIC is not necessarily a straight sequence



Selection

Trigger

Define

Measure

Analyse

Improve

Control

G

G

G

G

G

Post Project Reviews

G **Gate Review**

(assessment)

Questions to Answer at a Review

Is the project still likely to deliver a worthwhile result?

Is it forecast to end on time?

- If not what is the new projection?

Is the cost forecast still ok?

What is the updated status of the business risk?

What other significant risk is there?

How are these risks being handled?

Any barriers to successful conclusion – particularly political ones?

How is the team getting on?

What are the next steps?

Schedule 15-90 mins for this (keep the meeting lean and light)

Avoid meeting overrun

Some people use power point slides and either present them or e-mail them out

Gateways / End term assessments

It is sensible to review a project from time to time to see if all is well and if it should continue

- Often called ‘Tolls’, ‘Tollgates’, ‘Gates’ or ‘Gateway’ reviews
- A logical place for this in DMAIC is at the end of each phase

At this time those running the project should discuss the state of the project with the sponsors of the project

If you are running the project as a GB then your sponsors are likely to be your local champion and perhaps your manager and also your Black Belt

DFSS: Design For Six Sigma

Six Sigma is a process ***improvement*** methodology

DFSS is not as widely embraced as Six Sigma but still very popular

The most common methodology quoted for DFSS is DMADV

DFSS is complimentary as it is **focused on designing new products/services to Six Sigma quality** levels instead of improving something already in existence

DFSS is a framework which describes what a methodology needs to do to create high quality processes from scratch

DMADV

Define
Measure
Analyse
Design
Verify

3 Basic Approaches to Improvement Project Selection

Blatantly Obvious

Things that clearly occur on a repetitive basis and present problems in delivering our service(s) or product(s)

Brainstorming Approach

Identifies projects based on individual's "experience" and "tribal knowledge" of areas that **may** be creating problems in delivering our service(s) / product(s) and **hopefully** tie to bottom-line business impact

Structured Approach

Identifies projects based on organisational data providing a direct plan to effect core business metrics that have bottom-line impact

All three ways work… but the Structured Approach is the most desirable

Typical Improvement Project Areas (Services)

Process Area	Example of Pain
Change Requests Management	Uncontrolled influx of Change Requests, no impact assessment
Customer Relationship Management	Prioritisation, lack of follow-up, poor communication, long cycle time
Help Desk / Contact Centre	Wrong information, long cycle time, customer dissatisfaction
HR and Recruitment Process	Skills mismatch, wrong recruitment, breach of policies, non compliance with regulations
Incident Management	Wrong fixes, long cycle time, customer dissatisfaction
Invoicing, Billing, Cash Collection	Delays in cash collection, revenue leakage, incorrect bills
Project Management	Inaccurate estimates, inaccurate reporting, missed targets, waste, excessive resource consumption, high costs
Release Management	Inconsistencies, defects, no flexibility, lack of prioritisation
Sales and Business Development	Low hit rate of client proposals, long cycle time
Service Delivery	Poor quality (defects), long cycle time, high cost
Service Portfolio Management	Wrong prioritisation, no optimisation unclear requirements
Service Requirements & Design	Incorrect, ambiguous or missing requirements
Service Resources & Asset Management	High cost, excessive resource consumption, lack of optimisation, waste
Service Transition	Poor quality (defects), long cycle time, high cost
SLA Management	Systematic breaach of SLA, penalties and compensations
Software Development	High number of software defects, high testing costs, poor quality of requirements, ineffective verification activities

Project Selection – 3 Core Components

Business Opportunity

The Business Opportunity is a high-level articulation of the area of concern. This answers two primary questions;

- What is the business motivation for considering the project?
- What is our general area of focus for the improvement effort?

Project Charter

The Project Charter is a more detailed version of the Business Opportunity. This document further focuses the improvement effort. It can be characterised by two primary sections

- Basic project information
- Simple project performance metrics

Benefits Analysis

The Benefits Analysis is a comprehensive financial (or non-financial) evaluation of the project. This analysis is concerned with the detail of the benefits in regard to cost and revenue impact we are expecting to realise as a result of the project

Green Belt Agenda

Project Selection ☑

Some Improvement Methodologies ☑

DMAIC for Green Belts

- Define Phase
- Measure Phase
- Analyse Phase
- Improve Phase
- Control Phase

DMAIC

- ***Define***
- Measure
- Analyse
- Improve
- Control

Define

DEFINE

What exactly is the issue and can we deal with it

MEASURE

ANALYSE

IMPROVE

CONTROL

Objectives

- Provide clarification on what the problem is
- Generate the initial documentation
- Form the improvement team
- Create a high level process map
- Identify stakeholders and define the VoC

Outcomes

- Team formed and Team charter in place
- Customer requirements understood (CTQ’s established)
- Project charter (including Problem Statement, Goal Statement and Opportunity statement
- Process scoped at high level (SIPOC)

Project Charter

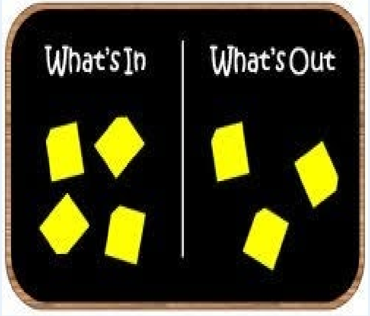
A Project Charter is a living document that outlines the issues, targets and framework for working on a process improvement

Team Development

Those who will participate on the project

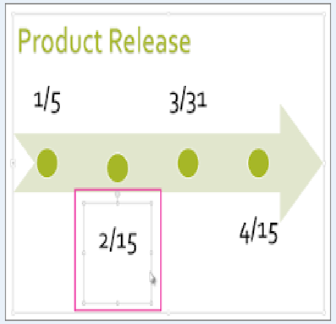
Problem Statement

The problem captured - make it measurable



Scope

What areas the project will cover and what is excluded



Business Opportunity

State the business reasons for fixing the issue

Goal Statement

The SMART target to achieve the improvement

Timeline

When varied deliverables will be attained

Project Charter – Focus and Direction for a Team

Aids in communicating the purpose of the team
(why are we doing this?)

Clearly communicates the scope
(what is in / what is out)

Aids in team design and selecting participants
(do we need specialists?)

Helps to clarify roles and responsibilities

Clearly defines expected accomplishments
(benefits)

Outline approach the team will use
(get validated by a champion or BB)

The charter is a teams' blueprint for success

Lists specific deliverables
- Review charter regularly at weekly progress meetings
- Start reviewing plans

Setting up the Team

Always include people from the 'grind'

- Those doing the work are usually best placed to work out how to improve it
- For a team to achieve its broad goals it must have members who are experts in the critical spheres of the project

Try to get the correct mix of personalities

See Annex for Belbin Team Roles

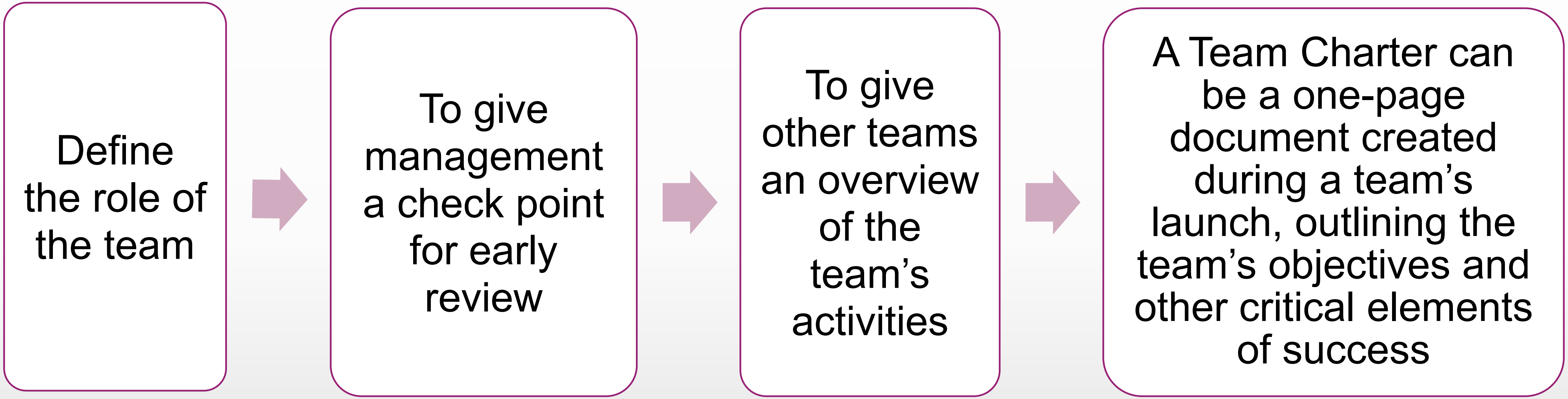
The aim is to develop a High Performing Team (HPT)

When setting up the team, ensure that the individuals are well-skilled – all too often we get whoever is free, or easy to do without, instead of the real experts we need

Typical Team Roles

Team Role	Attributes
Sponsor	• Defines the scope and goals of the project • Makes available the essential resources required by the team to work effectively • Monitors and controls the progress of the team
Team Leader/ Facilitator/ Coordinator	• Motivates, guides and helps the team to stay focused • Supervises team performance • Responsible for carrying out productive team meetings • Ensures the administration and documentation of the team’s activities team • Ensures responsibility for specific tasks are adequately allocated among team members • Assists in avoiding and resolving conflicts
Coach	• Coordinates with the team leader and facilitator to help the team function adequately • Assists team members in fulfilling their obligations by deploying relevant skills
Team Member	• Participates in team meetings and shares their own views • Use own expertise to accomplish assigned tasks

Team Charter



Define the role of the team

To give management a check point for early review

To give other teams an overview of the team's activities

A Team Charter can be a one-page document created during a team's launch, outlining the team's objectives and other critical elements of success

Keep it Lean
Keep it light!

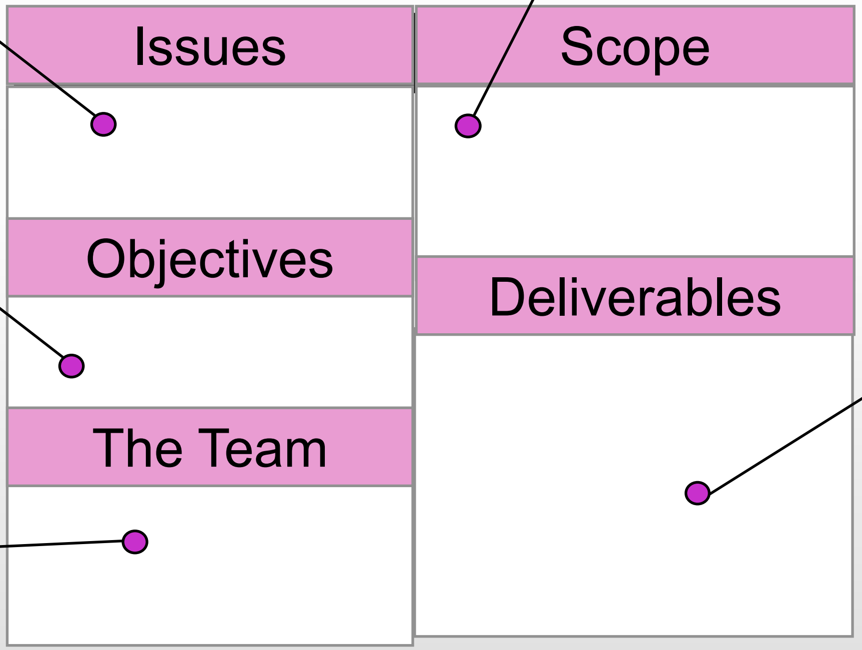
A Simple Team Charter Format

What is it that the team is trying to address?

e.g. The delivery of accurate reports, with data from various sources

Clearly defines what the team is to do (and NOT to do!)

e.g: The team will ensure that reporting database is available to respective project managers who are trained to input the data, but it will not verify the data sources



The aims of the team

e.g.to deliver respective accurate project reports within three months of year end

What will be the output/outcome of the team's work?

E.g.	Established reporting database
	Redesigned process
	OTGIs + training

Identifies the key people who need to be involved and allocating defined roles, as appropriate

e.g: Leader, Facilitator etc

- **Single piece of paper (can be large)**
- **Keep it up to date**
- **Can add other sections if you wish**

Features of a Lean Six Sigma Team

Small teams

(no more than 9 people)

Self directed

Self-motivated

Elected Coordinator

can vary

Demonstrate control – but using a lean (simple, minimalist, informal) control structure

Rich, informal communication

Whole team focusses on the ***High Performance Challenge***

A different philosophy of working as a team which supports the concepts of 'empowerment' and 'transparency'

Managing Progress and Demonstrating Control

Why?

- Teams are self-directed and autonomous
- However, control and direction are still necessary
- It is the responsibility of the Team Sponsor to satisfy themselves that the team is in control

How?

- Use of Team / Kanban Board
- Daily stand-up
- MoSCoW prioritisation

Team Boards

Contain relevant information to allow the team to understand and perform their work

Allow them to track trends

Pick up on waste

Simple graphical information

☐ The Board belongs to the team

☐ Makes a topic of conversation!

☐ Boards need to be accessible and close to the workplace

☐ Visual management boards do not have to look beautiful

Team/Kanban Board

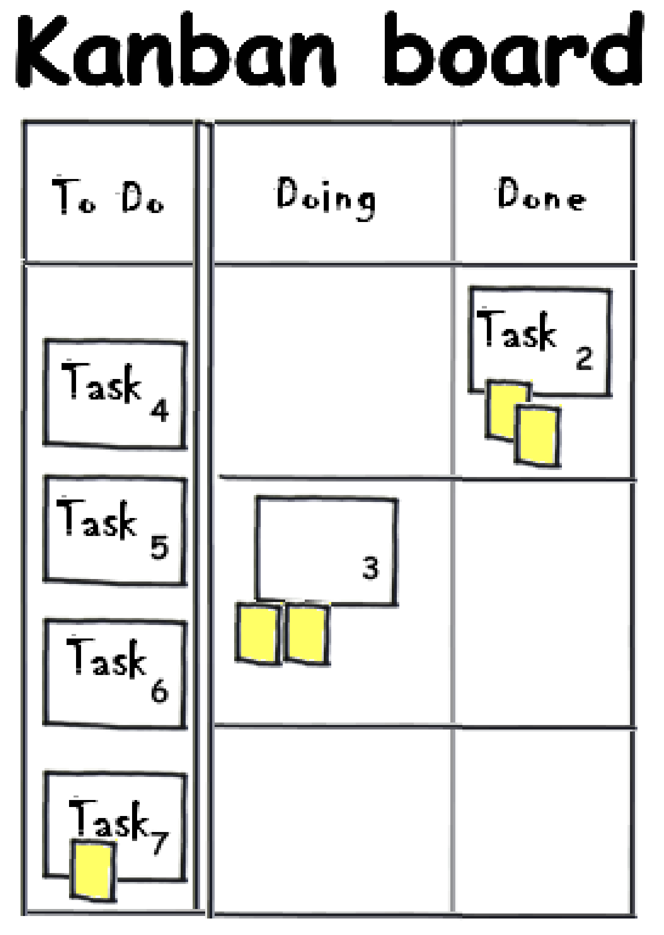
Visually illustrates the progression of tasks

Simplest version shown, however you may want to add extra columns depending on your business environment

- Signed off
- Passed User Acceptance Testing
- Shipped
- Etc

Tasks can be prioritised perhaps using MoSCoW

Can be part of the Team Board



Visual Management

See it together as a Team

Understand it together as a Team

Act together as a Team

A Visual Workplace (Visual Management) enables a team to effectively manage its processes with clear **VISUAL COMMUNICATIONS** that **ALL TEAM MEMBERS** can clearly see!

- Can we all clearly see when we have downtime issues?
- Can we all clearly see when there is an accident?
- Can we all clearly see what our team performance is?
- Can we all clearly see the state of our tools & supplies?
- Etc…

Daily Stand-ups

Ideally scheduled first thing daily

- ***All*** Team Members attend
- Wider stakeholders (including Leaders) can attend as non-participating observers

Each team member has ***2 minutes*** to report to the group:

1. Work and activities performed since last meeting
2. Work and activities planned for the next period
3. Any potential barriers to individual or team progress

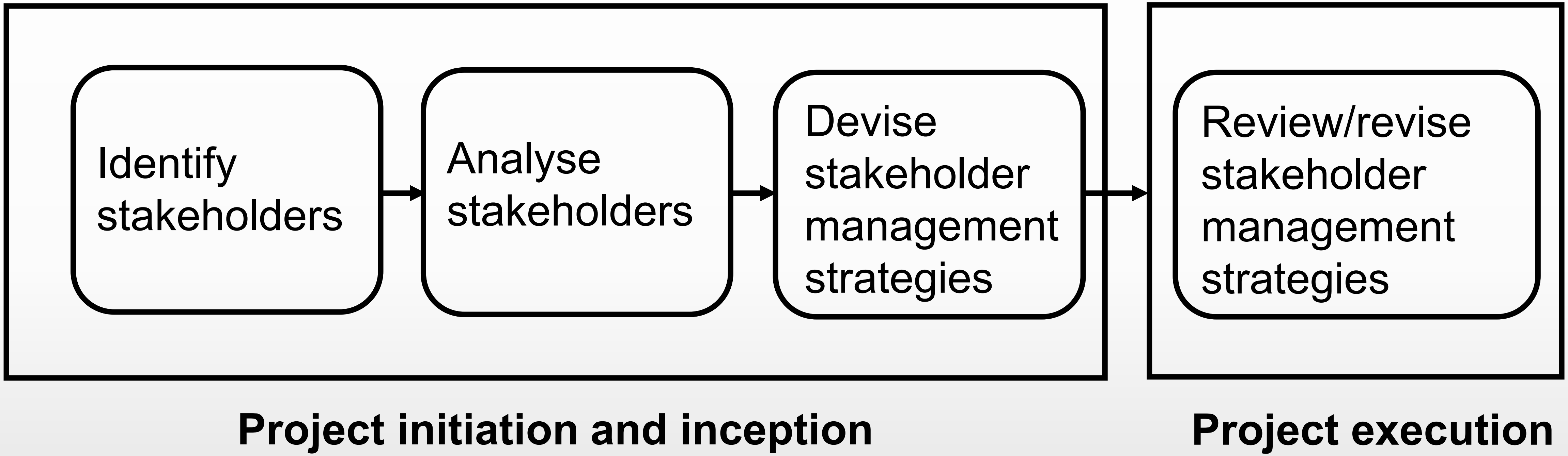
- Additionally – group leader sums up

Short and focused

- No discussions (these can happen *after* the stand-up ends)

Stand-ups maintain progress, demonstrate control and improve team integration and morale

Stakeholder Management in the Project Lifecycle



Identify stakeholders

Analyse stakeholders

Devise stakeholder management strategies

Review/revise stakeholder management strategies

Project initiation and inception

Project execution

Stakeholder Analysis

Stakeholders are those who have an interest in, or may be affected by, the issue under consideration. They may be internal to an organisation or operate externally to the organisation.

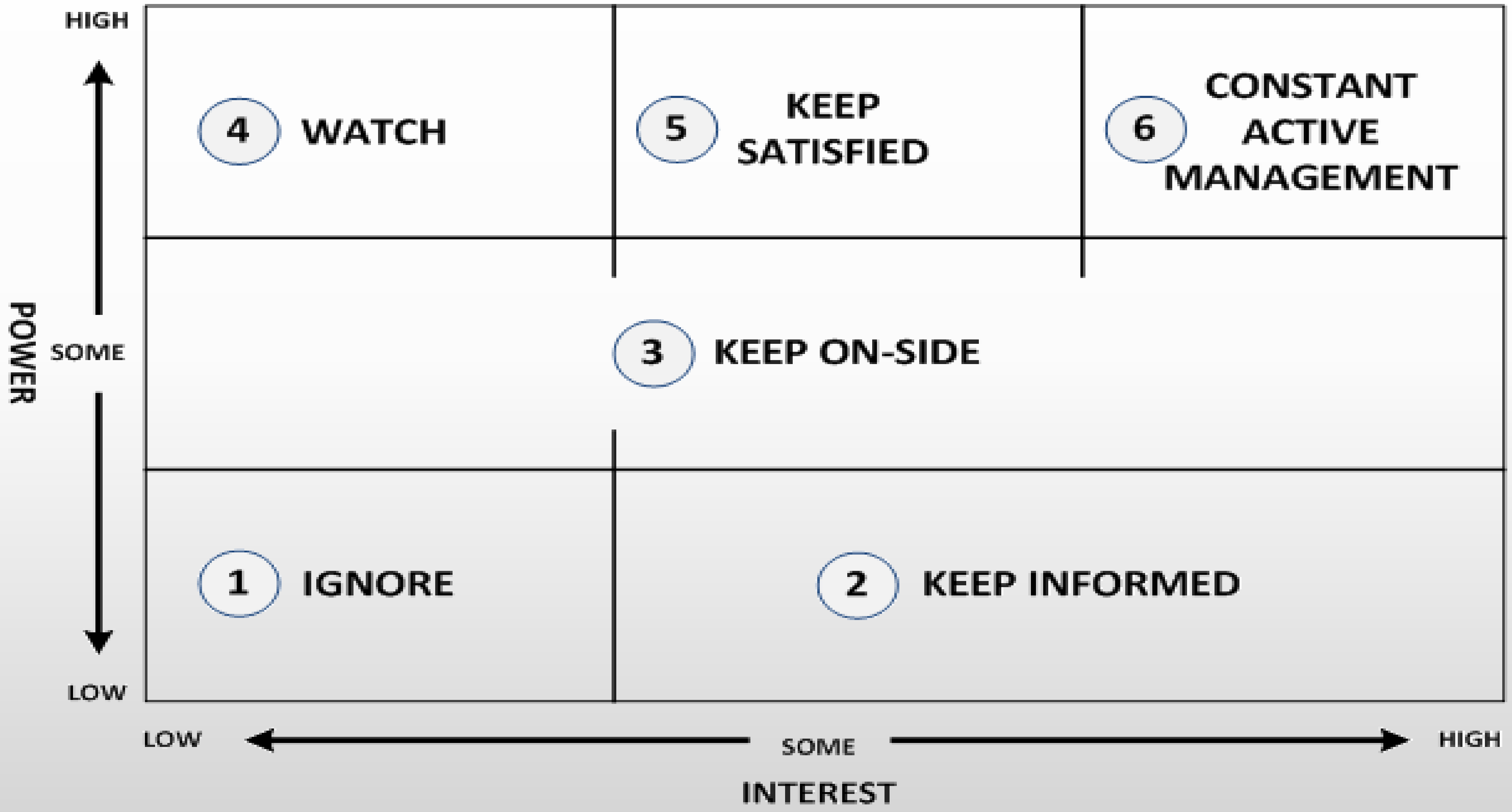
Many change programmes fail because stakeholders are viewed as being internal only, but changes can affect suppliers, customers, local business, transport systems, etc.

Partners are other organisations that provide services on our behalf, e.g. call centre services.

Suppliers are other organisations that provide our organisation with the goods and services we need.

Owners may be those who directly own the organisation, or as in the case of a plc, proxy owners such as fund managers in pension companies.

Stakeholder Management Strategies



HIGH

SOME

LOW

POWER

4 WATCH

5 KEEP SATISFIED

6 CONSTANT ACTIVE MANAGEMENT

3 KEEP ON-SIDE

1 IGNORE

2 KEEP INFORMED

LOW

SOME

HIGH

INTEREST

RACI / RASCI

R	Who is **R**ESPONSIBLE	The person who is **assigned** to do the work.
A	Who is **A**CCOUNTABLE	The person who takes the **final decision** and has **ultimate ownership**.
S	Who is **S**UPPORTED	The person who supports like an external consultant
C	Who is **C**ONSULTED	The person who must be consulted **before** a decision/ action is taken.
I	Who is **I**NFORMED	The person who must be informed **about** the decision/ action taken.

Example of a Basic GB Project – Communication Plan

COMMUNICATION PLAN

Stakeholder/ Stakeholder Group	**Objectives (Actions Desired)**	**Message Content**	**Delivery Method(s)/Venues**	**By When (Frequency)**
Shift Supervisors	Inform of project findings, create buy-in and ownership, participate in rollout	Results of Design of Experiments (DOE), solutions selected	Schedule meeting	15 each month starting March
Staff	Inform of project findings, instil confidence in team and process changes	Results of Design of Experiments (DOE), solutions selected	Schedule meeting	15 each month starting March
Chef	Inform of project findings, create buy-in and ownership, participate in rollout	Pilot results, training and implementation plan	Share at staff meeting	Attend all staff meetings
Prep Kitchen Staff	Inform of project findings, create buy-in and ownership, participate in rollout	Pilot results, training and implementation plan	Share at staff meeting	Attend all staff meetings
Purchasing	Purchase new packaging materials	Purchasing changes and execution dates	Email	By June first
Pick-Up Cashiers	Inform of project findings, create buy-in and ownership, participate in rollout	Pilot results, training and implementation plan	Share at staff meeting	Attend all staff meetings

Why People Resist Change

They don’t see the problem

They see the problem but don’t see the solution

They see the problem but don’t agree with the solution

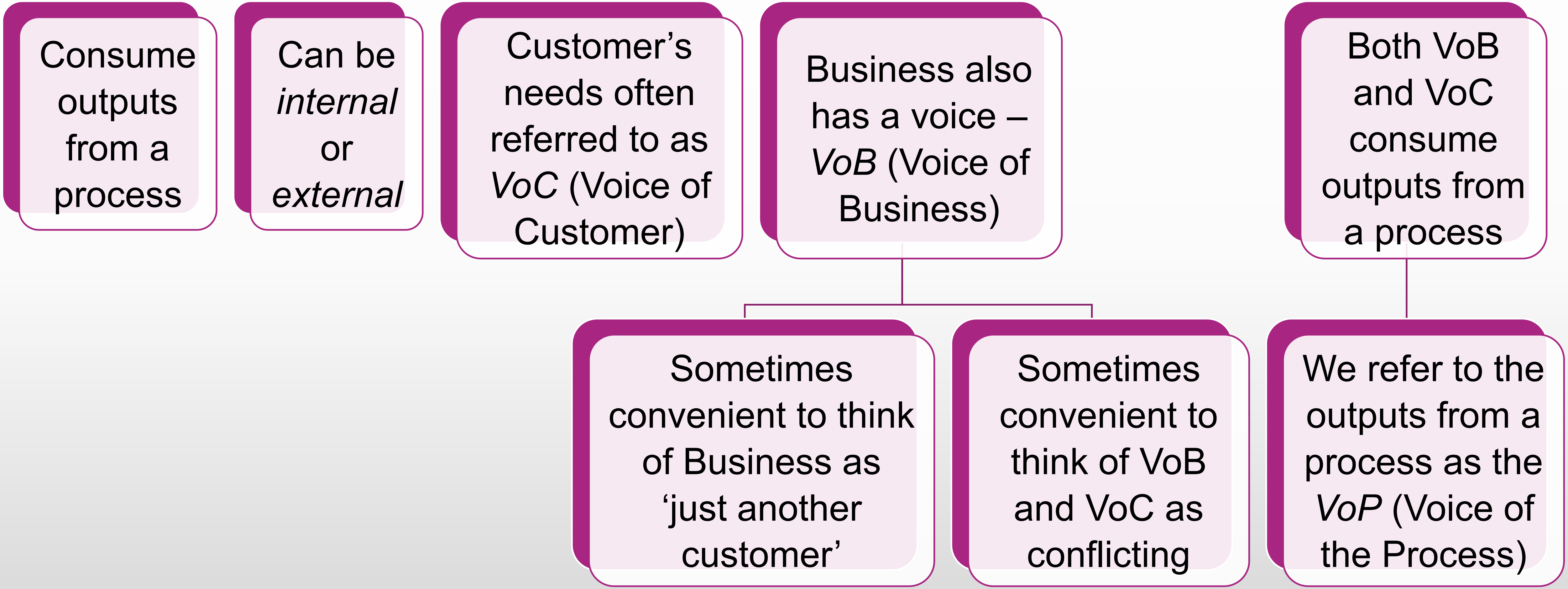
They see the problem but actively resist the solution (perhaps because they didn’t think of it?)

They see the problem and the solution but are afraid of the consequences of the solution and its impact on them

They don’t care – or think they don’t

The task is to help the person who is resisting change to express their concerns directly

What are Customers?



Consume outputs from a process

Can be *internal* or *external*

Customer’s needs often referred to as *VoC* (Voice of Customer)

Business also has a voice – *VoB* (Voice of Business)

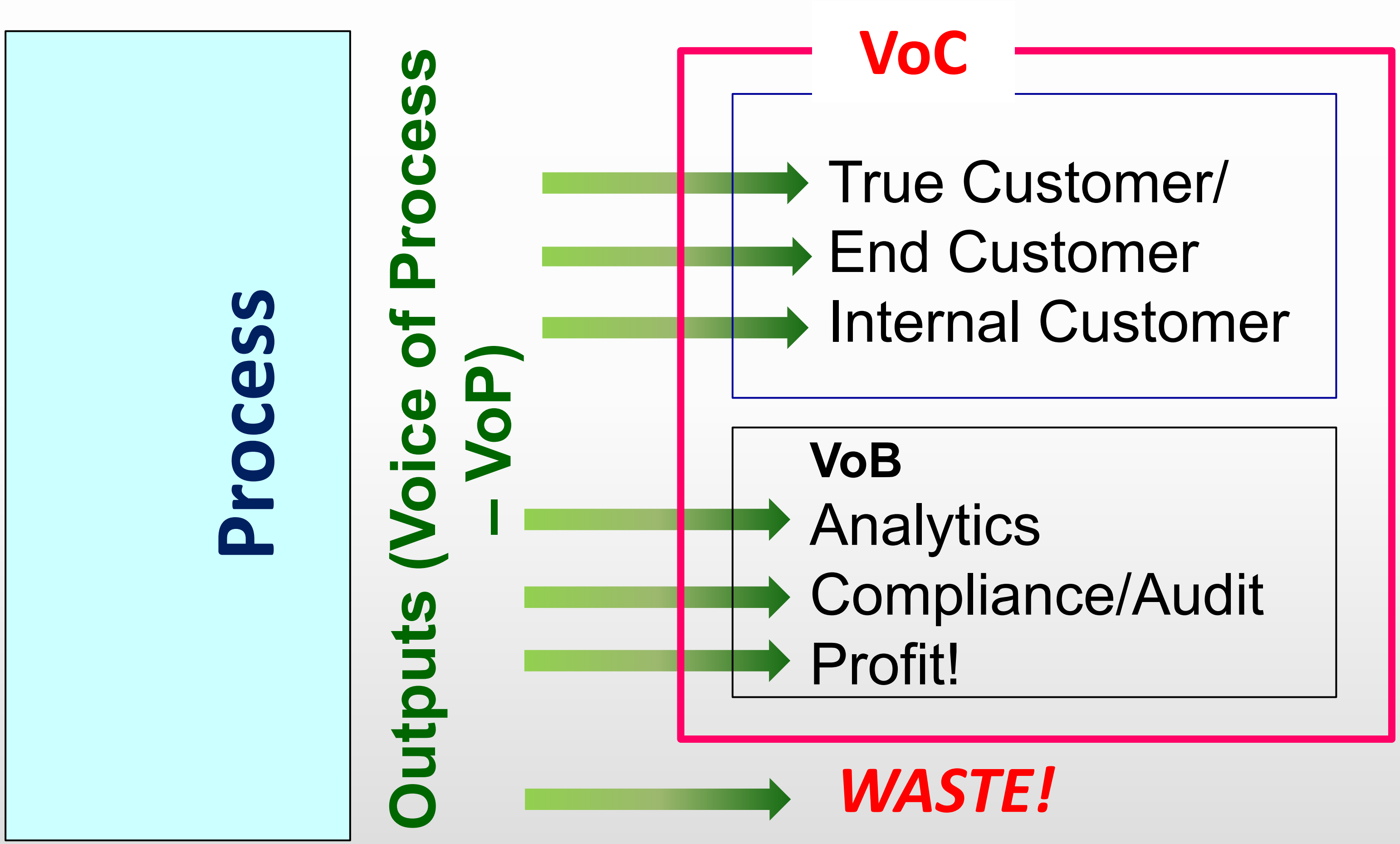
Both VoB and VoC consume outputs from a process

Sometimes convenient to think of Business as ‘just another customer’

Sometimes convenient to think of VoB and VoC as conflicting

We refer to the outputs from a process as the *VoP* (Voice of the Process)

Who wants the Outputs?



Process

Outputs (Voice of Process – VoP)

VoC

True Customer/
End Customer
Internal Customer

VoB
Analytics
Compliance/Audit
Profit!

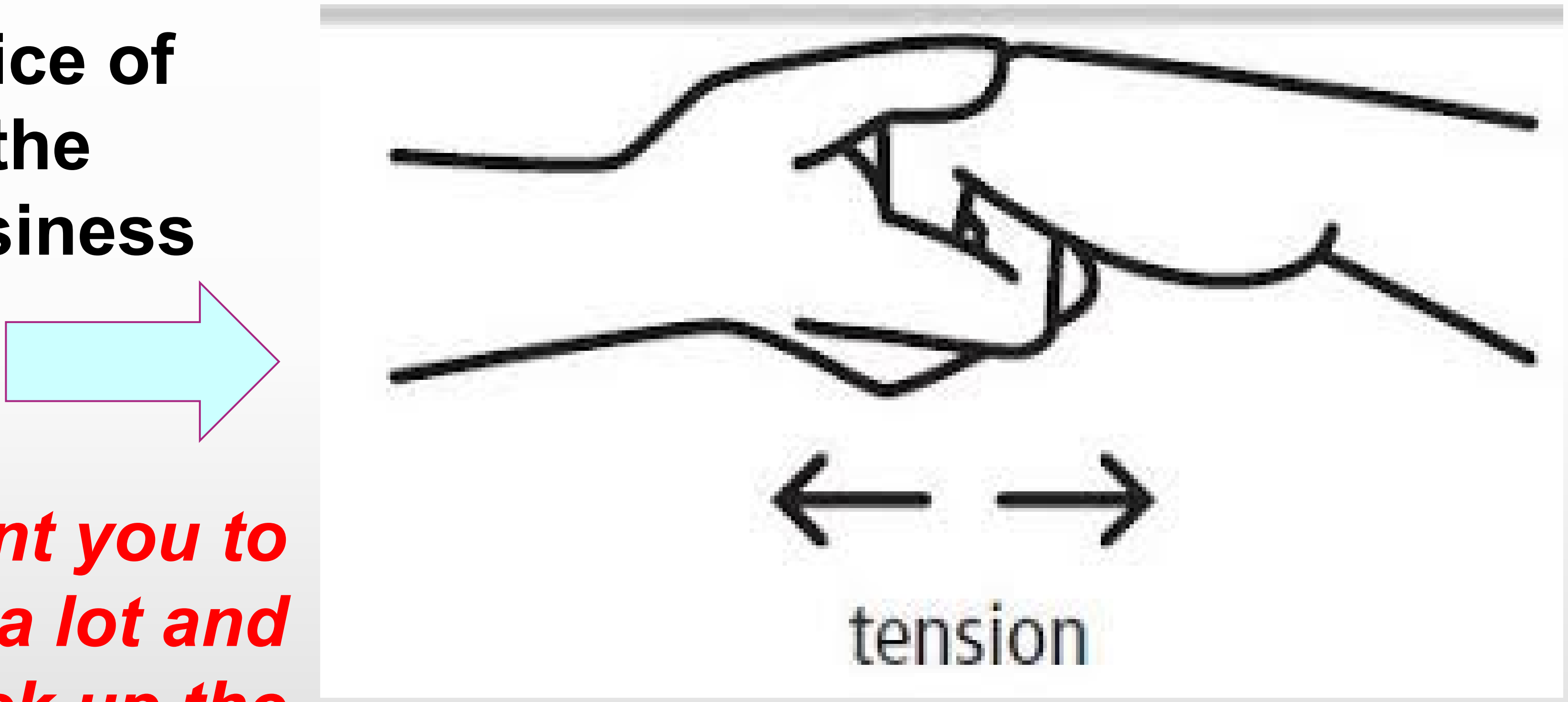
WASTE!

A customer takes an output from a process. This can be either ‘proper’ customers, downstream colleagues, business intelligence or regulatory compliance etc.

There is always tension between the VoB and VoC

Voice of the Business

"I want you to pay a lot and pick up the goods yourself!"



Voice of the Customer

"I want high quality goods, delivered immediately at a low cost."

What do we mean by Value?

A customer is willing to pay for it

- This can be VoC or VoB

A feature that a customer finds worthwhile or useful

- But they need to be able to afford it

Value is often categorised as follows:

Value term	What it means
Value Added (VA)	This feature, task, process step or output is worthwhile in the view of the customer and they would be willing to pay for it
Business Non-Value Added (BNVA)	This feature, task, process step or output is worthwhile in the view of the Business (it is necessary in some way to run efficiently or legally etc), but it does not directly add value in the eyes of the customer
Non Value Added (NVA) [Waste]	Neither Business nor Customer judges this feature or task or output as worthwhile

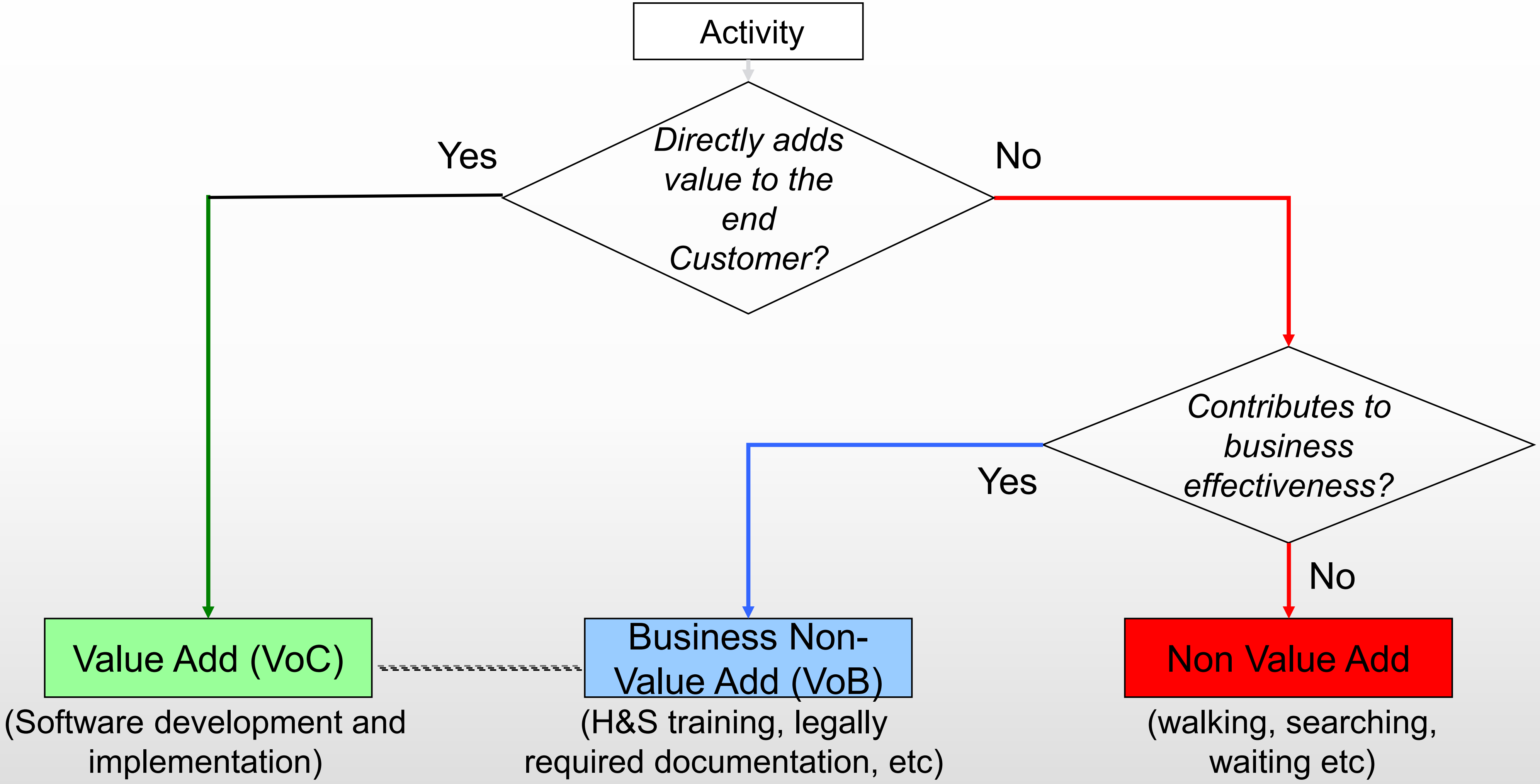
Maximise it!

Minimise it!

Remove it!

DEFINE

The Path to Value



Activity

Directly adds value to the end Customer?

Yes

No

Contributes to business effectiveness?

Yes

No

Value Add (VoC)

(Software development and implementation)

Business Non-Value Add (VoB)

(H&S training, legally required documentation, etc)

Non Value Add

(walking, searching, waiting etc)

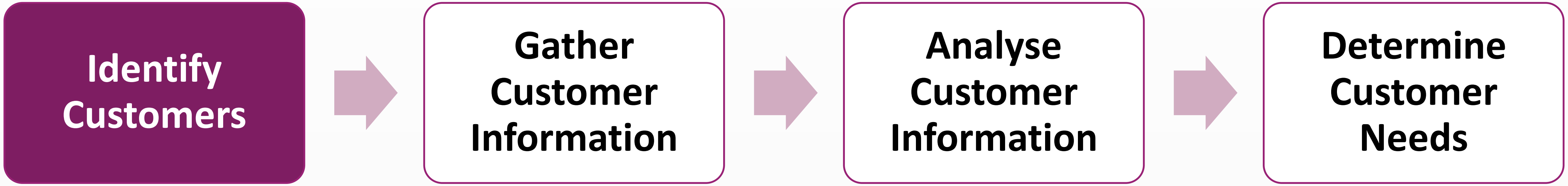
The key question to always ask is 'Would my customer pay for this?'

DEFINE

4 Steps of the VoC Methodology with Associated Tools

	1	2	3	4
	Identify Customers	**Gather Customer Information**	**Analyse Customer Information**	**Determine Customer Needs**
Tools	• **Customer Segmentation**	• **Listen to people** • **Observe their actions**	• **Affinity Diagram** • **KANO**	• **CCR/CTQ/** • **Requirements**
	Step 1: Developing customer-focused business strategy *To develop a customer-focused business strategy requires:* ▪ An assessment of the business needs ▪ The identification of customer segments	**Step 2: Listening to the VoC** *To obtain useful and valid customer information and feedback requires:* ▪ Selecting research methods to gather customer information ▪ Probing for complete understanding	**Step 3: Translating VoC to CCRs** *Translating the VoC into Critical Customer Requirements (CCRs) requires:* ▪ Organising and verifying customer needs data into CCRs ▪ Determining CCR priorities ▪ Identifying CCR measurement and targets	**Step 4: Developing Measures and Indicators** *Translating the CCRs into input, process and output indicators requires:* ▪ Identifying and selecting output indicators ▪ Establishing targets ▪ Determining process characteristics

VoC Step 1: Identify Customers



Identify Customers

Gather Customer Information

Analyse Customer Information

Determine Customer Needs

Tools:	Customer Segmentation
	Customer Archetype

Customer Segmentation

It is rare to have only one customer: each has their own voice

Some areas to identify

Interest area?

- Business, Consumer, compliance, etc.

Age?

Background?

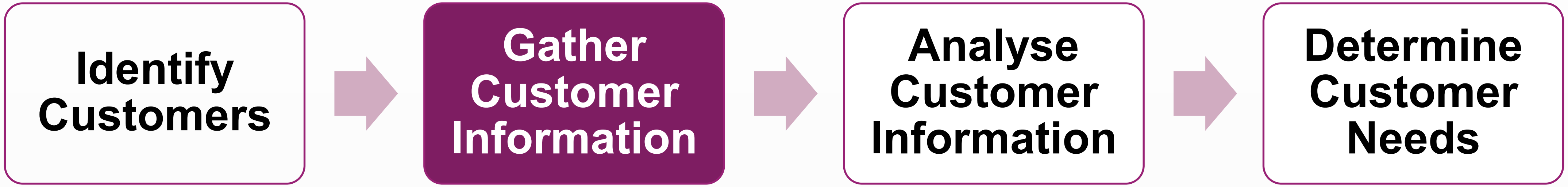
Criticality of supply?

Frequent / heavy user?

Casual / contractual

Customer Segmentation is splitting customers into groups according to different needs, behaviours etc…

VoC Step 2: Gather Customer Information



Identify Customers → **Gather Customer Information** → **Analyse Customer Information** → **Determine Customer Needs**

Objectives:	Identify and acquire relevant, topical and accurate information about the customer
Tools:	Observation Customer information sources

Example of customer information sources

Sources of Customer Information

Research Methods

- Interviews
- Focus groups
- Surveys
- Observations

Listening Post

- Complaints
- Customer service representatives
- Sales representatives
- Billing
- Accounts receivable
- Collection

Internal & External Data

- Existing company information
- Industry experts
- Secondary data
- Competitors

VoC Step 3: Analyse customer information

Identify Customers → Gather Customer Information → **Analyse Customer Information** → Determine Customer Needs

Objectives:

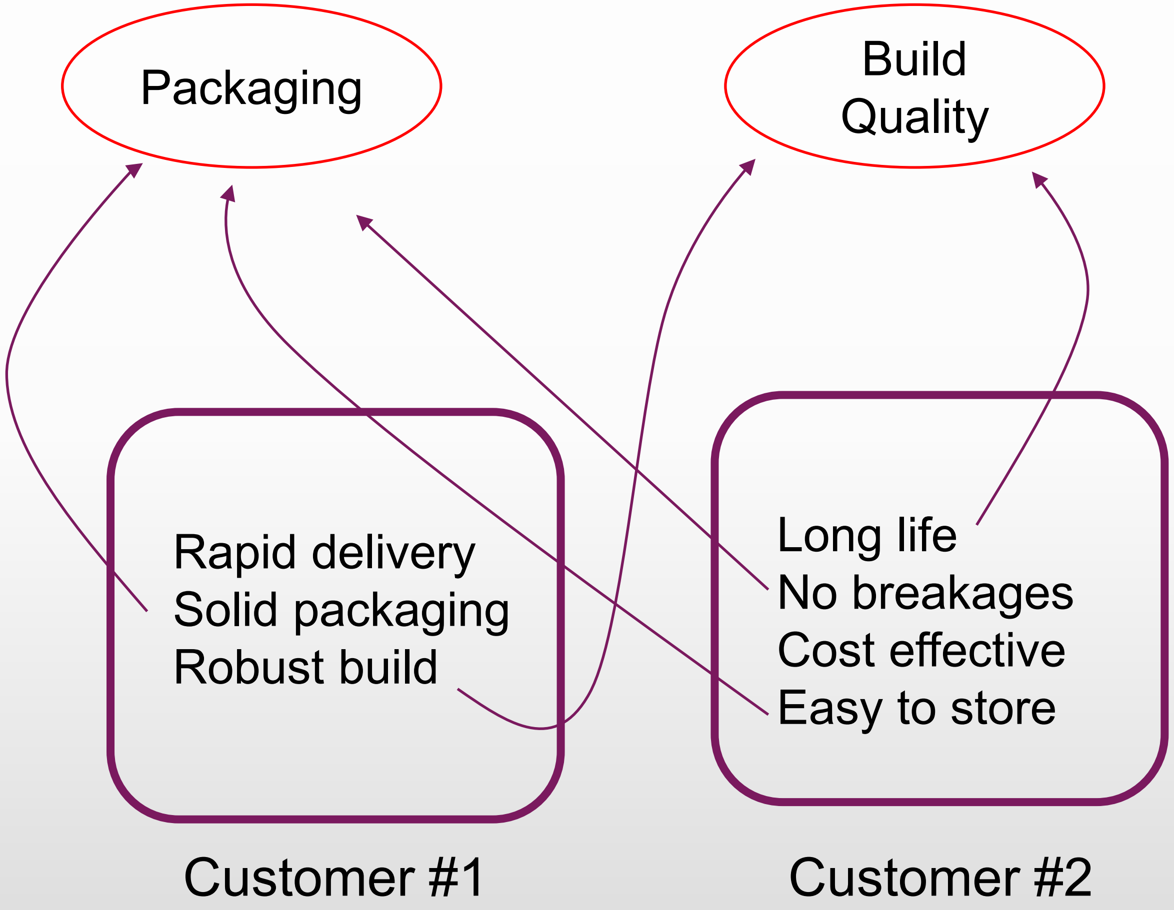
- Generate a list of key customer needs in ***their*** language
- Organise customer information
- Prioritise customer needs

Tools:

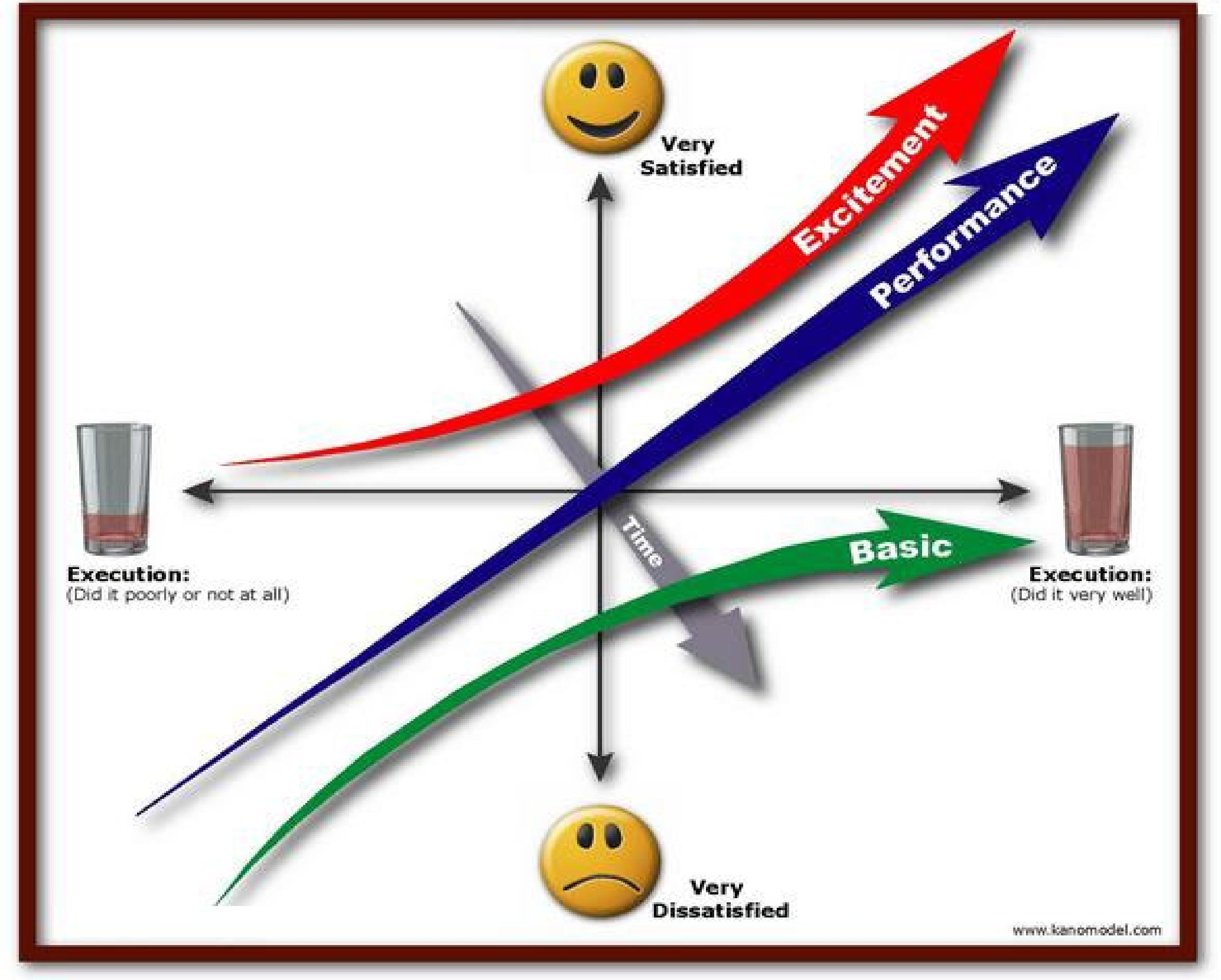
- Affinity diagram
- Kano analysis

Affinity Diagrams

- ❑Associate similar features into groups
- ❑We use it to consolidate similar features (perhaps from different customers) into a smaller number of common generalised features
- ❑This provides clarity of the key areas and features needed to appeal to as many customers as possible
- ❑These can be placed on a Kano diagram for example



The Kano Model



Developed in the 1980s by Professor Noriaki **Kano**, which classifies customer preferences into three main categories:

1) Basic (Must Haves)

2) Performance (Performers)

3) Excitement (Delighters)

The Kano model is used to differentiate between significant and distinguishing attributes related to the concepts of customer quality

The Kano Model

CRITICAL TO QUALITY:

Helps us understand and **prioritise customers requirements**

Lets us differentiate between:

- What is absolutely necessary to the customer (what they ***need***)
- What they would like to have but which is not essential (what they ***want***)
- What they don't expect but which will make them absolute fanatics for your product or service and your company (what ***delights/excites*** them)

The Kano model is not a mathematically derived precision tool – it is a positional way of understanding and prioritising customer requirements

Kano – Feature set

From the Customer's point of view – every service (or product) contains features from the following categories:

Feature	Customer...	What it is
Basic **Unspoken**	**Needs it**	The essential feature set ('must have'). If a product or service lacks a basic feature the customer simply will not consider it, no matter how attractive it is otherwise.
Expected **Spoken**	**Wants it**	What the customer would expect from this type of product ('should have')
Exciting **Unspoken**	**Delighted by it**	Unexpected but desirable features not normally expected ('could have')
Dissuader **Unspoken**	**Rejects it**	Features which will actively dissuade our customer from considering our product

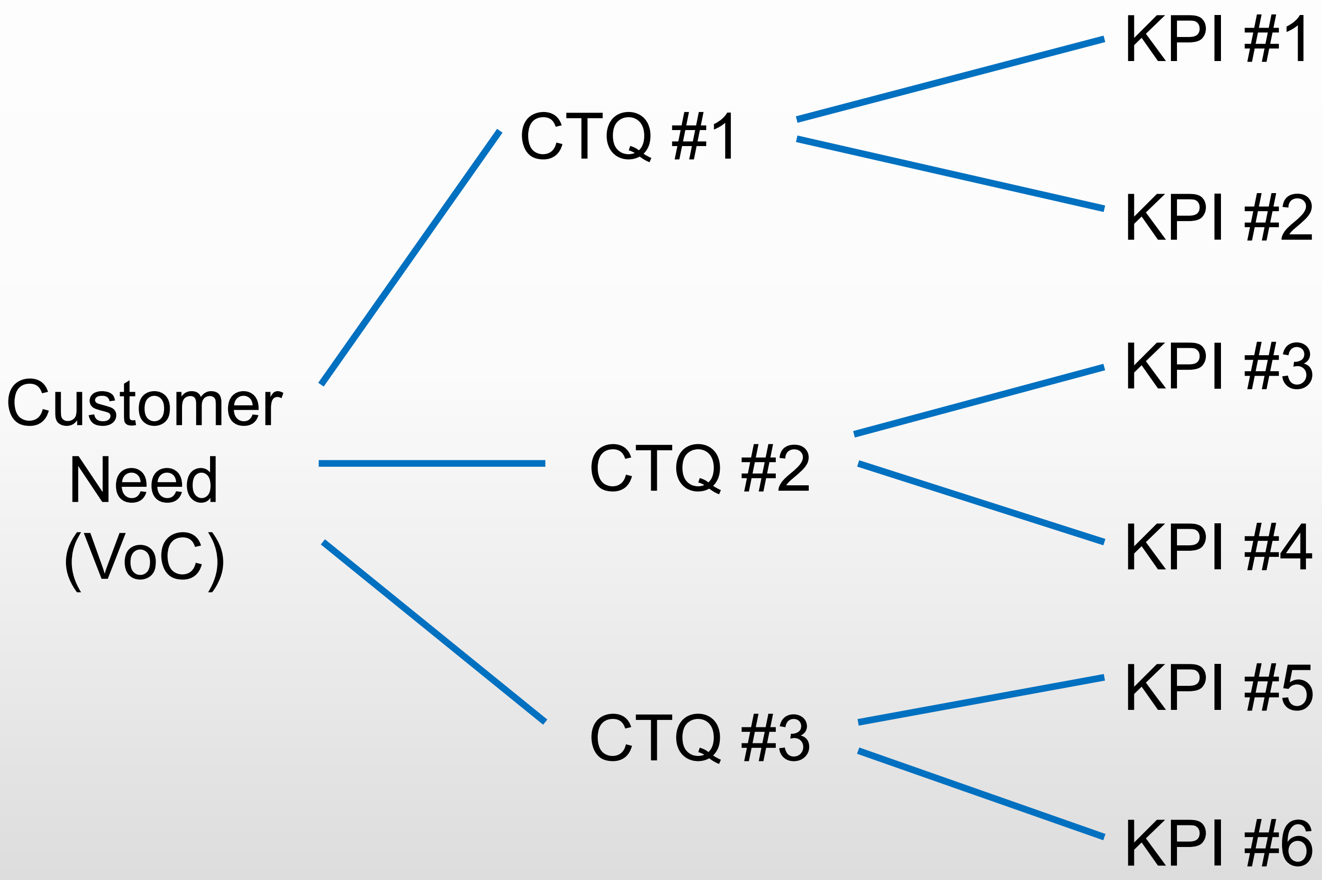
VoC Step 4: Determine customer needs

Identify Customers → Gather Customer Information → Analyse Customer Information → **Determine Customer Needs**

Objectives:

- Translate the customer language and identify the ***Critical to Quality*** requirements (*CTQs*)

Critical to Quality Trees



Customer Need (VoC)

CTQ #1

CTQ #2

CTQ #3

KPI #1

KPI #2

KPI #3

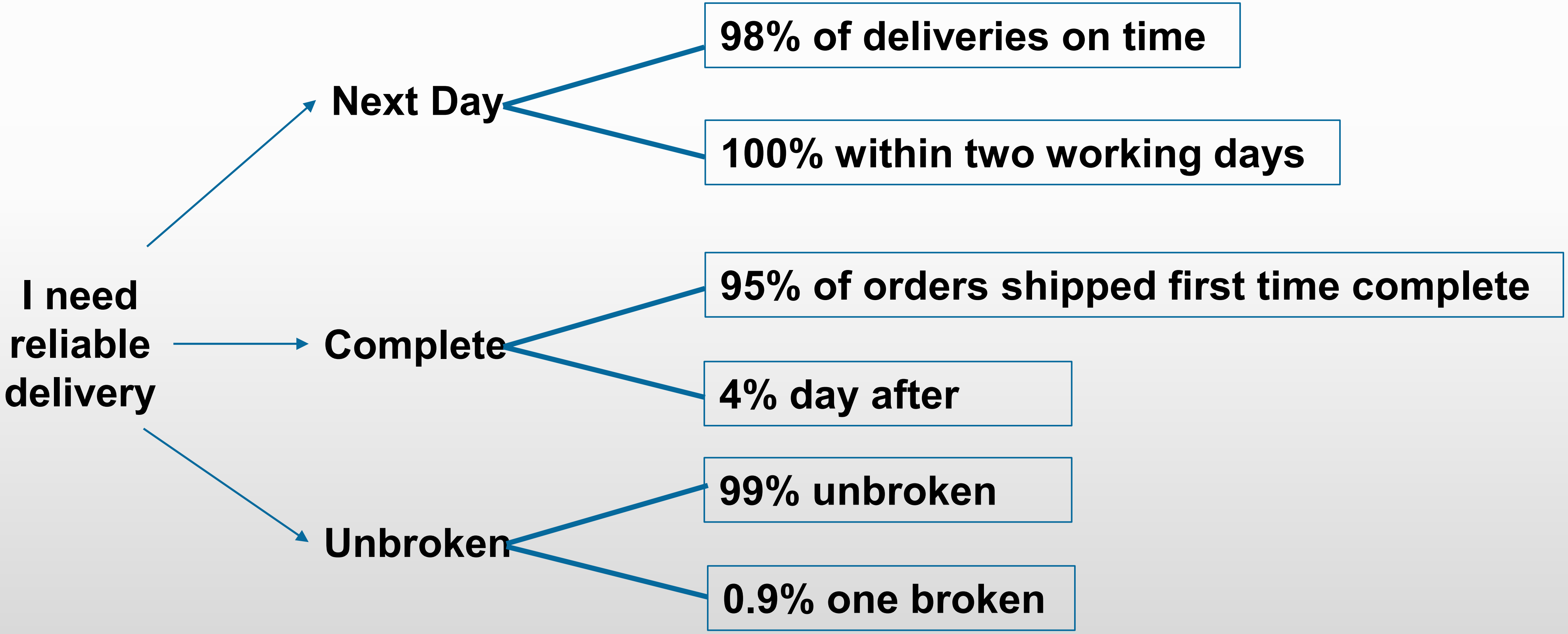
KPI #4

KPI #5

KPI #6

CTQ Trees: Identify KPIs

Once the CTQs have been identified, the team needs to define what level of service is acceptable to the customer (the KPIs):



- **I need reliable delivery**
  - **Next Day**
    - **98% of deliveries on time**
    - **100% within two working days**
  - **Complete**
    - **95% of orders shipped first time complete**
    - **4% day after**
  - **Unbroken**
    - **99% unbroken**
    - **0.9% one broken**

Identifying the Requirement

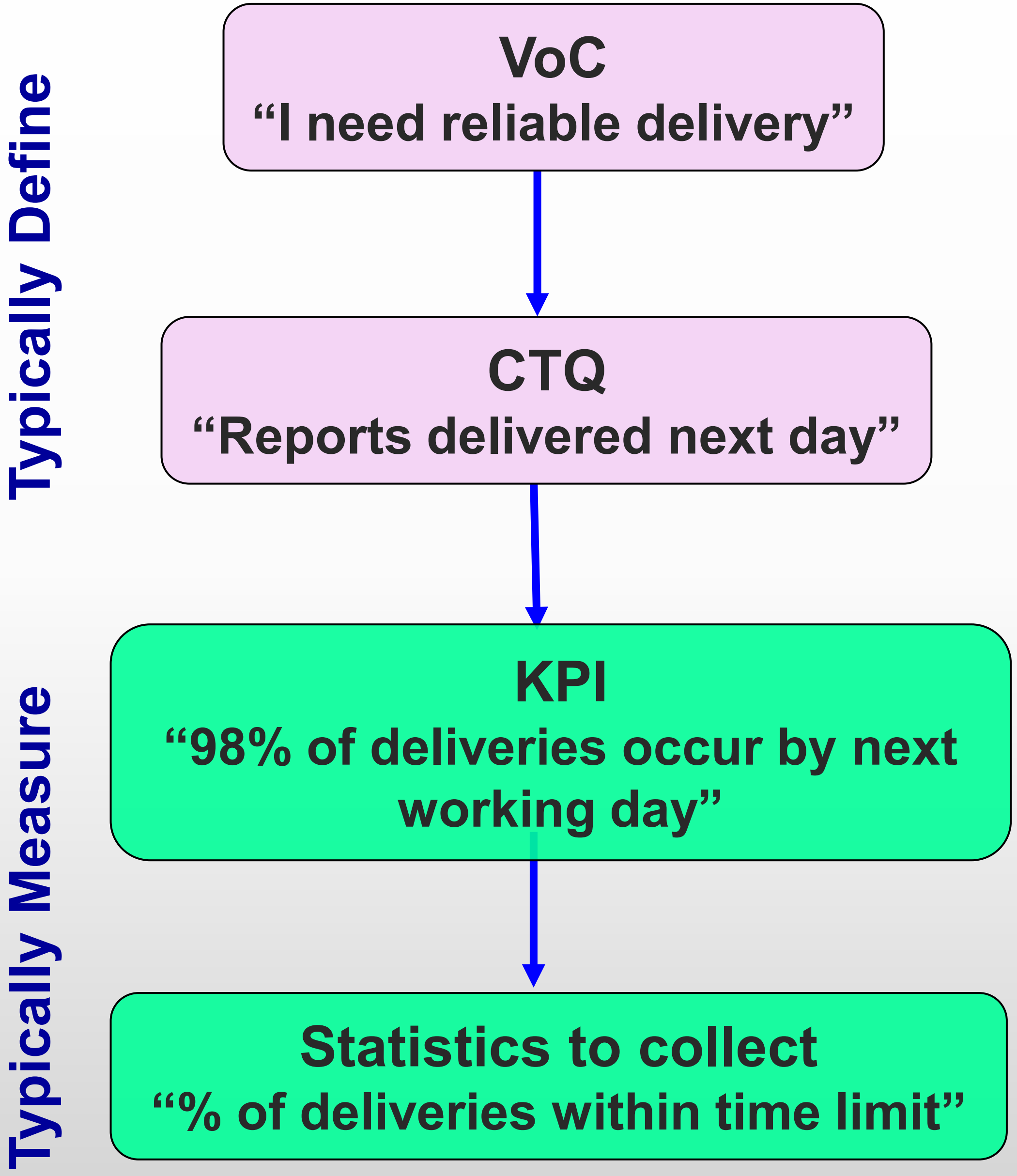
VoC is the starting point but we need measurable targets to satisfy VoC/VoB

Critical To Quality requirements translate the aspirational VoC into something that is measurable (quantifiable) and that can be used as a yardstick

- In turn CTQs can be used to define Key Performance Indicators – for measurability

Improvement projects should be aimed at achieving KPIs

KPIs help identify the data we need to collect



Typically Define

VoC
"I need reliable delivery"

CTQ
"Reports delivered next day"

Typically Measure

KPI
"98% of deliveries occur by next working day"

Statistics to collect
"% of deliveries within time limit"

What is a Critical To Quality (CTQ)?

It is important to the customer's buying decision

- The customer cares about it
- It is part of the customer's value equation

Specifies requirement – "must-have" or "must be" attributes

- Ultimately satisfy
- Potentially delight

Can be measured and related directly to the output of the business process

Establishes a target

- Customer specifications
- Acceptable range of performance

Class Exercise

Determine the CTQ for your process

Critical to Quality (CTQ) Trees

A Critical to Quality (CTQ) Tree, is a diagrammatic tool that can be used as an aid to develop and deliver a product or service that will meet the requirements of your customers

A broad set of customer needs are translated into specific, actionable and measurable performance requirements

CTQ Trees help you understand what customers want from a process in a measurable way and identify areas of potential conflict to balance out

There are *three* steps to creating a CTQ Tree:

- Identify critical customer needs (VoC)
- Identify the CTQs which defines a need
- Identify the KPIs which supports a CTQ

You can then identify the statistics to collect (as part of your data collection plan)

Problem Statement

Focus

❑ Formulating a problem is a teamwork exercise. Some basic questions to ask, include:

- ➢ What is the problem?
- ➢ Why is this a problem?
- ➢ Where does this occur?
- ➢ How often, how bad, how expensive?
- ➢ What is the implication if we do not solve it?

Key Points:

- ❖ **Describe briefly and avoid technical jargon – focus on the symptoms (who feels the pain, and where is it felt)**
- ❖ **Do not propose or imply a solution**
- ❖ **Do not delve into root causes of the problem here**
- ❖ **Define the scope and identify key stakeholders**
- ❖ **Included in Project Charter**

What does a Good Problem Statement look like?

A good *Problem Statement* should signify:
When / What / Magnitude / Impact or Consequence

Example of a Poor Problem Statement

Our employees are upset and disillusioned with the time it takes to claim their repayment following a mission trip

Example of a Good Problem Statement

In the last 12 months (**when**), staff have received a repayment for mission trip claims in an average of 30 days from the date of the submission (**what**), whereas they need to repay their credit card bills in no more than 14 days after the initial spending days (**magnitude**). This results in employee dissatisfaction and loss of productivity for time spent chasing their repayment (**impact/consequence**)

Class Exercise

Create your
Problem Statement

Cost of Poor Quality

What is CoPQ?

- Simply, just what it is referred to. Cost of Poor Quality is how much money a non-conforming deliverable costs your organisation… The **“How Much Does it Hurt”** metric.
- And quite a valuable metric it is! As the first key measurable in any Six Sigma project, it shows you, your team, and management the pain caused by the non-conforming condition or defect. Importantly, it shows how much pain.
- CoPQ is measured to obtain a baseline measure of where you are today in terms of costs. However, you can also use this measurement to **sell** improvement projects to management.
- CoPQ shows your management why it is critical that you begin your project now.

Cost of Poor Quality Categories

Total Cost of Quality

Cost of Good Quality

Prevention

Appraisal

Cost of Poor Quality

Internal Failure

External Failures

Cost of Poor Quality Categories

Prevention

- Error Proofing Devices
- Supplier Certification
- Design for Six Sigma
- Etc…

Appraisal (Detection)

- Supplier Audits
- Sorting Incoming Parts
- Repaired Material
- Etc…

Internal CoPQ

- Quality Control Department
- Inspection
- Quarantined Inventory
- Etc…

External CoPQ

- Warranty
- Customer Complaint Related Travel
- Customer Charge Back Costs
- Etc…

Business Opportunity

Focus

- ☐ L6S is different from *project management* in that at the *Define* phase, the solution is rarely known or if the process can be improved
  - ➢ So, a formal *cost-benefit* analysis is often impossible
- ☐ The simple *Business Opportunity* is that the owner of the process has an issue which they believe requires attention
- ☐ At *Define*, if the solution is known, then just implement it (L6S DMAIC is n/a)

Key questions to consider:

- ❖ **Why is the project worth doing?**
- ❖ **Why is it important to do it now?**
- ❖ **What are the consequences of not doing it?**
- ❖ **What is the cost of dealing with the process failure?**
- ❖ **What activities have equal or higher priority?**
- ❖ **How does it align with current business strategy?**

Sample Business Opportunity Statement

A good *Business Opportunity Statement* should capture:

- **Why it is important to do this now**

(from the Champion's point of view)

- **Some form of financial justification (or reference to CoPQ), where possible**

Example of a Business Opportunity Statement (1)

Streamlining an organisation's processes is always a good thing. So, centralising the tasks that are not country-management focussed will make the the process better.

Example of a Business Opportunity Statement (2)

In support of the organisation's strategy to become efficient with its processes – eliminating unnecessary hard copy reports, centralising certain functions and placing other reports online – it is expected that we can reduce the time spent on non-value tasks within the country-management processes.

Which of these is a good Business Opportunity statement?

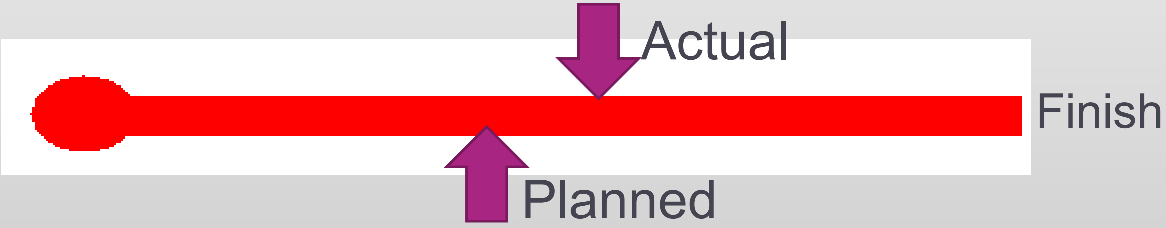
A Simple DMAIC Plan

Activity Number	Phase/Activity	Date	Duration	Predecessor	Resources
1.0	Define	22/4			
1.1	Define process improvement need	22/4	One day		**Quality facilitator, finance director**
1.2	Identify goals	23/4	Two days	1.1	**Quality facilitator**
1.3	Form team	25/4	Two days	1.2	**Finance director, consulting manager**
2.0	Measure	27/4		1.0	
2.1	Profile current state	27/4	14 days		**Quality facilitator, process analyst, finance clerk**
2.2	**Identify problems that contribute to process inefficiencies an errors**	**11/5**	**Five days**	**2.1**	**Quality facilitator, process analyst, finance clerk**

Project start date: 22nd April

Project End Date: 27th May (*estimated*)

Project progress:



Planning (see prior slide – "A Simple DMAIC Plan")

Do no more than is necessary at any time

In Define phase, have an outline list of key milestones

(phase start dates etc)

Only go into more detail if it helps the team (can be good for phase end reviews)

At the end of each phase you might wish to expand the next phase to include significant milestones within it:

- Data collection plan and forms completed
- Collection starts
- Collection ends
- VSM and Process Capability

Stick the plan on a wall so all can see it

Keep it up to date

(fill in the actual fields) including the progress bar

Goal Statement

Make it SMART

- ☐ **S**pecific – An observable action, behaviour or achievement linked to a rate, number, percentage or frequency. {*Answer the phone*}
- ☐ **M**easurable – A system, method or procedure exists to allow the tracking and recording of the behaviour {*Within 3 seconds*}
- ☐ **A**greed – Objectives aligned to business strategy and agreeable to relevant stakeholders
- ☐ **R**ealistic – Objectives can be attained (not necessarily easy or simple though)
- ☐ **T**ime-bound – When the objective can be met

GOAL: In line with meeting customer expectations, customer services will be able to answer the phone within 3 seconds from 1 October 2022

Class Exercise

Create your Goal Statement

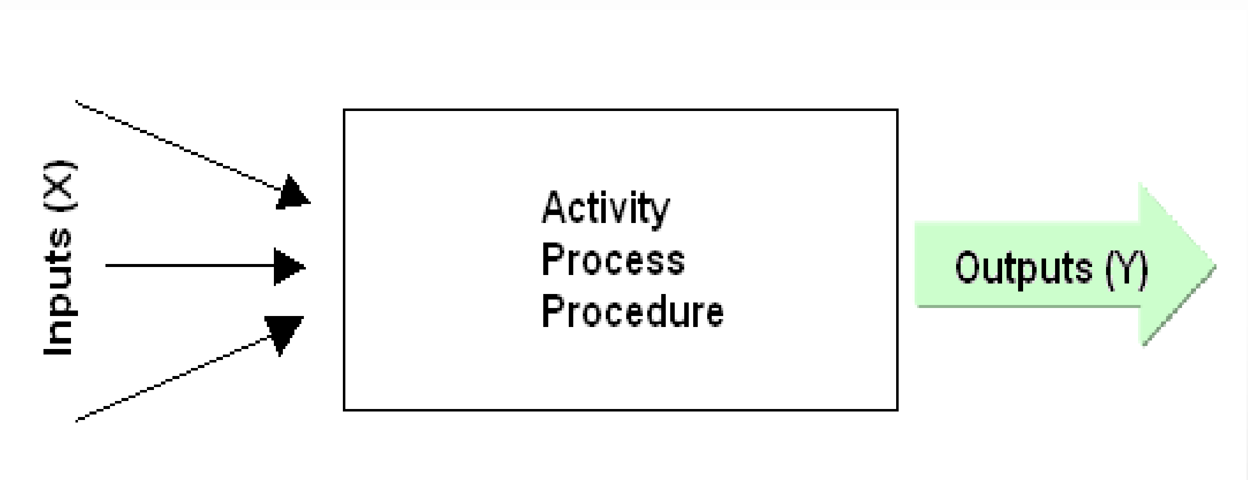
What is a Process?

Everything!

- *Any activity, process or procedure that transforms one or more inputs into one or more outputs*

Examples:

- Processing an order
- Filling in a purchase requisition
- Making a car door handle
- Brushing your teeth
- Painting a room



Anatomy of a process

$$Y = f(X)$$

Question:

Which parts of the process have we historically focused on?

Types of Processes

Making things

Manufacturing

Providing a service

Service

Transactional

Interactive

Manufacturing	The path a product takes from its creation to delivery to a customer
Service	The customer’s journey How a service provides a solution to a customer Service processes can be split depending on the amount of *End Customer* interaction there is

What is a SIPOC?

A first cut, ***High level*** view of the area to be improved

Identifies: **S**uppliers, **I**nputs, the **P**rocess, **O**utputs and **C**ustomers

Identifies the scope of the improvement project

- Shows us the task

Scoping an improvement project is ***critical*** to achieving success

- Don’t take on too much!
- A SIPOC will allow you to gauge this and help narrow the focus

SIPOCs provide the following benefits:

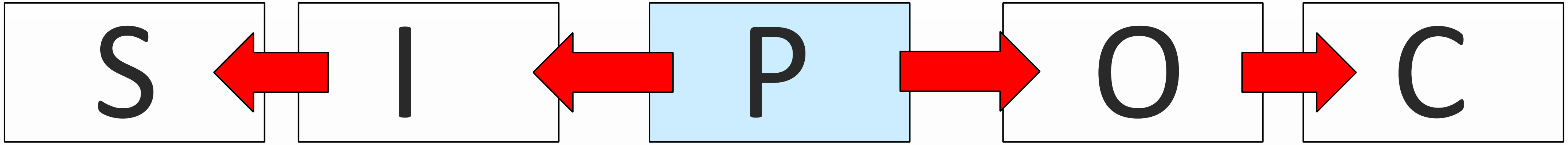
- Enables the entire team to have a focus for the workflow to be improved

- Ensures that the key players are identified

- Clarifies an understanding of the scope of the work between management and the team

- May identify ‘quick wins’ that can provide an early improvement

Example SIPOC



Suppliers
Providers of inputs to your process

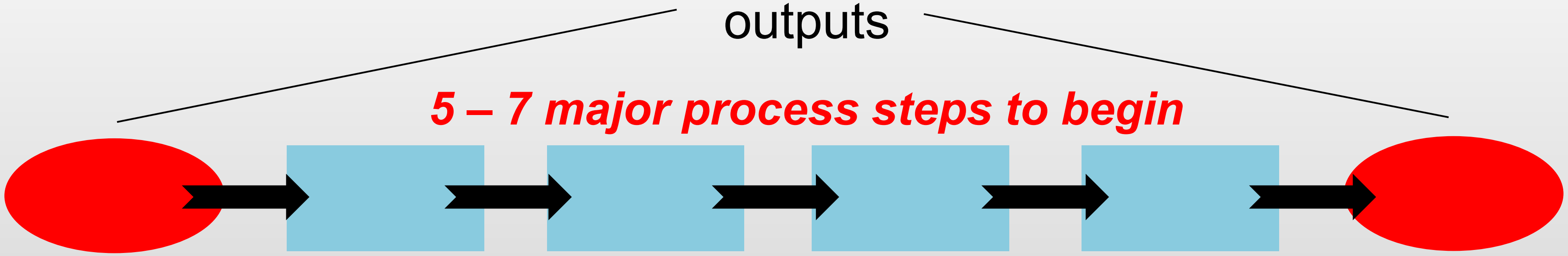
Inputs
Materials, resources or data required to do the process

Process
A structured set of activities that transform a set of inputs into workable outputs

Outputs
The products or service from the process

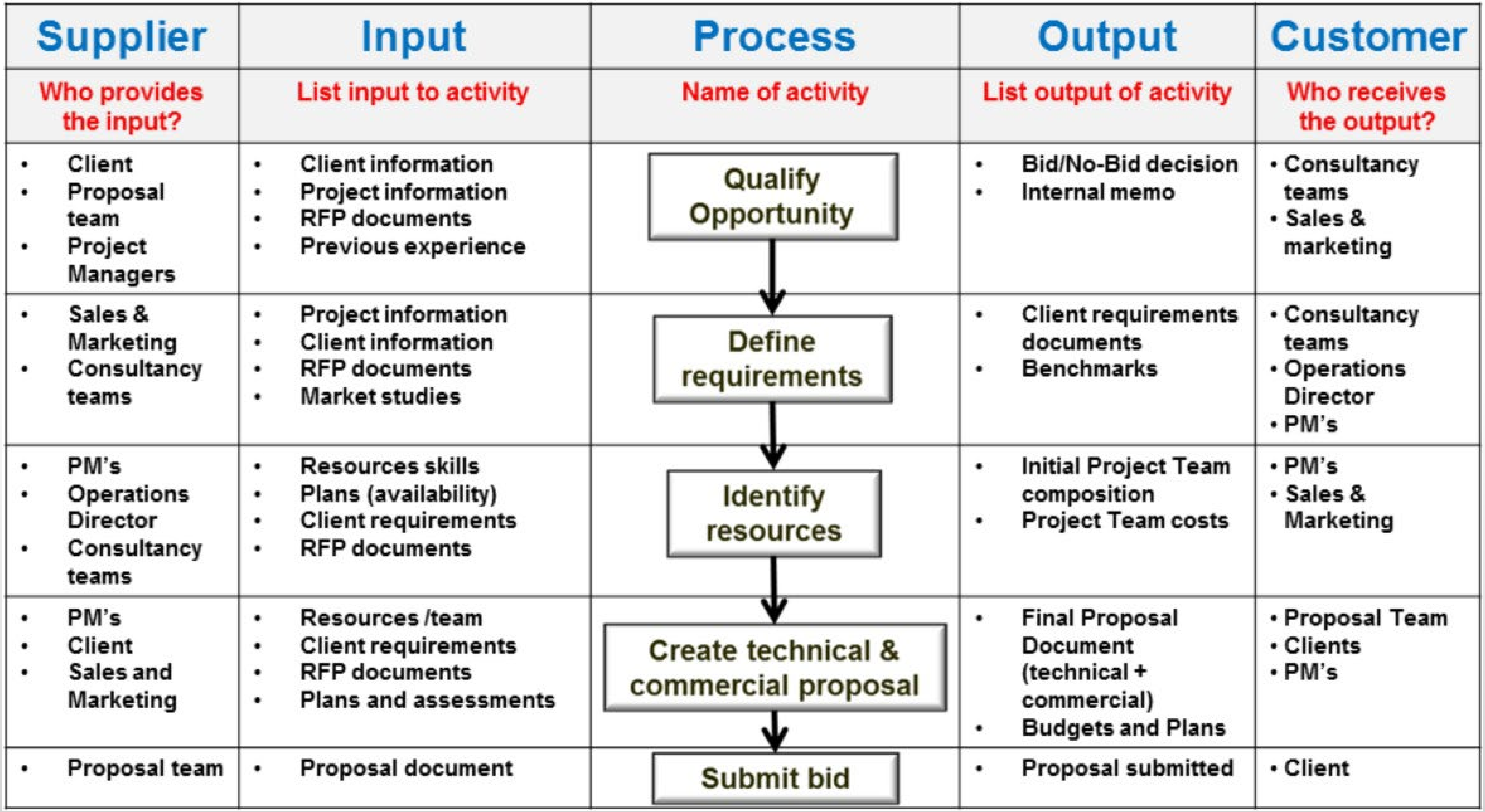
Customers
The recipient of the process output

5 – 7 major process steps to begin



S.I.P.O.C is used to identify high level AS-IS processes – an effective communication tool

SIPOC Example – Proposal Submission



Supplier	Input	Process	Output	Customer
Who provides the input?	List input to activity	Name of activity	List output of activity	Who receives the output?
- Client - Proposal team - Project Managers	- Client information - Project information - RFP documents - Previous experience	Qualify Opportunity	- Bid/No-Bid decision - Internal memo	- Consultancy teams - Sales & marketing
- Sales & Marketing - Consultancy teams	- Project information - Client information - RFP documents - Market studies	Define requirements	- Client requirements documents - Benchmarks	- Consultancy teams - Operations Director - PM's
- PM's - Operations Director - Consultancy teams	- Resources skills - Plans (availability) - Client requirements - RFP documents	Identify resources	- Initial Project Team composition - Project Team costs	- PM's - Sales & Marketing
- PM's - Client - Sales and Marketing	- Resources /team - Client requirements - RFP documents - Plans and assessments	Create technical & commercial proposal	- Final Proposal Document (technical + commercial) - Budgets and Plans	- Proposal Team - Clients - PM's
- Proposal team	- Proposal document	Submit bid	- Proposal submitted	- Client

Class Exercise

Drafting a SIPOC

Draft SIPOC of your process

Define Phase – Review Questions

- ☐ Can you describe why your project is important and what the problem and goals are?
- ☐ What is the VoC?
- ☐ What techniques can be used to identify customer requirements and link them to metrics?
- ☐ What is the VoP? How do we represent this in L6S?
- ☐ What is CoPQ?
- ☐ What is the Project Charter, and what are its main components?

DMAIC

- Define
- ***Measure***
- Analyse
- Improve
- Control

Measure

DEFINE

MEASURE

Quantify the current state (determine the baseline)

ANALYSE

IMPROVE

CONTROL

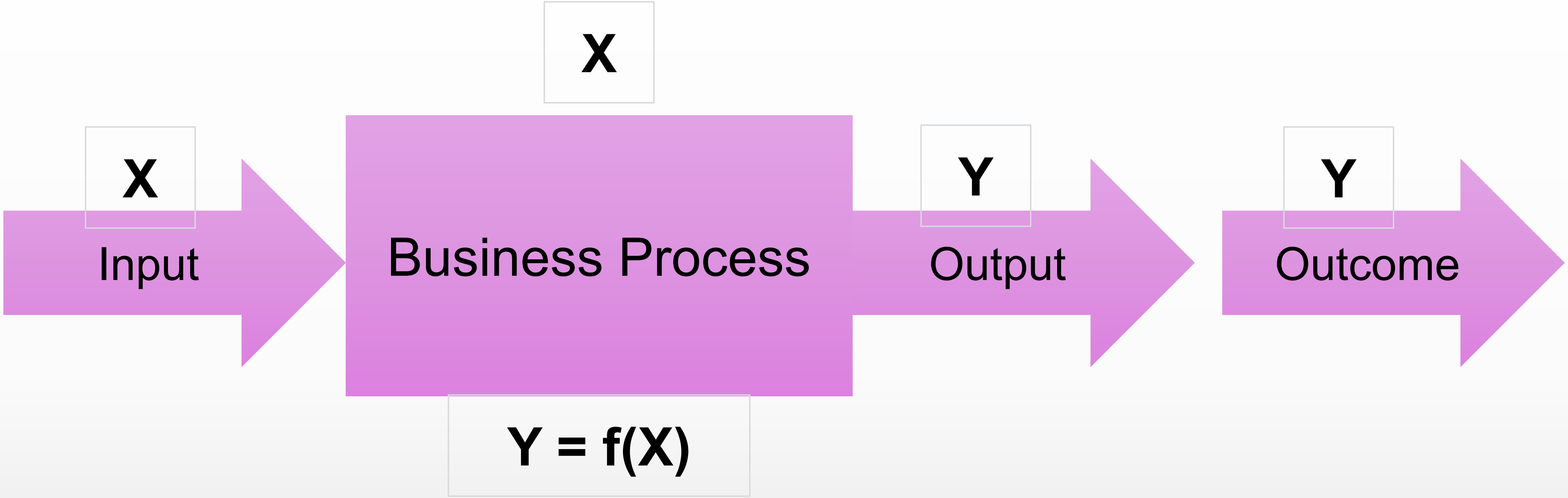
Objectives

- To gain a clear understanding of the current state of the process under investigation
- Collect data and obtain thorough understanding of the process
- Understand the magnitude of the problem
- Baseline this '***As-is***' state

Outcomes

- Type of data to collect
- Data collection plan/forms
- Data collected

Types of Measure



Input:	Resources including cost and workforce
Process:	Activities, efforts, workflow
Output:	Product or service delivered
Outcome:	Results, accomplishments, impacts from output

Types of measures – Input

What do we need for our work?

Hint: **The '4 M' rule**

M A T E R I A L S

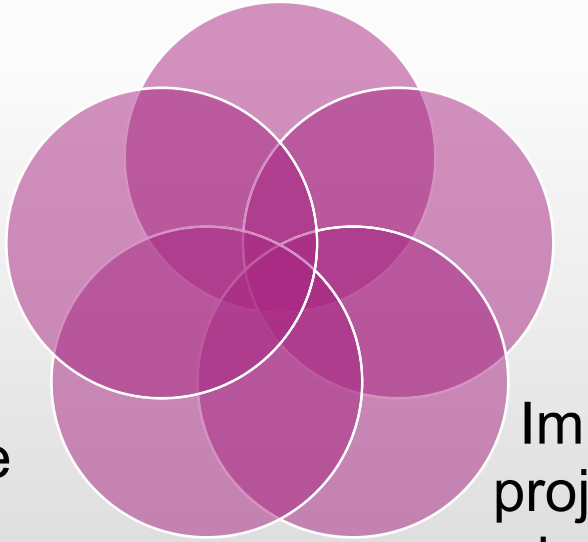
M A N P O W E R

M A C H I N E S

M E T H O D

Key Performance Indicators (KPI)

Measurable targets which the process needs to achieve to satisfy VoC / VoB



This links into the CTQ Trees discussed earlier

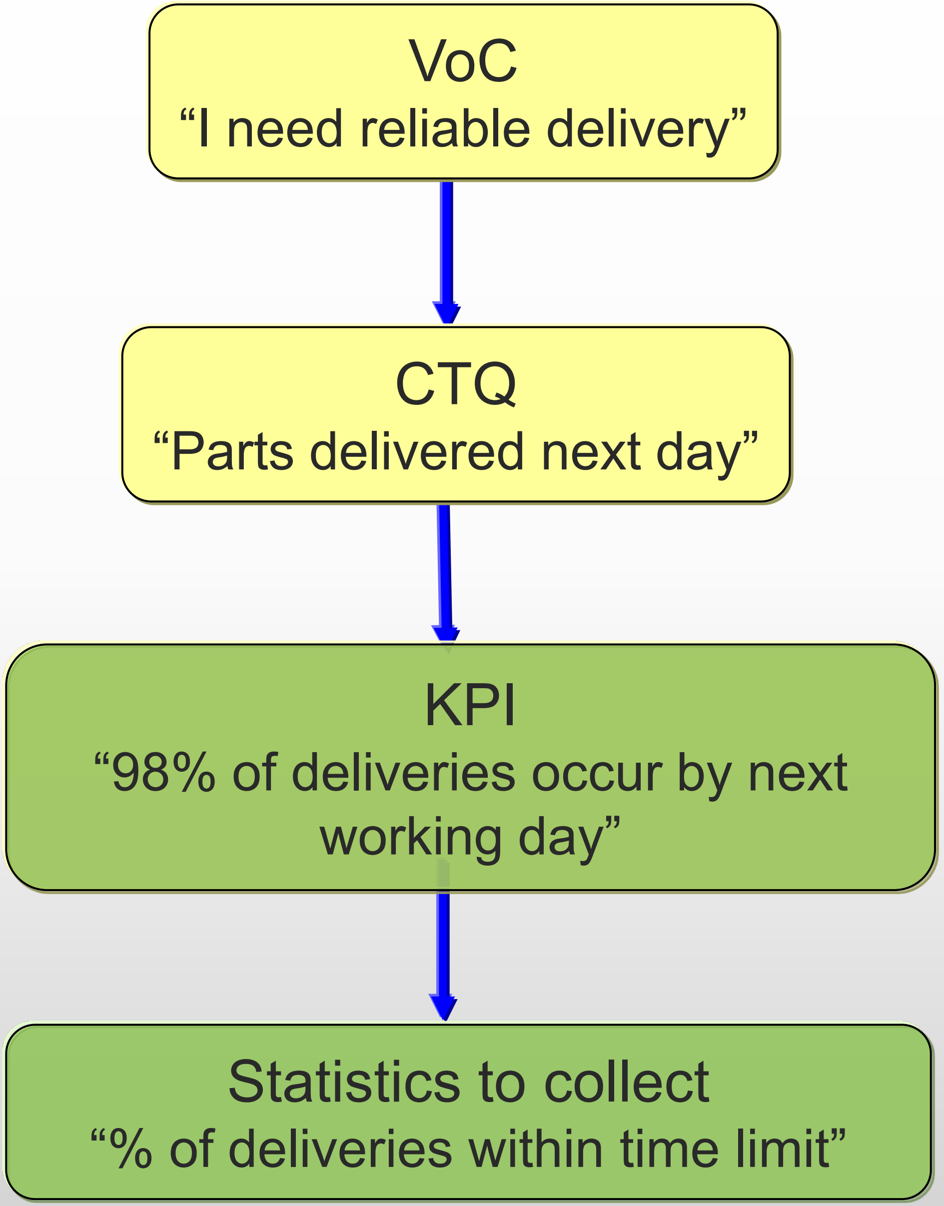
Should be driven by VoC and CTQs

KPIs help identify the data we need to collect

Improvement projects should be aimed at achieving KPIs

Typically Define

Typically Measure



VoC
“I need reliable delivery”

CTQ
“Parts delivered next day”

KPI
“98% of deliveries occur by next working day”

Statistics to collect
“% of deliveries within time limit”

Measure

- ***Gemba Management / Process Stapling***
- Process Maps: Swim Lane / Value Stream Maps
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Data Collection Plan
- Graphical representations
- Process Capability
- Control Charts
- Process Efficiency

MEASURE

Gemba (The Real Place)

Gemba can be translated as:

- The real place
- The place where work gets done
- The shop floor

As a philosophy, Gemba is a reminder to managers of all levels that sitting in an office isolates them from ‘real’ processes and work. In Gemba, there is a drive for management and leaders to stay connected with the shop floor (the place where the real action occurs).

By practising the Gemba philosophy, management gains a deep and thorough understanding of real-world issues, by first-hand observation and by talking with plant floor employees

Gemba Tools

Gemba Walk

Management go to the workplace daily to observe and look for potential problems and wastes

Managing By Wandering Around (**MBWA**)

Management tries to stay and work in Gemba as much as possible

Go Look See (**Boots On The Ground**)

No business decisions are made without visiting the relevant part of the business – ideally, the decision is made by managers while standing on the shop floor

Other Gemba Management Tools

- Consensus Building tools
    - Facilitated workshops
    - Brainstorming Sessions
    - De bonos 6 thinking hats
    - Pugh Matrix
    - Fishbone Diagram
    - Affinity Diagrams

- Visual Management
    - Kanban Boards
    - Andon Lights
    - Kaizen Event boards
- Daily Stand up Meetings
    - Scrum meetings (Agile Project Management)

Process Stapling

Following a process through ‘end-to-end’

Record everything that happens

- Even the unexpected and one-offs

Video is useful

Make sure this does not have a negative effect on the people in the process

- Make sure they know it is not about testing them
- Possible have staff do the recording

Some people prefer to work through a well known process backwards

Measure

- Gemba / Process Stapling
- ***Process Maps: Swim Lane / Value Stream Maps***
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Data Collection Plan
- Graphical representations
- Process Capability
- Control Charts
- Process Efficiency

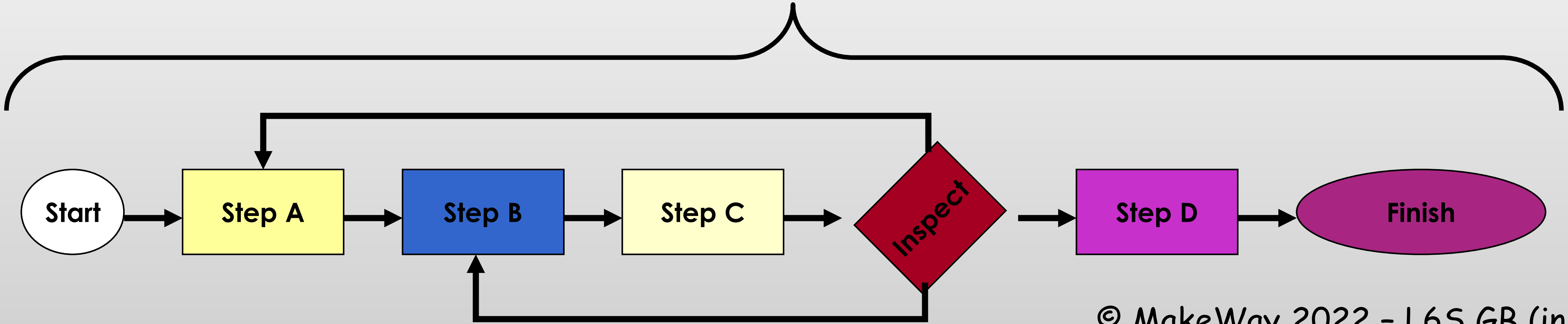
Process Maps

Types of Process Maps

☐ High level process map
☐ Detailed process map
☐ Swim Lane process map
☐ Value Stream Map

Key Points:

- A way of illustrating the flow of a process
- Describes how the flow works and identifies the complexities therein
- In L6S, the *Process Map* forms the basis of a Value Stream Map
- The *Process Map* communicates the focus of problem solving



Process Maps

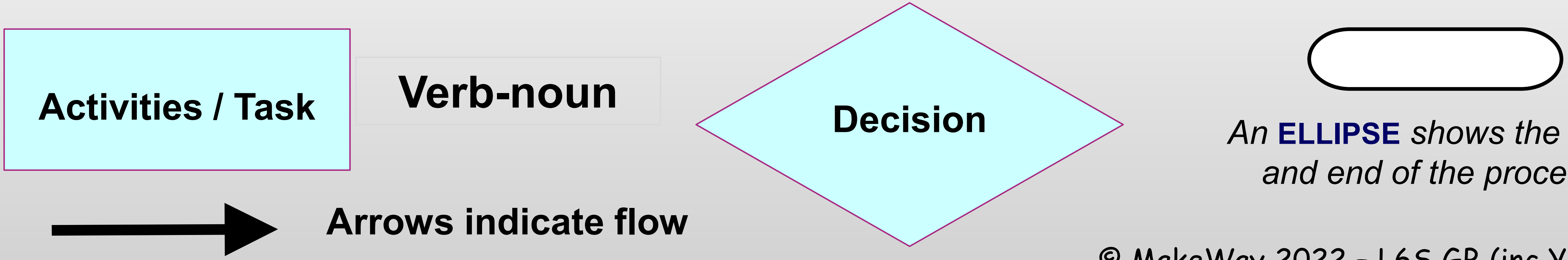
Process Maps are living documents and must be changed as the process is changed

→They represent what is **currently** happening not what you **think** is happening

→They should be created by the people who are closest to the process

Usually the ‘flow’ of the process is left to right although can be top to bottom

Each step is recorded as a symbol linked by arrows showing the flow



An **ELLIPSE** *shows the start and end of the process*

Advantages of Visual Mapping

Provides a VISUAL representation of the process

Mapping out the actual process enables an objective view of reality

Identifies re-work loops and redundancies

Serves as a training and orientation tool

Identifies non-value added steps

Helps identify where in the process data can be collected from

Identifies where different work teams use different processes

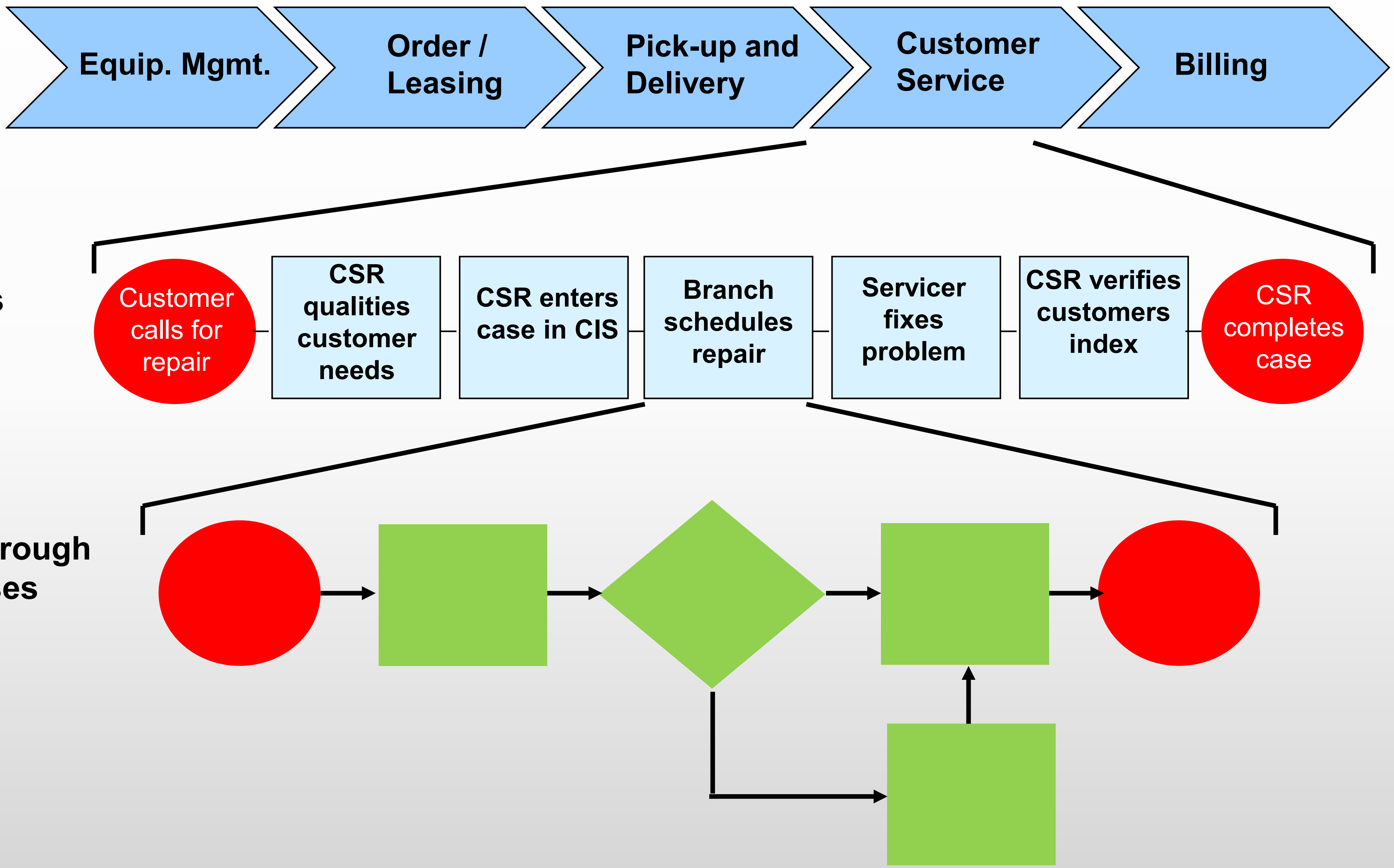
Process Maps form the basis of Value Stream Maps

Example Process Map

Core process (level 1) SIPOC

Sub-processes (level 2)

Sub-processes through micro-processes (level 3)



Equip. Mgmt.

Order / Leasing

Pick-up and Delivery

Customer Service

Billing

Customer calls for repair

CSR qualities customer needs

CSR enters case in CIS

Branch schedules repair

Servicer fixes problem

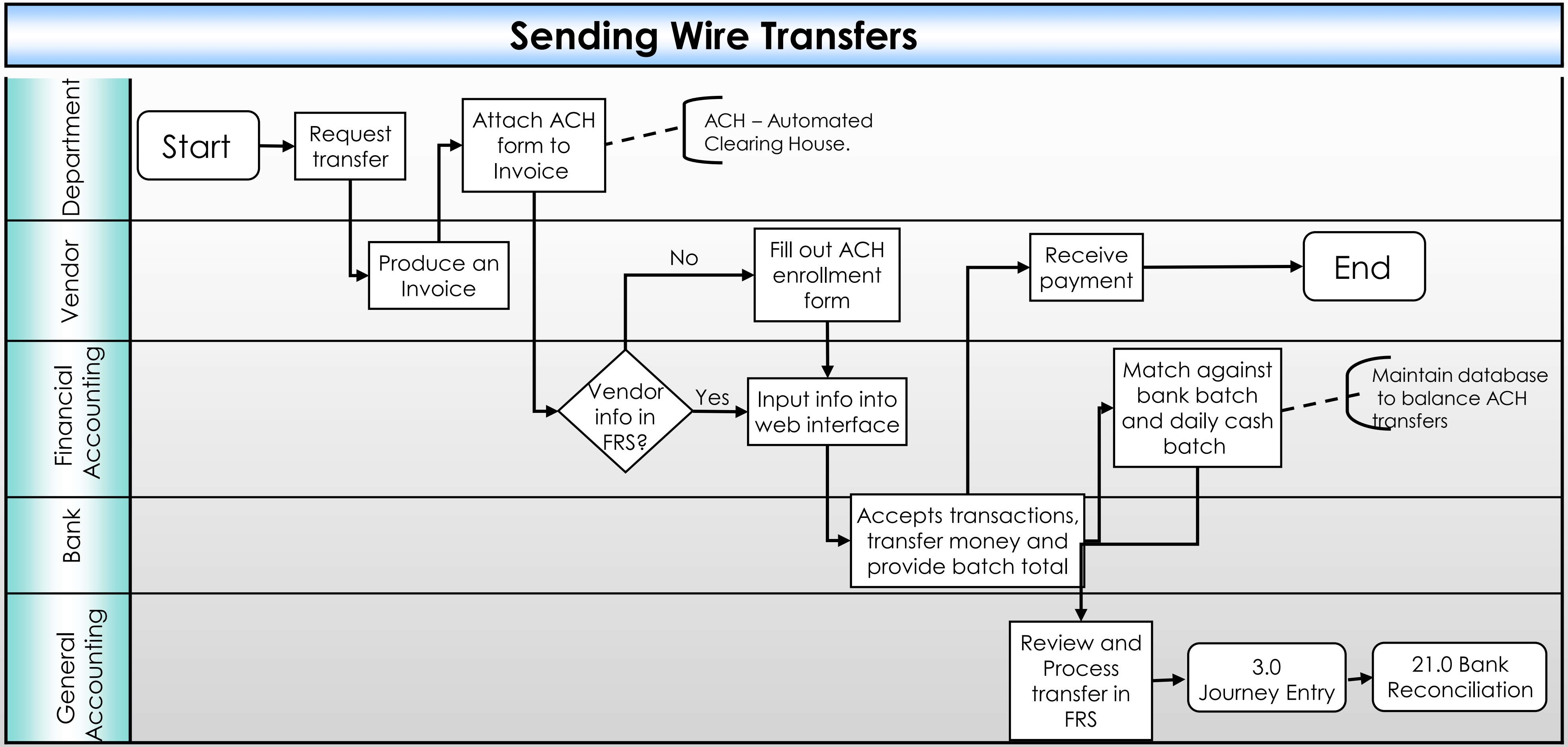
CSR verifies customers index

CSR completes case

Swim Lane (or Cross-Functional) Chart

When multiple departments or functional groups are involved in a complex process it is often useful to use Cross Functional Process Maps.

- Draw in either vertical or horizontal Swim Lanes and label the functional groups then draw the Process Map



Sending Wire Transfers

Department
Vendor
Financial Accounting
Bank
General Accounting

Start
Request transfer
Produce an Invoice
Attach ACH form to Invoice
ACH – Automated Clearing House.
Vendor info in FRS?
No
Fill out ACH enrollment form
Yes
Input info into web interface
Accepts transactions, transfer money and provide batch total
Receive payment
End
Match against bank batch and daily cash batch
Maintain database to balance ACH transfers
Review and Process transfer in FRS
3.0 Journey Entry
21.0 Bank Reconciliation

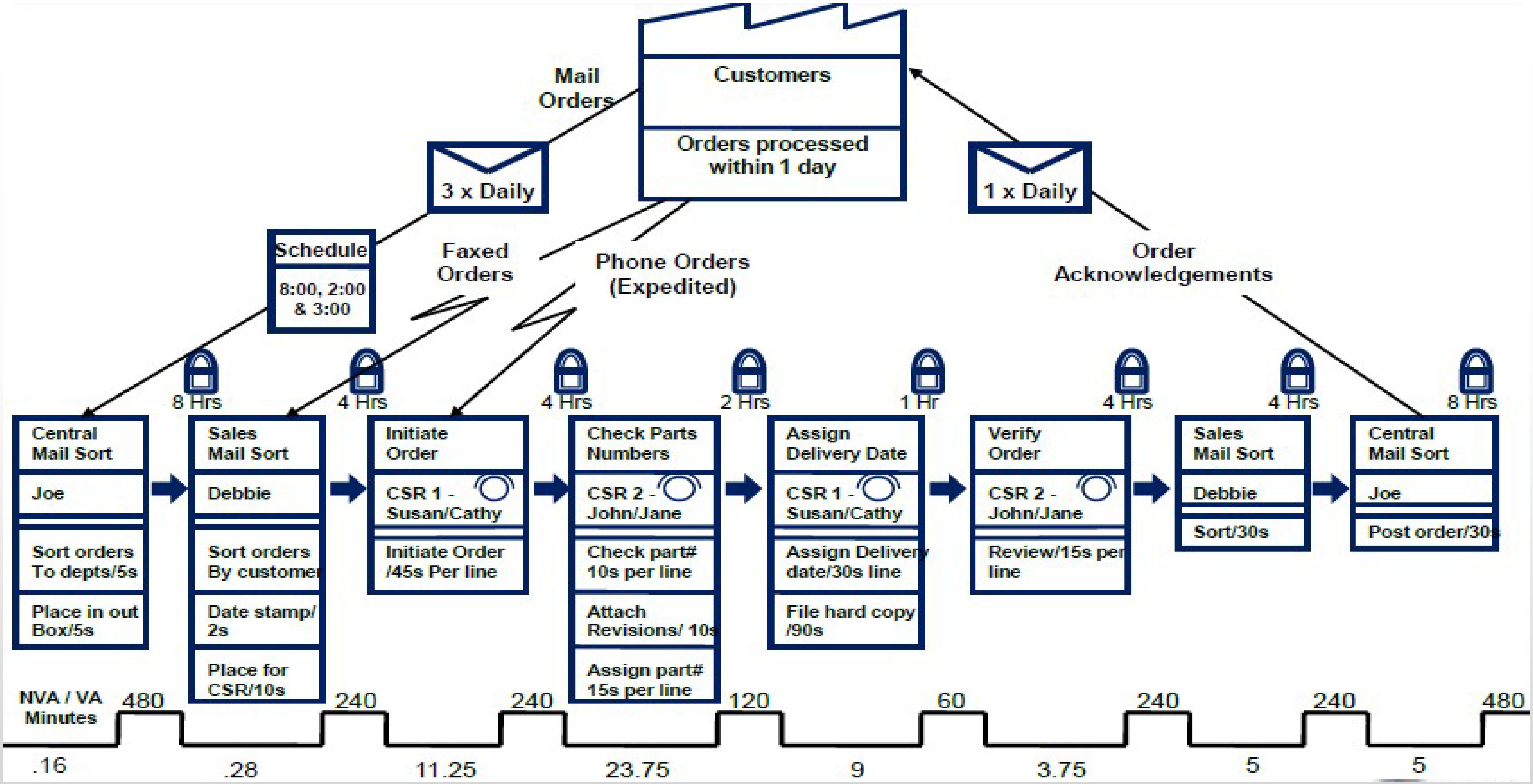
Value Stream Maps (VSMs)

A value stream map builds onto a process map by illustrating the flow of value through the process

This includes…. • People and other resources • Value and Non-value added time • Inventory • External and internal movement • Communications (verbal, electronic etc)	A VSM is useful for identifying bottlenecks and areas that could be improved	Creating a map on a large sheet of paper is still considered best as… • It visually displays the end-to-end process • It can be brought alive with photos and sample documentation • It is an excellent engagement tool

A VSM is an excellent engagement tool that can also be brought alive with photos and sample documentation

Value Stream Mapping ('As Is')



What is a Value Stream?

A Value Stream is the series of steps that must be performed (in the correct sequence) which provides an output for a customer

- Remember – if no customer wants an output then that output is waste!

The complete value stream includes *both* information flow *and* product or material flow

The value stream includes *all* steps; value-added and non value-added

The value stream is usually depicted as a graphical representation known as a 'Value Stream Map' (VSM)

- Value Stream Mapping: Creating the VSM
- Value Stream Analysis: Using the VSM to identify areas of waste

If there is a product, service or process for a customer, there is a value stream

Value Stream Mapping enables us to:

Show in simple graphical terms the entire operation – ***End to End***

Agree upon the ***AS IS*** state

Remove silos – make the value stream flow

Identify waste (including the source of waste) and Non-Value add activities, so that we can make improvements without adversely impacting the customer

Design the ***TO BE*** state and get validation

Understand and increase value added activity

Value Stream Analysis tools are about analysing the current state (AS IS) and designing and quantifying the future state operations (TO BE)

Where are VSMs used?

We first use the VSM in the ***Measure*** stage, to draw up and illustrate how the process is working at the moment (the ‘As is’, ‘Current State’ or ‘Baseline’ version)

In the ***Analyse*** phase, we re-draft the VSM to produce an illustration of how the process could look if selected wastes were removed (‘To Be’ / ‘Future State’ / ‘Target State’)

- This helps us understand if making an improvement is worthwhile

In the ***Improve*** phase the VSM is useful background information to help formulate an improvement plan

Creating the 'AS-IS' VSM

- Go to the Gemba and examine the process
- Identify the scope of the Value Stream Map
  - A SIPOC helps here
- Identify logical blocks/cells
  - Flow chart or Swim Lane diagrams can be useful here
- Gather data using a Data Collection Plan and appropriate forms
- Create the Current State Value Stream Map, showing:
  - Material Flow
  - Information Flow
- VA+BNVA/ NVA classification

In step 5 you can use the six-step creation process described a little later in these notes

Measure

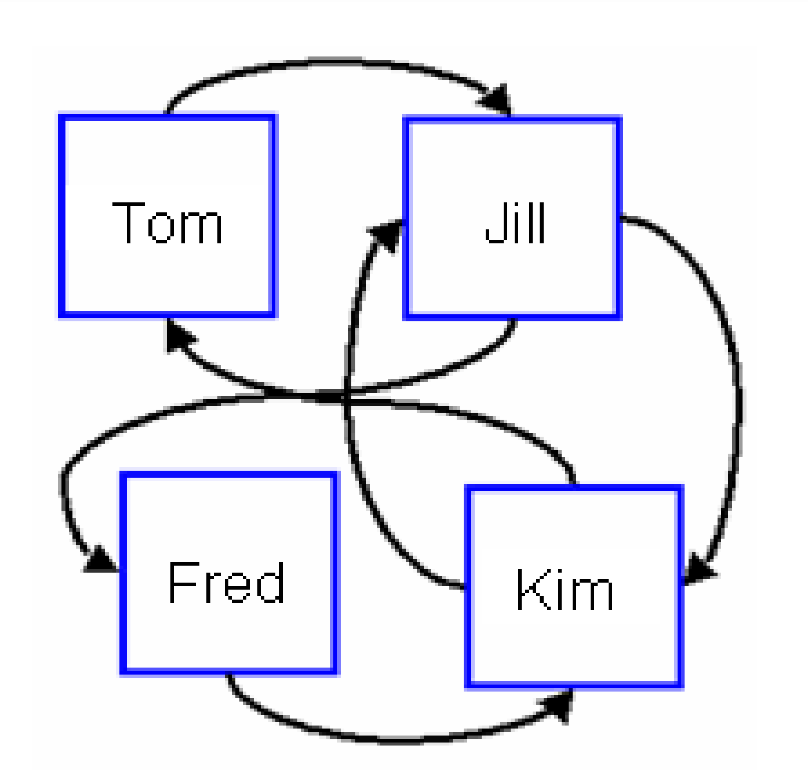
- Gemba / Process Stapling
- Process Maps: Swim Lane / Value Stream Maps
- ***Spaghetti Diagram***
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Data Collection Plan
- Graphical representations
- Process Capability
- Control Charts
- Process Efficiency

Spaghetti (Movement/Transportation) Diagrams

Tracks how a piece of work physically moves during production

This could be:

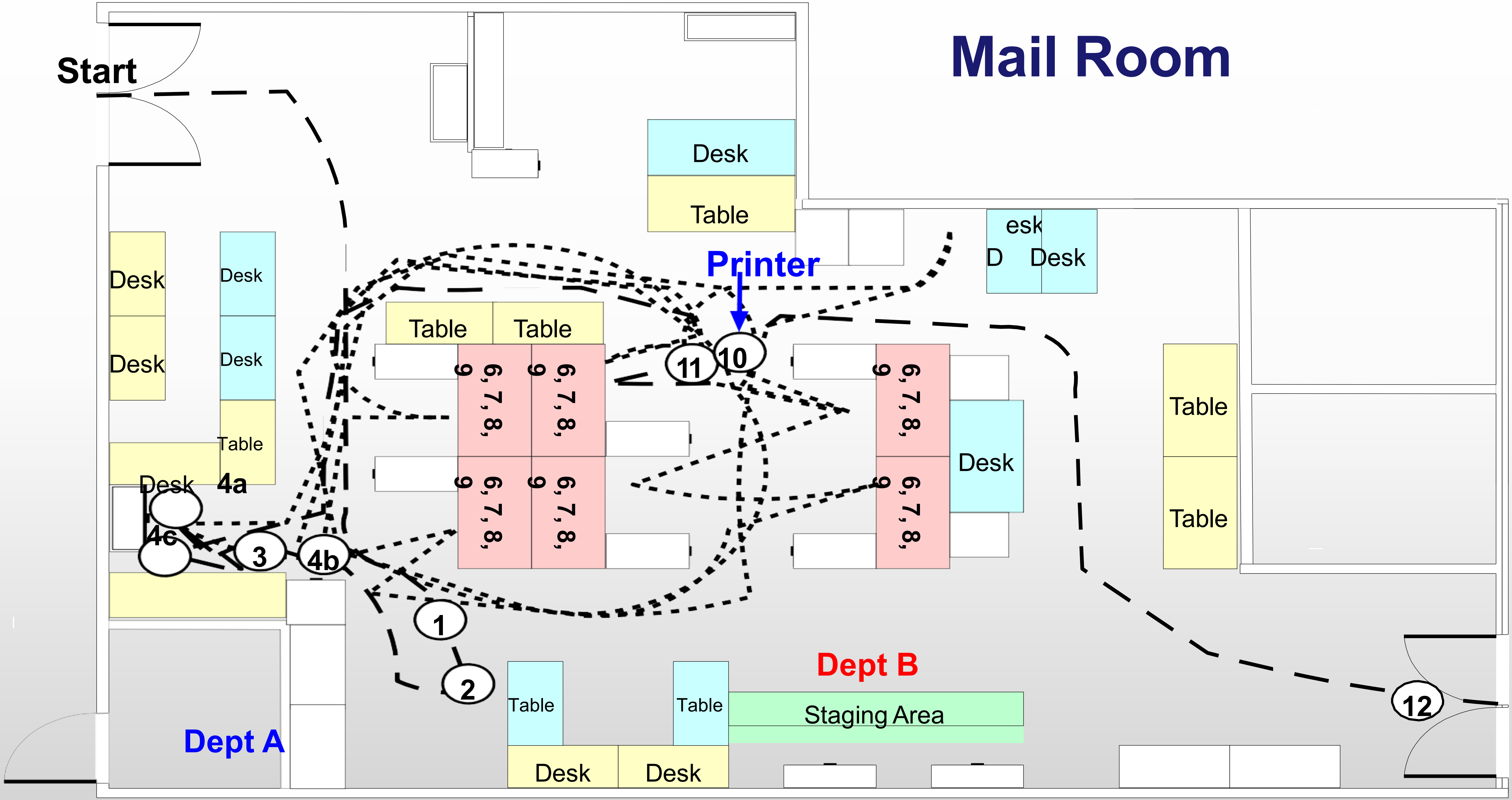
- An electronic document passing between staff (illustrated)
- A mechanical part being assembled
- A car tyre being fitted
- A sales person handling a shoe request



Example Impact of Shared Equipment

Distance travelled to e.g. printer	☐ Dept A = 92 ft. per trip
	☐ Dept B = 696 ft. per trip
120 occurrences per day = 4656 miles/year	
Walk pace = 1 mile per hour	☐ = **582 days/year** of unproductive, non-value-adding time
	☐ = **4,656 hours**
	☐ = **2.4 FTEs**

Spaghetti (Shows people and deliverable travel) Diagrams



Measure

- Gemba / Process Stapling
- Process Maps: Swim Lane / Value Stream Maps
- Spaghetti Diagram
- ***Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)***
- Data Collection Plan
- Graphical representations
- Process Capability
- Control Charts
- Process Efficiency

Data Types

Variables are things that we measure, control or manipulate in research

But we measure different types of things:
1) Number of employees in a department (1,2,3…)
2) Overtime hours worked by each employee
3) Whether anyone has been trained (Yes/No)

The type of data and the way we measure our data (the "*type*") will determine the statistical models that we can use

When choosing variables think about the degree of detail required as well as the team's ability to collect the data

How to Qualify a Process?

- **We must begin by determining the nature of the X's and Y of the process**

Variables

- **Qualitatives**
  - **Nominal**
    - Region
    - Colour
  - **Ordinal**
    - Dissatisfied/neutral/satisfied
    - Low/Medium/high
  - **Binary**
    - Male/female
    - OK/Not OK
- **Quantitatives**
  - **Discrete**
    - Whole number
  - **Continuous**
    - Decimal

Basically we measure two types of data…

Data type	What it is	Example …
Numeric data	The value that we measure has a numeric meaning	Temperature in a room (Continuous) People in a room (Discrete)
Attribute data	The data identifies plots by the presence of an attribute or feature	Gender An item is acceptable or not Number of faults in a batch

Numeric data consists of two types:

- ***Continuous Data*** – the value can take any number between identified limits (in the table above, the first example – ‘Temperature in a room’ is continuous)
- ***Discrete Data*** – the value can only take specific numbers between identified limits (in the table above, the second example ‘People in a room’ is Discrete)

You need ‘tool’ to Measure

What you can count

Class Exercise: Types of Measure

- Time to process loan application
- Customer satisfaction rating (v. good, good, neutral, bad, v. bad)
- The time taken to process a sale is measured
- Number of invoices past due date
- Number of customer complaints

Measurement System Analysis (MSA)

The tools that you use to measure your data and the way that you use them, will add distortion to your data

- ***Bias*** – data is shifted up or down from its real values
- ***Precision*** – additional variation is added to the data

If there is too much distortion in your measurement system then your findings could lead you to seriously wrong conclusions

Make sure your measurement tools (gauges) are able to measure to the correct resolution needed and that people using them produce the same results

Best way for Green Belts

- Test how samples are measured using samples with known values
- Test multiple times (blind tests)
- Retrain operators where needed and use calibration tables to correct

MSA Terms

Gauge (Gage)

- Measurement tool / measurement process

Repeatability

- Can the same person get the same result when measuring the same item?

Reproducibility

- Do different people get the same results when measuring the same item?

Resolution

- The smallest unit that can be measured
- Often gauge capability is the limiting factor – ask the question:

"*Is the resolution sufficient*?"

Frequency and Sample Size

Frequency

Look for blocks and boundaries that might illuminate the problems you are investigating. For example, could work shifts or the day of the week be significant?

Can you identify any cycles in the process (ask the people in the process or investigate what customers think)

Attempt to sample at least 4 times within the shortest cycle or block and measure over 4 cycles if possible

Sample Size

You need a big enough sample to model the system and answer your research questions

The type of data collected influences the sample size

Big one-off units are best measured individually

For small parts, measure a group and aggregate

Population and Sample

Population

- The full set of everything we wish to investigate e.g.
  - The UK population
  - The number of bank workers on the payroll as of today

Sample

- A portion of the population e.g.
  - The number of bank cashiers

Plots

- Readings or figures taken – individual members of a population or sample

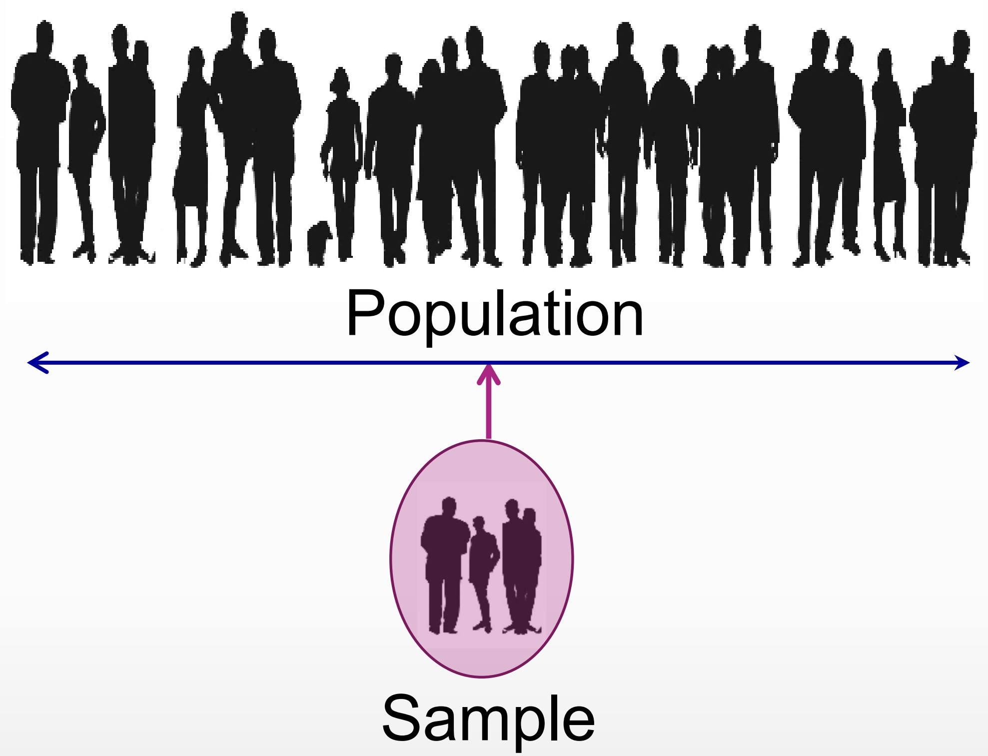
Frequency

- The number of identical plots in a population or sample

	Mean	Standard Deviation	Variance
Population	μ	σ	σ^2
Sample	$\bar{x}$	s	s^2

In Statistics, different symbols are used for data collected from a population and data collected via a sample.

Population and Sample



How representative is the sample of the full population?

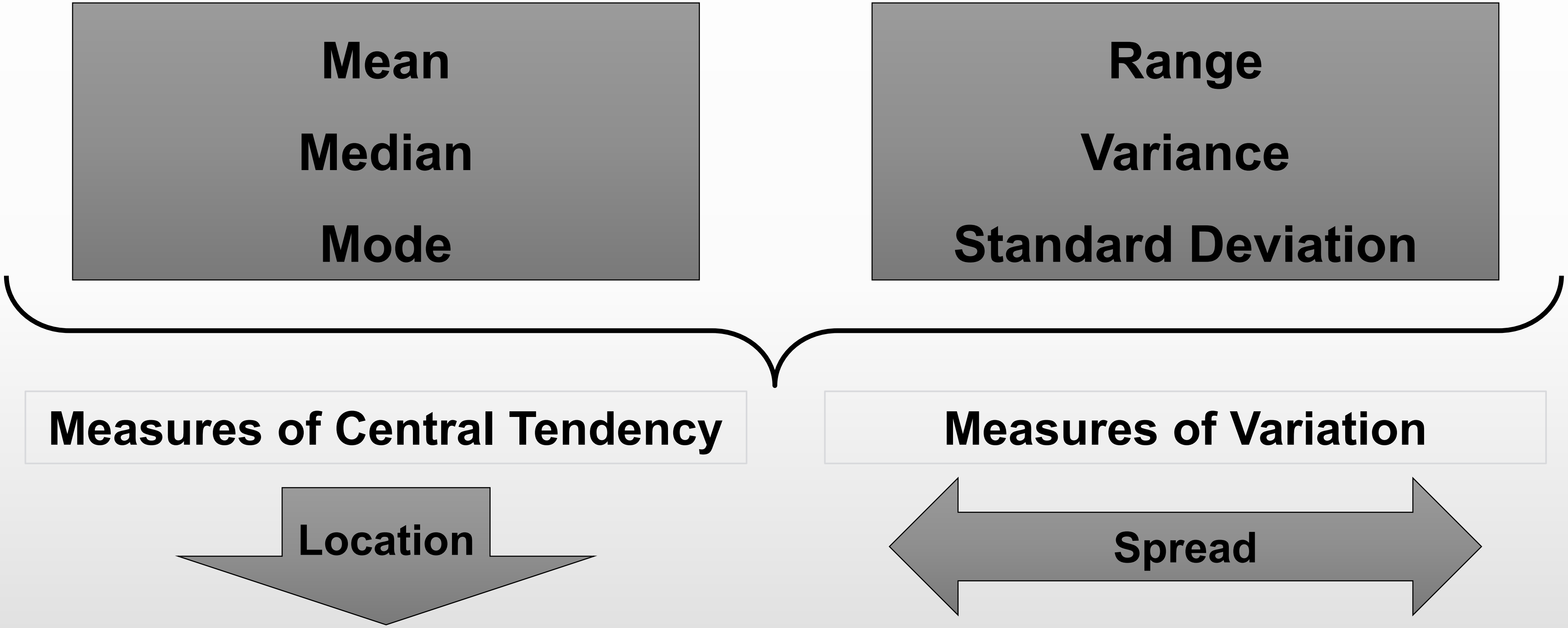
How much confidence would you have in forecasting from the sample to the population?

Population Size	Suggested Minimum
2 – 8	2
9 – 15	3
16 – 25	5
26 – 50	8
51 – 90	13
91 - 150	20
151 – 280	32
281 – 500	50
501 – 1200	80
1201 – 3200	125
3201 – 10000	200
10001 – 35000	315
35001 – 150000	500
150001 - 500000	800
> 500000	1250

Adapted from MIL Master Table for Normal Inspection (Guide to Quality Control; K Ishikawa)

Basic Statistics – Numeric Representation

Sample data can be summarised in two forms:



Mean

Median

Mode

Range

Variance

Standard Deviation

Measures of Central Tendency

Measures of Variation

Location

Spread

Central Tendency + Measures of Variation provides a summary of the data set

Centre of Data: Averages

Mean

- The sum of values divided by the number of values
- Most useful average in statistics
- Normal distribution peaks around the mean

2,2,5,6,7
Mean = 4.4

Median

- The mid-point value amongst all our values
- We have to use this if the data is skewed (ie with Poisson)
- Will give less accurate forecasts than using the mean

2,2,5,6,7
Median = 5

Modal

- Most frequently occurring event
- Useful when we categorise items than cannot be ordered (e.g. eye colour)

2,2,5,6,7
Modal = 2

Measures of Spread in Data: Variability Indicators

Range

- Subtract the smallest observation (minimum) from the largest observation (maximum)

Standard Deviation

- It is a measure of dispersion or spread
- It is always greater than or equal to 0 (zero)
- Obtained by taking the square root of the *Variance* and measures the spread around the *Mean*.

Variance

- Obtained by averaging the squared deviations of observations around the *Mean*. Because its units are the square of the variable Y, it is a measure that is not used directly, but to calculate *Standard Deviation*.

Calculating Standard Deviation with a Worked Example

Find the SD of the following 4 numbers: 4,4,8,16

1. Calculate the *Mean* $\overline{X}$	**[4+4+8+16=32]; then (32/4 numbers) = 8**
2. Subtract mean from each plot in the batch	[4-8=**-4**], [4-8=**-4**], [8-8=**0**], [16-8=**+8**] (quick check – do they all add up to zero?) **-4-4+0+8 = 0**
3. Square the result	-4^2, -4^2, 0^2, 8^2 +16, +16, 0, +64
4. Add results together	96
5. Divide total by sample size	(96/4) = 24
6. Take the Square root	[√24] = **4.90** (to 2 decimal places)

Standard Deviation

σ (‘Sigma’ or ‘SD’) is the ***average*** deviation of the individual values from their mean average value

The greater the SD the more variation in a process

Example:
Two companies measure the time taken for each to make a customer call back:

Company A	
1	20 mins
2	2 mins
3	40 mins
4	6 mins
5	38 mins
SD = 7.6 mins	

Company B	
1	20 mins
2	22 mins
3	18 mins
4	16 mins
5	19 mins
SD = 1.2 mins	

Measure

- Gemba / Process Stapling
- Process Maps: Swim Lane / Value Stream Maps
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- ***Data Collection Plan***
- Graphical representations
- Process Capability
- Control Charts
- Process Efficiency

Five-Step Data Collection Process

Step 1

Clarify data collection goals

- Link customer requirements to output measures
- *"Why are we collecting this data?"*

Step 2

Develop operational definitions and procedures

- What types of data?
- How much?
- How often?
- What accuracy?

Step 3

Plan the data collection methodology

- Validating measurement systems
- How good is your measuring system?
- Create and test your Data Collection Plan and Forms

Step 4

Begin data collection

- Be careful, this is where a lot of people want to begin!

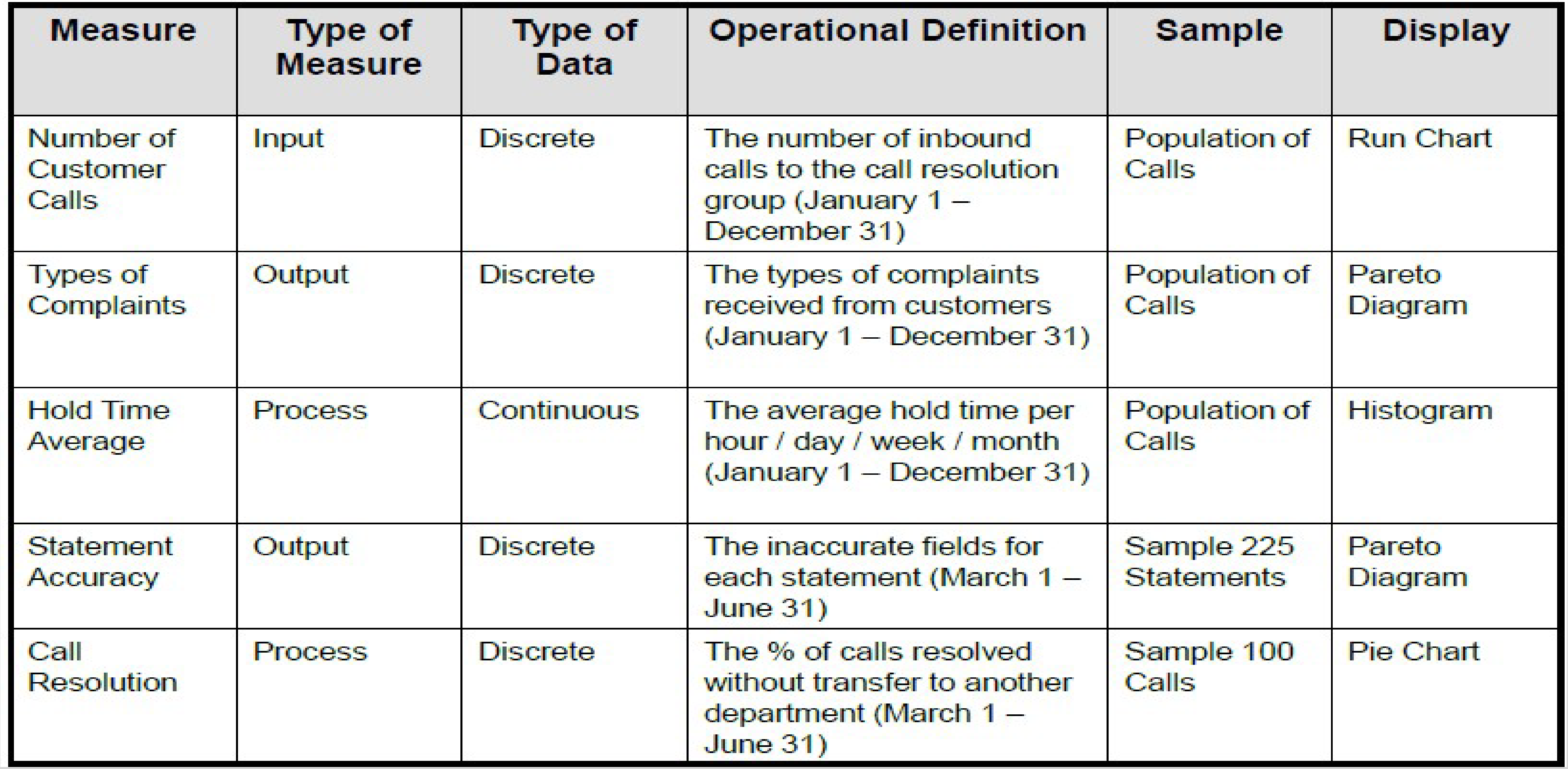
Step 5

Monitor, test and improve collection

- Test your data as you go along – will it answer your questions?
- Audit collection staff – are they still following procedures?
- Share lessons learned

Improve

Data Collection Plan – An Example



Measure	Type of Measure	Type of Data	Operational Definition	Sample	Display
Number of Customer Calls	Input	Discrete	The number of inbound calls to the call resolution group (January 1 – December 31)	Population of Calls	Run Chart
Types of Complaints	Output	Discrete	The types of complaints received from customers (January 1 – December 31)	Population of Calls	Pareto Diagram
Hold Time Average	Process	Continuous	The average hold time per hour / day / week / month (January 1 – December 31)	Population of Calls	Histogram
Statement Accuracy	Output	Discrete	The inaccurate fields for each statement (March 1 – June 31)	Sample 225 Statements	Pareto Diagram
Call Resolution	Process	Discrete	The % of calls resolved without transfer to another department (March 1 – June 31)	Sample 100 Calls	Pie Chart

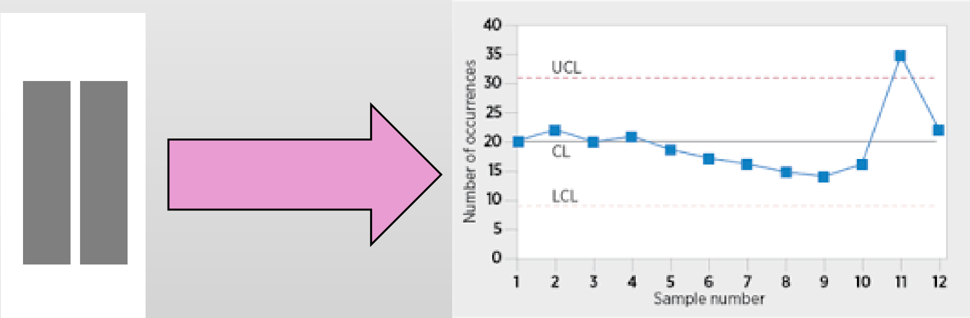
Measure

- Gemba / Process Stapling
- Process Maps: Swim Lane / Value Stream Maps
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Data Collection Plan
- ***Graphical representations***
- Process Capability
- Control Charts
- Process Efficiency

Statistical Process Control (SPC)

- SPC is a group of tools which model a system using some form of statistical analysis
- The basic aim is to illustrate system behaviour by taking raw data and displaying it in a graphical picture
- SPC is typically used to:
  - Help us understand the process ‘right now’
  - Help us project into the future
  - Understand process capability
  - Identify and differentiate Special & Common cause variation
  - Identify where waste/defects occur in a system and help discover cause & effect

Raw data



Modelled with a Control chart

Statistical Process Control (SPC) – 7 Basic Tools

Influenced by the teaching of Edward W Deming, Kaoru Ishikawa (aka, the father of quality circles) came up with **7 basic tools of quality** – *a fixed set of graphical techniques identified as being most helpful troubleshooting issues related to quality*.

1. **Check (or Tally) Sheet** – form used to collect data at the location they are generated
2. **Histogram** – an accurate representation of the distribution of numerical data
3. **Pareto Chart** – individual values are represented in descending order by bars
4. **Control Chart** – used to study changes in a process over time (guides: UCL / CL / LCL)
5. **Scatter Diagram** – the pattern of data points suggests if correlation may be present
6. **Run Chart** – helps to determine trends (or patterns) in a process
7. **Fishbone Diagram (Cause and Effect)** – used to categorise possible causes of a problem in order to determine the root cause

In SPC, we need to define a representative sample and then model it. Our model illustrates how the population is now and helps us to figure out how it could be improved.

Graphical Representation

- Frequency Distribution Tables
- Bar Charts and Histograms
- Pareto charts
- Run Chart
- Scatter Diagrams
- Normal Distribution
- Control Charts

Frequency Distribution Tables

Often statistical modelling needs you to organise the data in a sample or population by sample size

A frequency table can be used for this purpose

This simple table organises the sample values by grouping them together

This information can be used to generate Bar charts, Pie charts, Histograms etc

As well as whole numbers, you can select ranges or categories

Samples

4,1,1,2,3,4,2,2,3,5,2,3,3,3

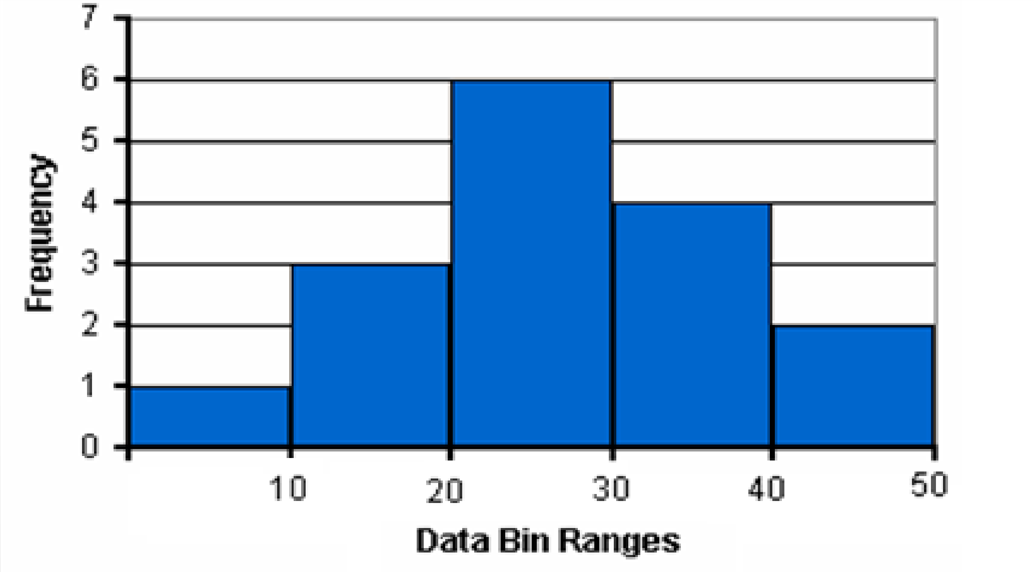
Sample Value	Frequency
1	2
2	4
3	5
4	2
5	1

Frequency Table

Histograms

A ***histogram*** is “a representation of a frequency distribution by means of rectangles whose widths represent class intervals and whose areas are proportional to the corresponding frequencies.” - *Online Webster's Dictionary*

Data Range	Frequency
0-10	1
11-20	3
21-30	6
31-40	4
41-50	2



Bin ID (X axis)

The number on the join by convention identifies the left-hand bin with the right-hand bin starting at the next increment. So, for example, the first bin holds values 0-10 then the next bin starts at 11 and finishes at 20

Bar Charts and Histograms

Bar Graphs are good when your data is in categories (e.g. sales by region) especially when you want to compare them

But when you are measuring one thing (such as the number data sources for deliverable report) then a Histogram might be a better choice

The area under the Histogram represents the sample or population, with each bar representing a select segment

- Bars are kept the same width so the variance in each segment can be easily identified by height
- If a segment does not have any samples recorded in it then leave a gap (frequency = 0)

Histograms

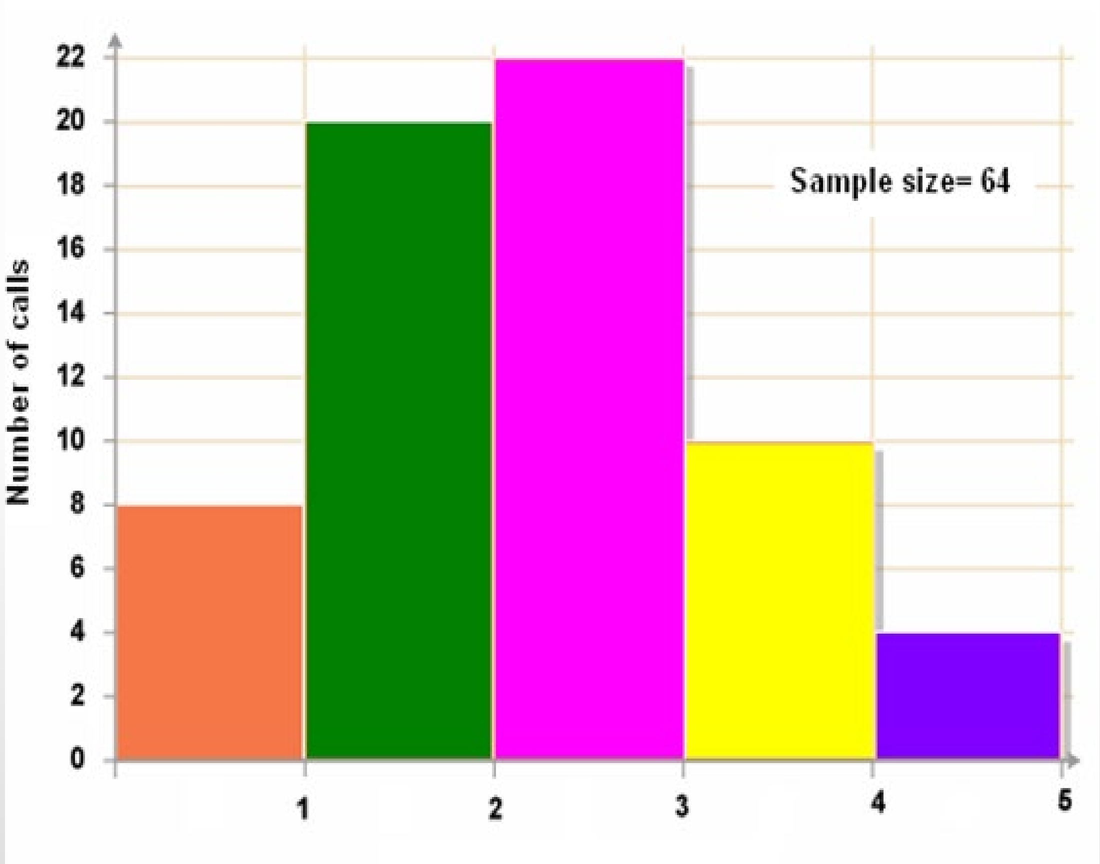
The segments are all aligned (although you can have bins with zero contents)

The segment area represents the total sample percentage of that range

Frequency (number of samples that fit the range) is indicated by height (all segments are the same width)

The convention is that the starting number identifies the smallest value counted in that segment (so anything below 1 min is in the first bin)

frequency



Call Centre pick up times

Pareto Principle…

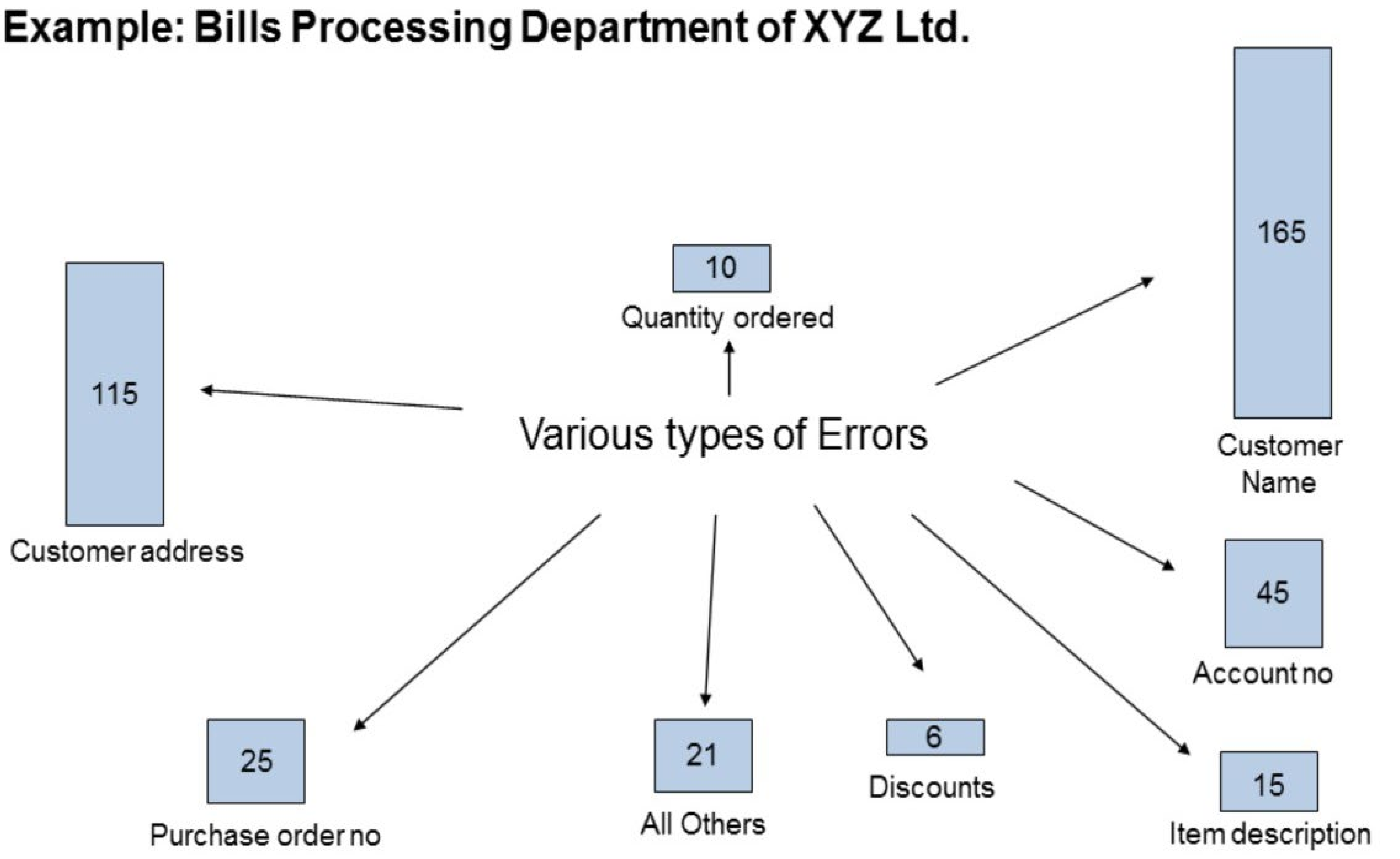
The **Pareto principle** (the **20–80 rule**, the **law of the vital few,** or **principle of factor sparsely**) states that for many events, roughly 80% of the effects come from 20% of the causes

Italian economist Vilfredo Pareto observed in 1906 that 80% of the land in Italy was owned by 20% of the population. He developed the principle by observing that 20% of the pea pods in his garden contained 80% of the peas.

Pareto – An Example

About 400 invoices with errors have been collected. The types of error have been determined. [Note that 21 individual errors have been combined at the end]

This information here is then placed onto a Pareto Chart – see next slide.



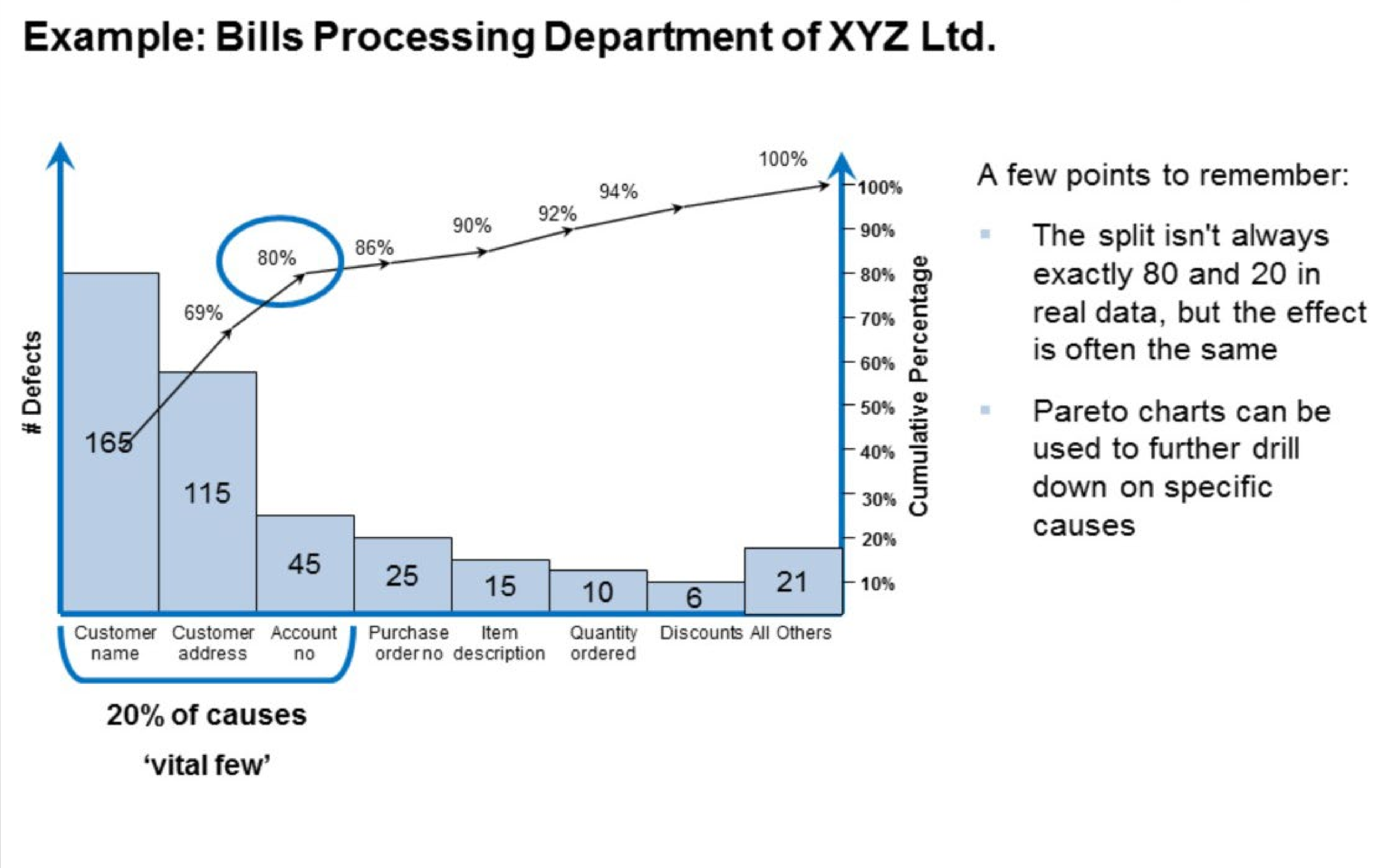
Pareto – An Example (contd.)

ADVICE:

Focus first on the largest bar – this could reduce errors by 40% (not bad for a GB improvement).

Having completed that move to the next one, etc.

<ins>Another benefit</ins> of the Pareto is that it can be used as a before and after picture to demonstrate improvement at Control.



Example: Bills Processing Department of XYZ Ltd.

A few points to remember:

- The split isn't always exactly 80 and 20 in real data, but the effect is often the same
- Pareto charts can be used to further drill down on specific causes

How to Create a Pareto Chart

Segment the range of the data into groups (also called segments, bins or categories) e.g.

- Unable to download
- Can’t find the file
- Open as read only
- Etc.

The left-side vertical axis of the Pareto chart is labelled Frequency (the number of counts for each category

The right-side vertical axis of the Pareto chart is the cumulative percentage, and the horizontal axis is labelled with the group names of your response variables

You then determine the number of data points that reside within each group and construct the Pareto chart, but unlike the Bar chart, the Pareto chart is ordered in descending frequency magnitude

Class Exercise

Create a
Pareto Chart

Run Charts

A run is defined as one or more consecutive data points on the same side of the median

A run could have a single point, or many points chart

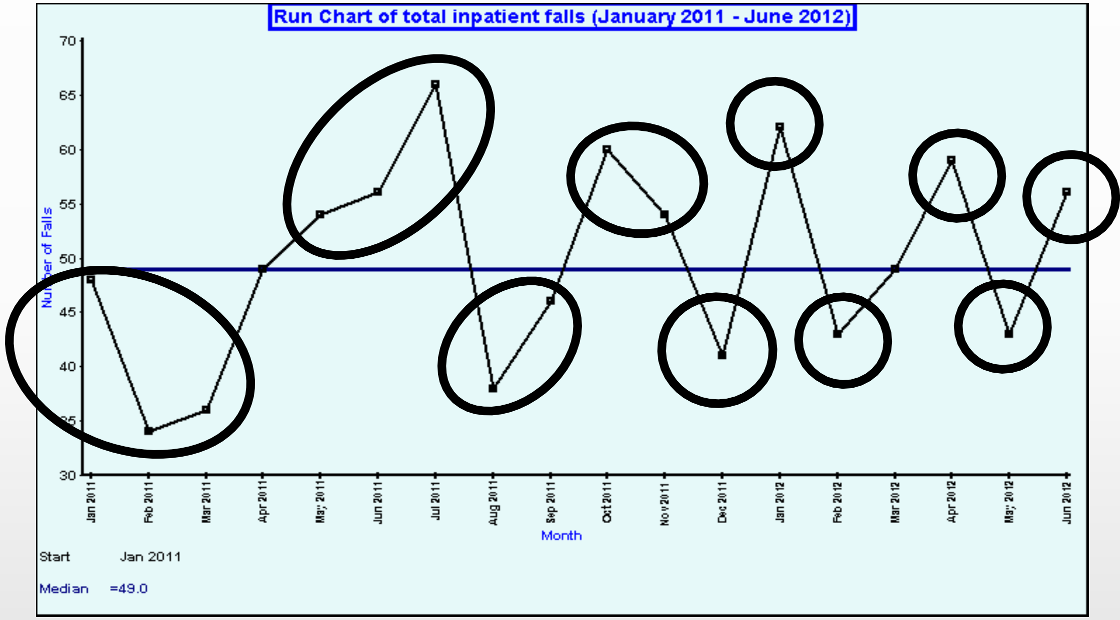
Help to identify trends in data

Link changes in the process to points in time

Do not need the normal distribution

Often used in the Control phase to track process performance

In this case the acceptable values are often 'hard wired' onto the chart



In this chart, there are 10 runs.

- Notice that the runs exclude any points that are on the median line.

Run Chart – Special Causes

Test 1

- **The presence of too much or too little variability**
  - This is determined by analysis of the number of runs, and ascertaining if there are too few or too many runs based on the total number of observations.

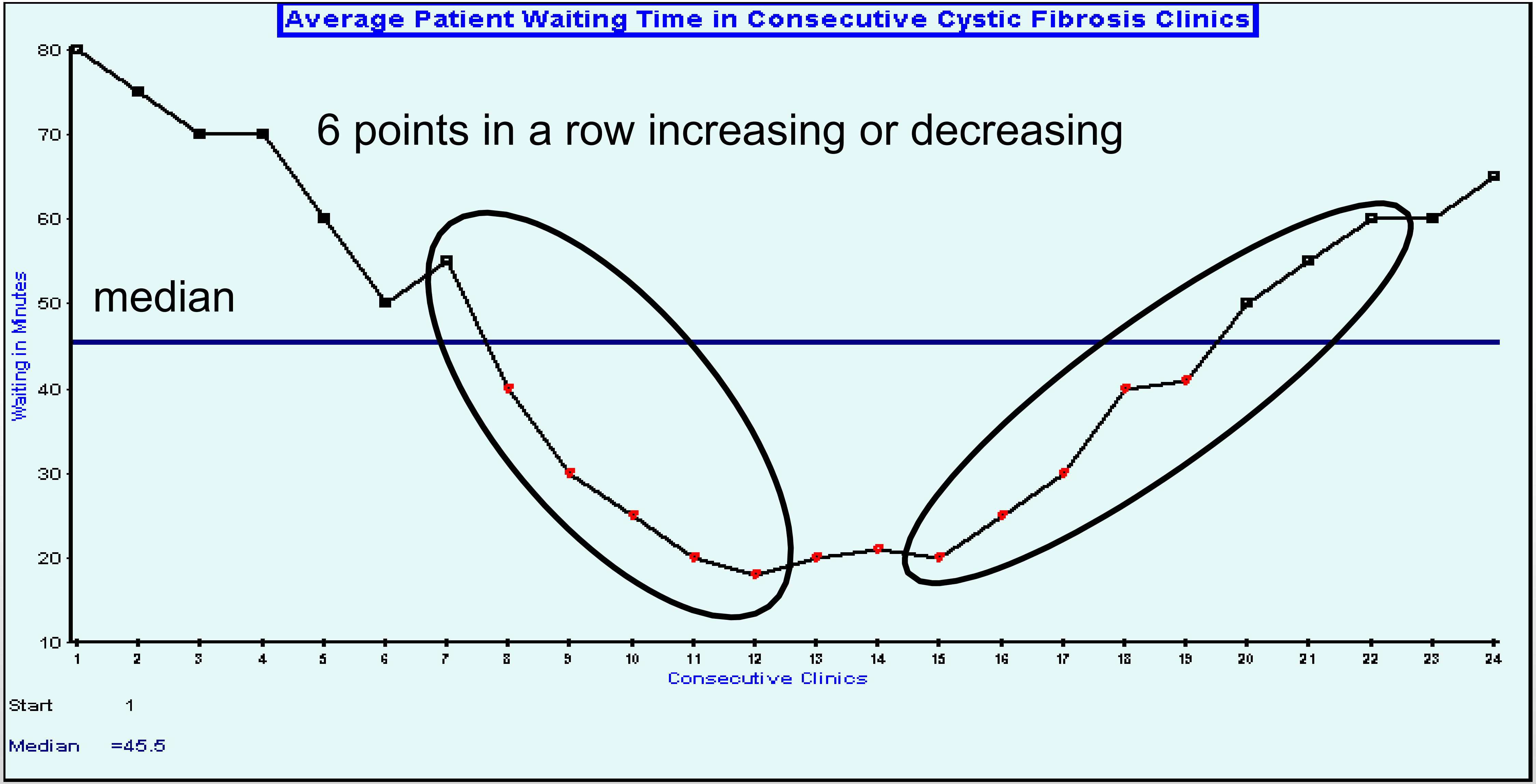
Test 2

- **The presence of a shift in the process (the run is too long)**
  - With 20 or more data points, a run of eight or more data points is “too long”.

Test 3

- **The presence of a trend**
  - A trend is defined as an unusually long series of *consecutive* increases or decreases number should be at least six or seven

Run Chart – Special Causes – Trend



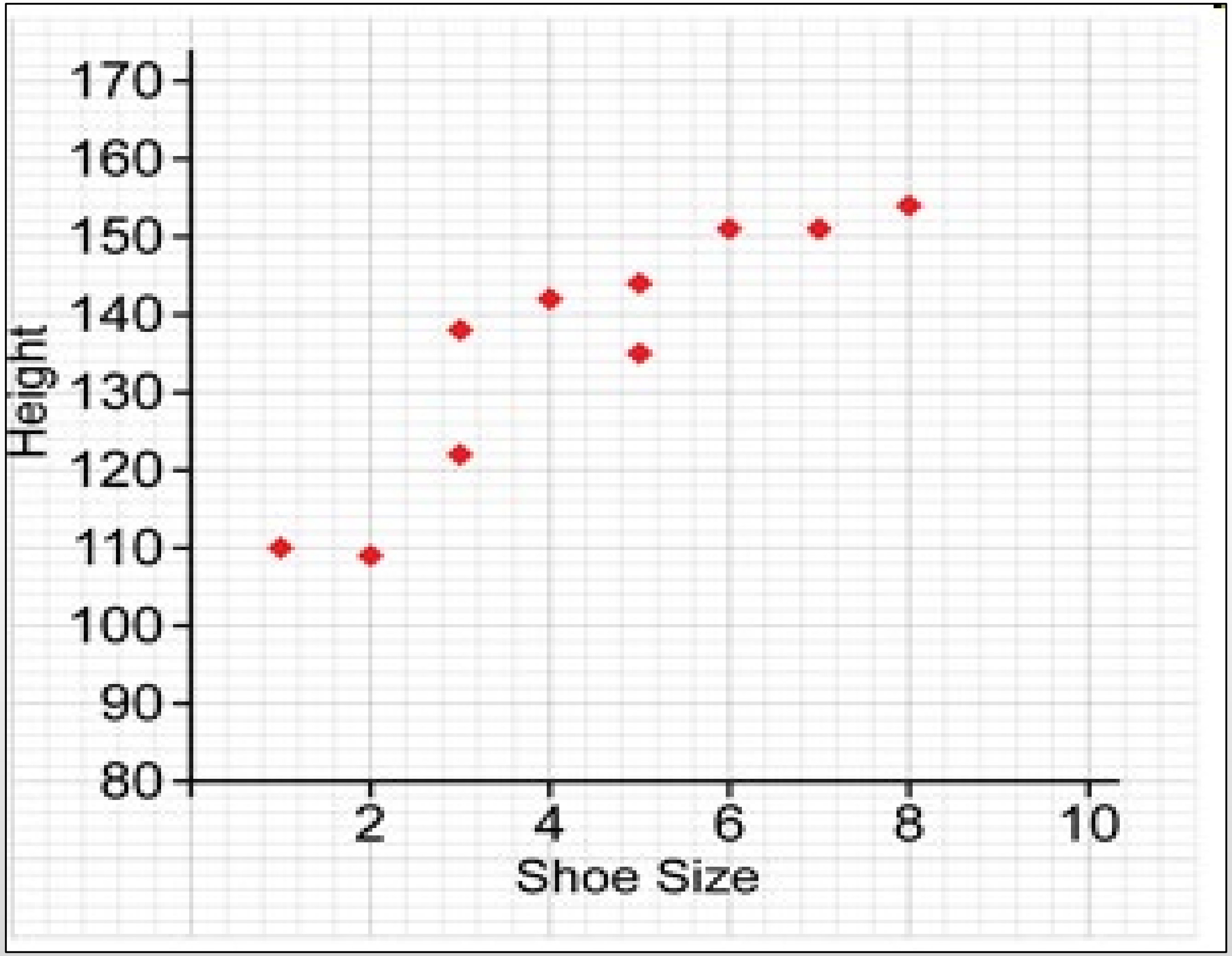
Scatter diagrams

Used to map data points between two axis

- X: horizontal
- Y: vertical

Used to indicate if one variable is linked with another (if there is a correlation)

Do you think that a person's height and shoe size could be related?



Creating scatter diagrams

Identify the input and output variables you wish to investigate

Design a data collection plan and appropriate forms to capture the states of both variables in a way that can be linked (e.g. measure the ‘X’ and the ‘Y’ at the same time)

Plot the pairs of data on a graph – convention is using the input variable as the vertical (‘Y’) plot

Look to see if you can identify a direction – if you can draw a straight line through the middle (aim for 50% of the plots on either side)

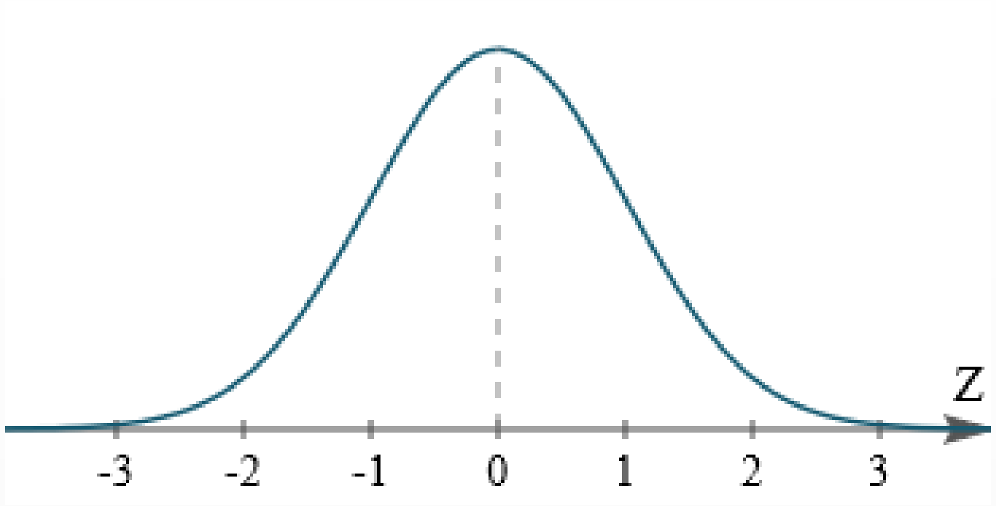
Distributions and Distribution Curves

Distribution

- All the possible values which a variable can take (the population)

Distribution Curve

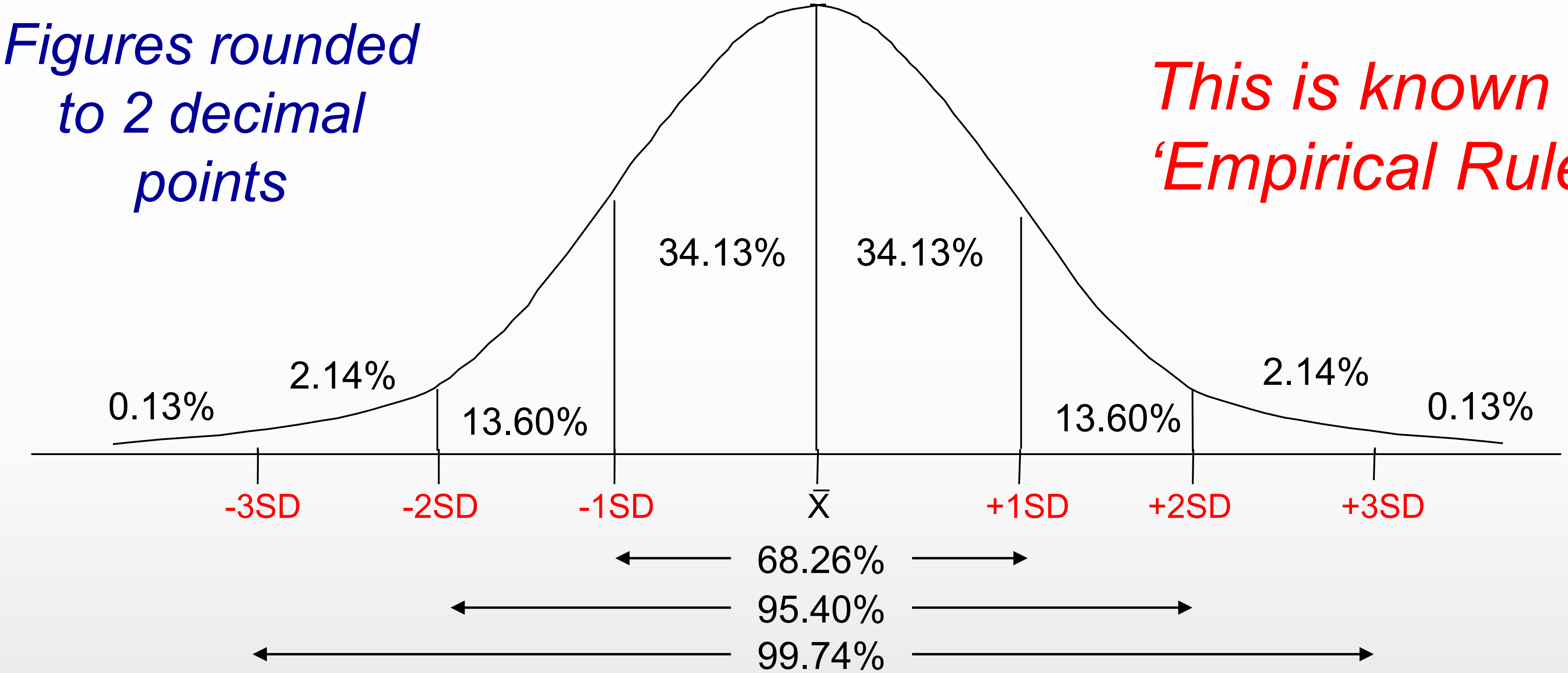
- The boundary of the distribution
- Can be shown as a graph or described in a mathematical function
- The area under the curve represents
  100% of the population



There are many different types of Distribution Curves – in this course we will look at the most common (and useful): The Normal Distribution (Bell Curve)

Plot Density under the Normal Distribution

Figures rounded to 2 decimal points



This is known as the 'Empirical Rule'

σ = SIGMA

68.26% Fall within +/- 1 sigma

95.40% Fall within +/- 2 sigma

99.74% Fall within +/- 3 sigma

Note how the majority of plots occur closest to the mean

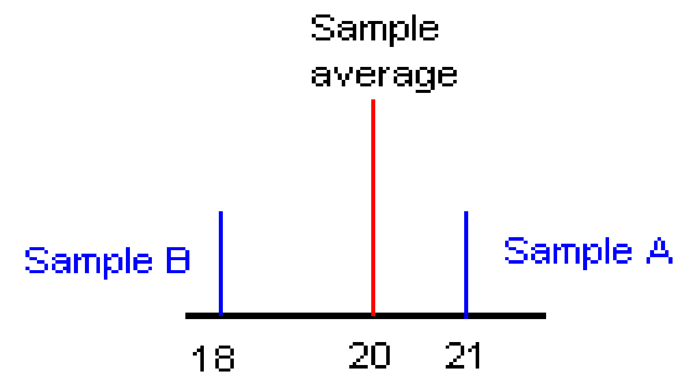
Standard Deviation (σ or SD)

Deviation is the term used to describe the difference between an individual plot and the mean

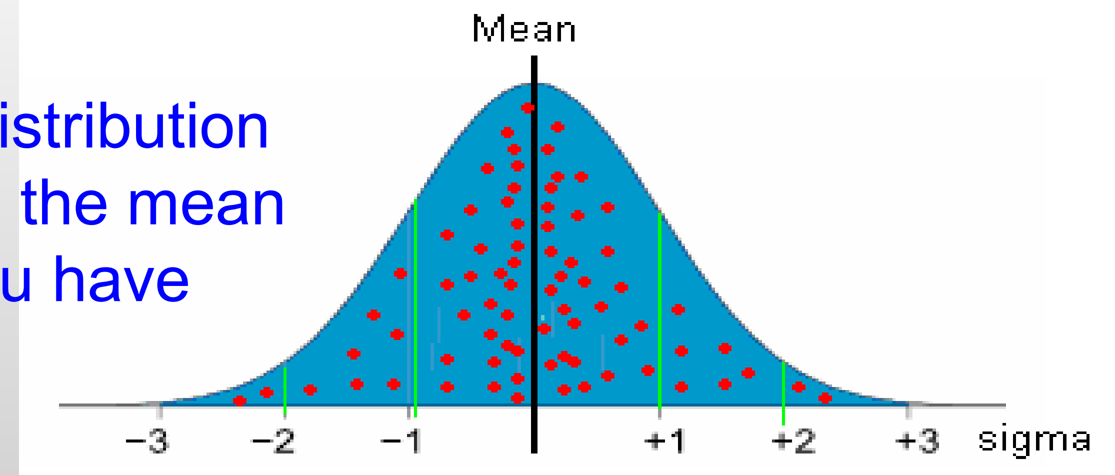
The Standard Deviation, σ (sigma) or 'SD' is the mean average of all the individual plot deviations

In a Normal Distribution (Bell curve), you can estimate the plot density by using the mean value and the SD

Mean of 100 plots = 20
Deviation of A = +1 (21-20)
Deviation of B = -2 (18-20)
SD for just these two plots = -0.5 (1-2/2)



Under the Normal Distribution the nearer you get to the mean the more plots you have



Measure

- Gemba / Process Stapling
- Process Maps: Swim Lane / Value Stream Maps
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Data Collection Plan
- Graphical representations
- ***Process Capability***
- Control Charts
- Process Efficiency

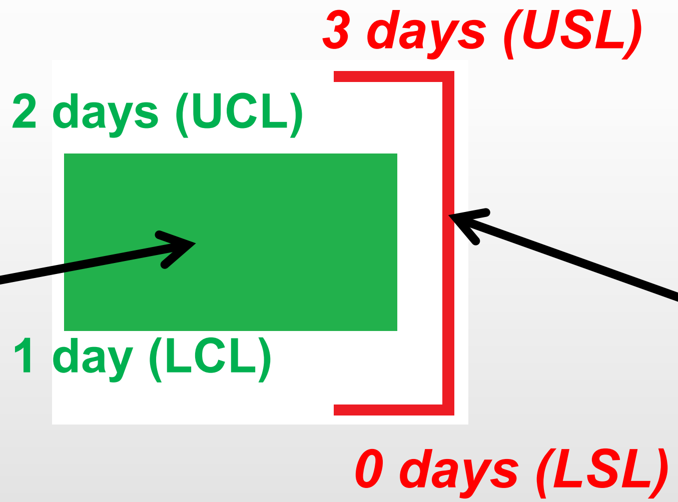
Process Capability

All processes have variation in their outputs

Customers will only accept a certain range of variance (tolerance) from a supplier

The ***capability*** of a process is a measure of its ability to deliver within customer tolerance

Process Variation
The maximum and minimum values created by the process



3 days (USL)

2 days (UCL)

1 day (LCL)

0 days (LSL)

Customer Tolerance
The maximum and minimum values they will accept from a process

Example: Customers expect a response to a question within 3 days. When measured, the company responded to all questions within 1-2 days. This is therefore a ***capable*** process

Defects

Anything produced greater or smaller than the customer specifications (i.e. outside their tolerance)

Process Variation

The maximum and minimum values created by the process

Customers Tolerance

The maximum and minimum values the customer will accept from a process

---

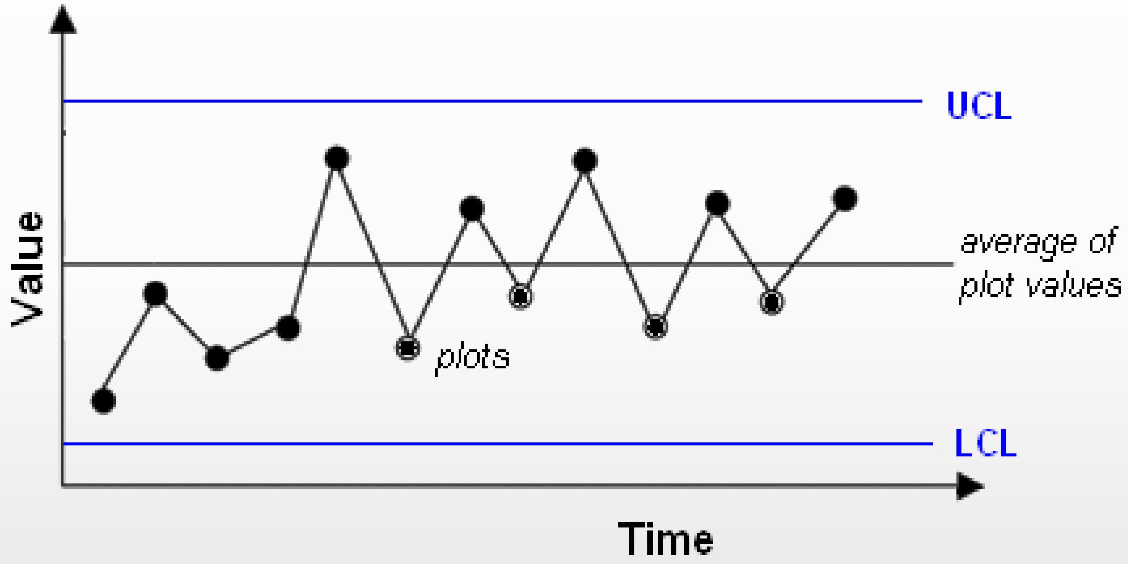
Example: Customers expect a response to a question within three days. When measured the company responded to all questions within 1-5 days. This is therefore ***NOT*** a ***capable*** process

Measure

- Gemba / Process Stapling
- Process Maps: Swim Lane / Value Stream Maps
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Data Collection Plan
- Graphical representations
- Process Capability
- ***Control Charts***
- Process Efficiency

Understanding Control Charts

A control chart is a graph used to study how a process changes (varies) over time. Data are plotted in time order



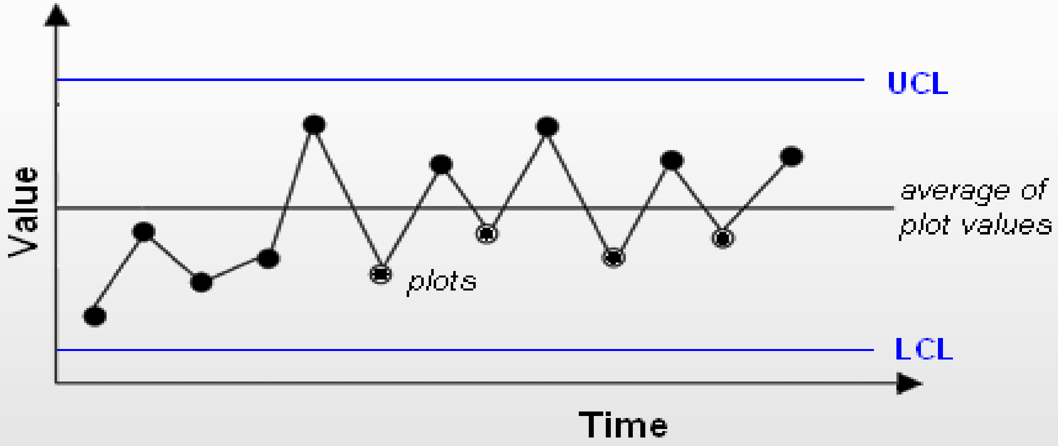
A control chart monitors on-going process performance by measuring the output of a process. It identifies how well it is performing and will show the performance of the process over time. It can be used to demonstrate that your improvements were sustained.

All control charts share 3 attributes

A ***centre line*** representing an average value of the selected data characteristic

An ***Upper Control Limit*** (UCL) representing a statistically determined upper boundary of 'acceptable' variation

A ***Lower Control Limit*** (LCL) representing a statistically determined lower boundary of 'acceptable' variation



The values of the UCL and LCL are selected so that most of the common cause variation (typically 99.73%) lies between them (as shown in the graphic). Thus, if you sample your process and you get a value outside of the *Control Limits*, you can suspect that there is a **Special** (or '**Assignable**') cause behind it which you must then investigate.

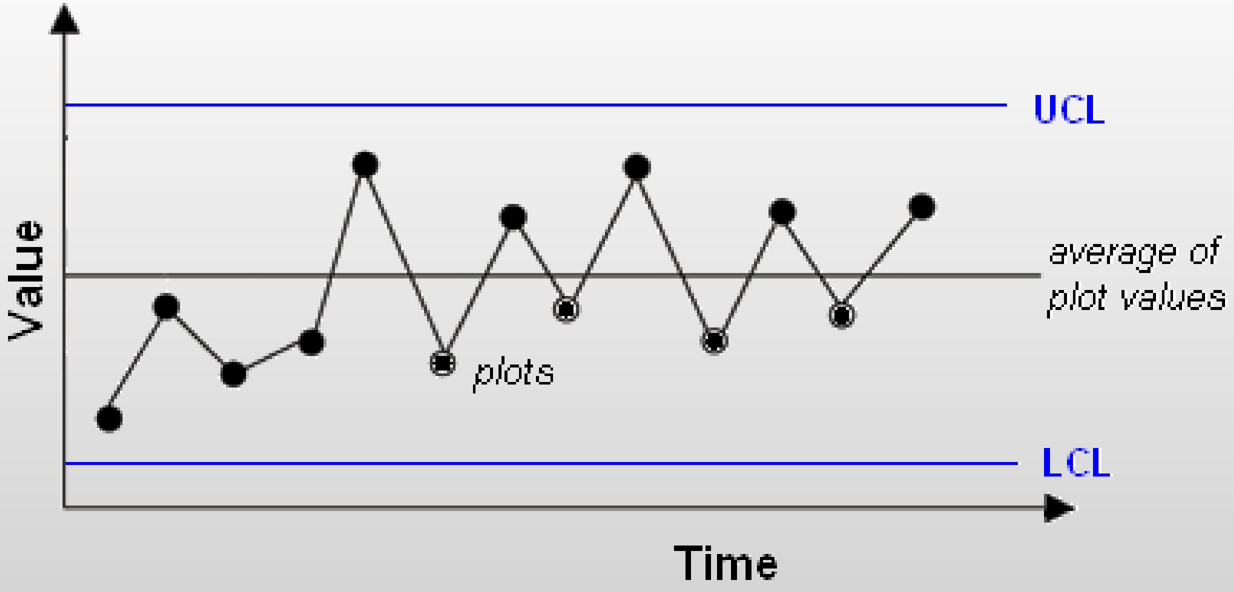
Creating Control Charts (Overview)

Sample the process by taking measurements (data values)

Record these values on a chart in the order received (plots)

Calculate the average value and show this on the chart

Calculate the UCL and LCL and show these on the chart

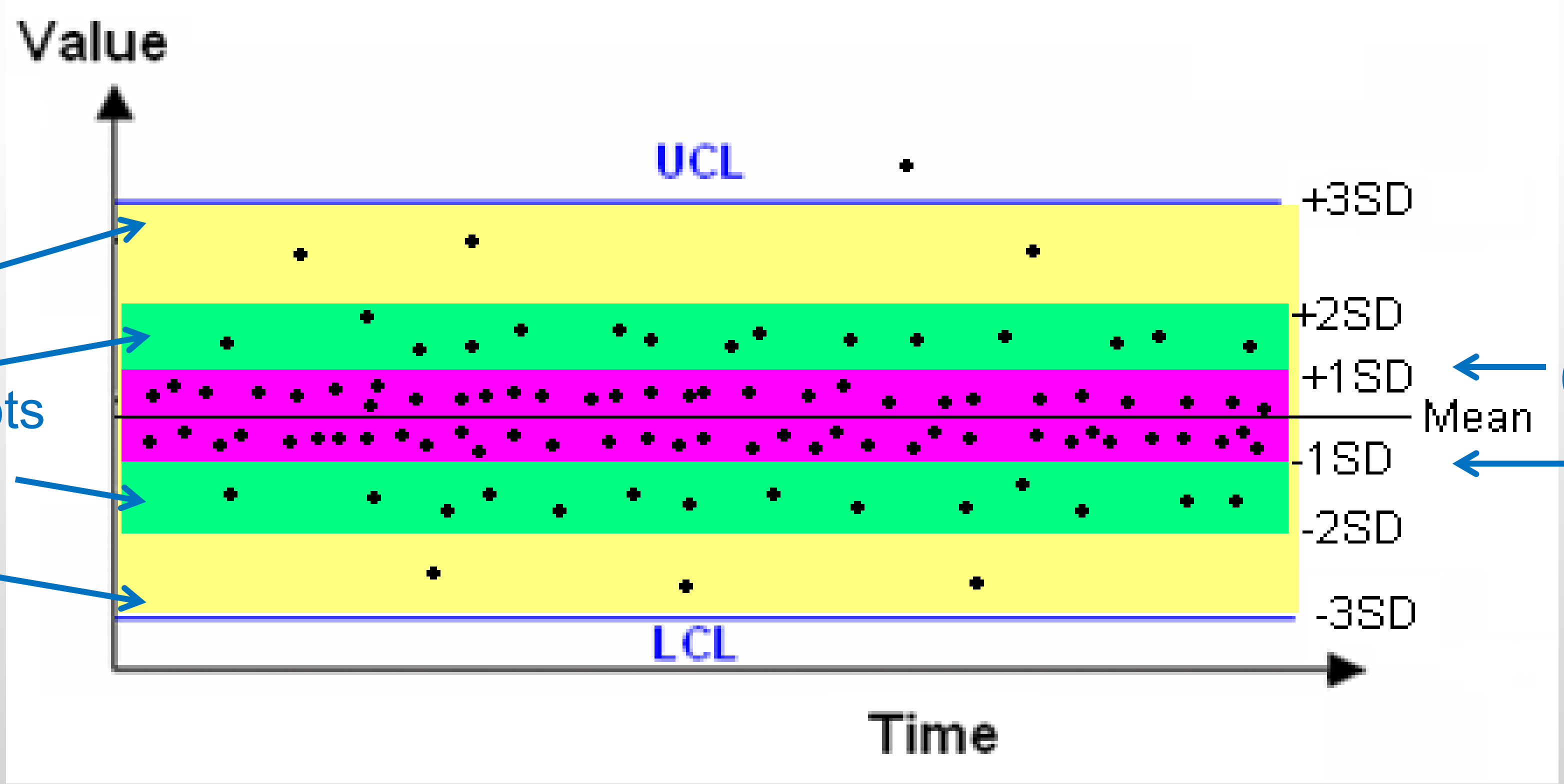


Common Cause variation and SD (Sigma) – the Empirical rule

About 68% of our values will be between **+/- 1 SD** of the mean

About 95% of our values will be between **+/- 2 SDs** of the mean

About 99.73% of our values will be between **+/- 3 SDs** of the mean



99.73% plots here

95% plots here

68% plots here

Two Types of Process Variation

Common Cause variation

- Variation due to the natural variation that is inherent within a process
- If all variation is due to '***common causes***', the result will be a ***predictable*** or ***stable*** system

Variation is the "Voice of the Process" – learn to listen to it and to understand it

Most processes have both types of variation – Control Charts can help identify them

Special Cause variation

- Additional variation with a specific external cause
  - A more capable operator reduces variation
  - Electrical spark from elevator causes a cutting machine to reset
- If some variation is from '***Special Causes***', the result is an ***unpredictable*** or ***unstable*** system
- Remove special causes before using statistical analysis (usually a quick fix)

Measure

- Gemba / Process Stapling
- Process Maps: Swim Lane / Value Stream Maps
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Data Collection Plan
- Graphical representations
- Process Capability
- Control Charts
- ***Process Efficiency***

Identifying Process Efficiency

There are three common ways of describing the efficiency of a process:

Yield

- How many pieces are within the customer's specification limits?
- Usually expressed as a percentage of the total batch

DPMO

- **D**efects **P**er **M**illion **O**pportunities
- In a million defect opportunities how many defects will actually occur?

Process Sigma

- A way of forecasting how likely our process is to meet the customer's requirements – the higher the Sigma number, the more successful we are
- The value of Sigma is derived practically from the variation within a process

Methodology for Calculating Yield

The % of total which is not defective

- 84% of trains on time
- 90% customers satisfied
- 95% of faults fixed on first visit to customer

Common and well understood term

Can add decimal points

- 5 nines (99.999%)

Can have difficulty expressing very low loss

$$\text{Yield} = \frac{\textbf{Number of pieces acceptable to the customer}}{\textbf{Total number of pieces produced}}$$

Methodology for Calculating DPMO

Equation for defects per million opportunities:

$$\textbf{DPMO} = 1{,}000{,}000 \quad \text{x} \left(\frac{D}{N \text{ x } O} \right)$$

N = Number of units processed

D = Total number of defects made (including defects made and later fixed)

O = Number of defect opportunities per unit

A worked example...

Number of units processed	**N** = **500**
Total number of **d**efects made (include defects made and later fixed)	**D** = **57**
Number of defect **o**pportunities per unit	**O** = **3**
Solve for **d**efects **p**er **m**illion **o**pportunities	$$\textbf{DPMO} = 1{,}000{,}000 \quad x \quad \left(\frac{D}{N \text{ x } O}\right)$$

1,000,000 x 57/(500 x 3)

= **38,000**

Key DPMO terms

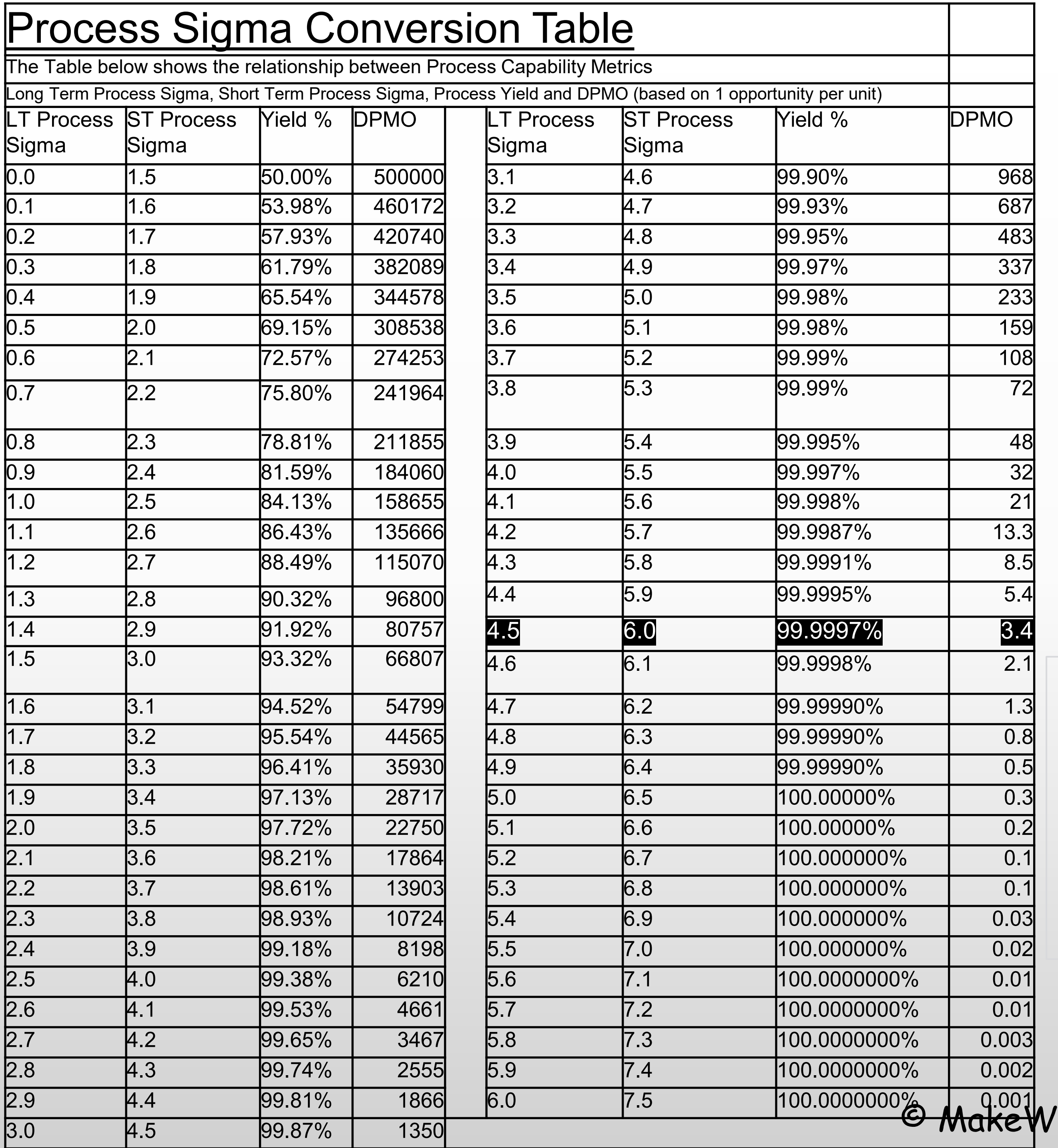
Unit	• A Piece or item • It is sometimes convenient to consider a process as a Unit
Defect	• Something about a product or process which a customer finds unacceptable • A unit which exceeds a Specification Limit or Tolerance level
Defective	• A Unit with at ***least*** one defect
Defect opportunity	• A chance to create a defect
Batch	• A group or series of units

Determining Baseline Sigma

To establish the **process sigma**, three things need to be known with respect to the process output:	1) The number of **units** the process produces
	2) The number of the different types of **defects** that can cause failure for the process per unit (e.g. how many things can cause the input of wrong data into Excel)
	3) The total number of **opportunities** to have a failure – this will be the number of units churned out by the process

Once you have this information, the defects per opportunity (**DPO**) can be calculated by dividing the total number of defects by the total number of units, and then multiplied by the number of opportunities; thus, you get the error per unit.

This DPO figure is then multiplied by 1,000,000 to determine the **DPMO**.



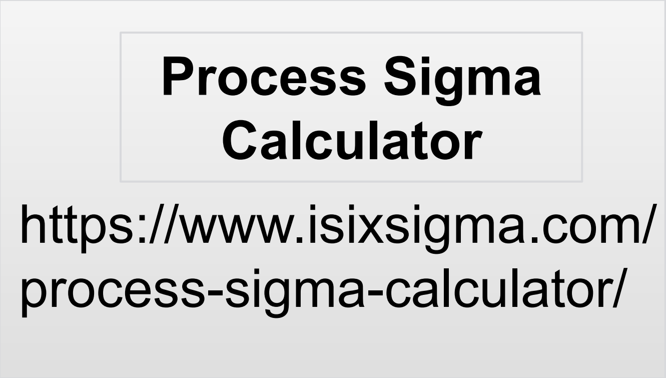
Process Sigma Conversion Table

The Table below shows the relationship between Process Capability Metrics

Long Term Process Sigma, Short Term Process Sigma, Process Yield and DPMO (based on 1 opportunity per unit)

LT Process Sigma	ST Process Sigma	Yield %	DPMO	LT Process Sigma	ST Process Sigma	Yield %	DPMO
0.0	1.5	50.00%	500000	3.1	4.6	99.90%	968
0.1	1.6	53.98%	460172	3.2	4.7	99.93%	687
0.2	1.7	57.93%	420740	3.3	4.8	99.95%	483
0.3	1.8	61.79%	382089	3.4	4.9	99.97%	337
0.4	1.9	65.54%	344578	3.5	5.0	99.98%	233
0.5	2.0	69.15%	308538	3.6	5.1	99.98%	159
0.6	2.1	72.57%	274253	3.7	5.2	99.99%	108
0.7	2.2	75.80%	241964	3.8	5.3	99.99%	72
0.8	2.3	78.81%	211855	3.9	5.4	99.995%	48
0.9	2.4	81.59%	184060	4.0	5.5	99.997%	32
1.0	2.5	84.13%	158655	4.1	5.6	99.998%	21
1.1	2.6	86.43%	135666	4.2	5.7	99.9987%	13.3
1.2	2.7	88.49%	115070	4.3	5.8	99.9991%	8.5
1.3	2.8	90.32%	96800	4.4	5.9	99.9995%	5.4
1.4	2.9	91.92%	80757	4.5	6.0	99.9997%	3.4
1.5	3.0	93.32%	66807	4.6	6.1	99.9998%	2.1
1.6	3.1	94.52%	54799	4.7	6.2	99.99990%	1.3
1.7	3.2	95.54%	44565	4.8	6.3	99.99990%	0.8
1.8	3.3	96.41%	35930	4.9	6.4	99.99990%	0.5
1.9	3.4	97.13%	28717	5.0	6.5	100.00000%	0.3
2.0	3.5	97.72%	22750	5.1	6.6	100.00000%	0.2
2.1	3.6	98.21%	17864	5.2	6.7	100.000000%	0.1
2.2	3.7	98.61%	13903	5.3	6.8	100.000000%	0.1
2.3	3.8	98.93%	10724	5.4	6.9	100.000000%	0.03
2.4	3.9	99.18%	8198	5.5	7.0	100.000000%	0.02
2.5	4.0	99.38%	6210	5.6	7.1	100.0000000%	0.01
2.6	4.1	99.53%	4661	5.7	7.2	100.0000000%	0.01
2.7	4.2	99.65%	3467	5.8	7.3	100.0000000%	0.003
2.8	4.3	99.74%	2555	5.9	7.4	100.0000000%	0.002
2.9	4.4	99.81%	1866	6.0	7.5	100.0000000%	0.001
3.0	4.5	99.87%	1350				

Six Sigma DPMO to Sigma to Cpk Chart



Process Sigma Calculator

https://www.isixsigma.com/process-sigma-calculator/

Short Term and Long Term Process Sigma (1)

Short term process sigma	**Long term process sigma**
What the ***Supplier*** sees	What the ***Customer*** sees
The result of measuring a process over a short period of time	The result of measuring a process over a longer period of time
Outliers which increase SD (and reduce Process Sigma) are rare and usually are missed in short term measurement	Outliers which increase SD (and reduce Process Sigma) will occur during the longer time span and decrease the short term figure
This results in an over optimistic assessment of process sigma	

Motorola tested a stable system and estimated that a short term assessment of process sigma was reduced by 1.5 sigma over the long term

Short Term and Long term Process Sigma (2)

The problem lies with mapping to DPMO and Yield

As a result there are two conflicting tables in existence:

- Short Term (corrected)
- Long Term (uncorrected)

Long Term Sigma – DPMO mapping is 1.5 sigma less than the corrected short term

Process Sigma	Yield %	DPMO
1.9	97.13	28717
1.8	96.41	35930

Long term conversion table uncorrected

Process Sigma	Yield %	DPMO
3.4	97.13	28717
3.3	96.41	35930

Equivalent entries in short term conversion table corrected to reflect 1.5 sigma shift

Expressing Process Efficiency

By % of good output (yield)

By % of defectives

By the number of defects per number of opportunities to go wrong

- Typically per million opportunities (DPMO)

By the Short Term or Long Term Process Sigma Level

Yield %	**DPMO**	**LTσ**	**STσ**
97.72	22750	2.0	3.5
99.87	1,350	3.0	4.5
99.997	32	4.0	5.5
99.9997	3.4	4.5	6.0
99.9999998	0.002	6.0	7.5

TIP: *If you want to determine which type of process sigma a chart is using, look for the DPMO value against 6σ. If the DPMO = 3.4 you have a short term, (corrected) chart*

Measure Phase – Review Questions

☐ What is important in the measurement system?
☐ What is important in choosing a sample size?
☐ What different methods can be used to collect a representative sample?
☐ What do the *Mean*, *Median* and *Mode* estimate?
☐ What do we use to describe the *spread* of data?
☐ What does *Rolled Throughput Yield* mean?
☐ What does a *Pareto Chart* show?
☐ What are the two types of variation in a process?
☐ What does a control chart show?

DMAIC

- Define
- Measure
- ***Analyse***
- Improve
- Control

Analyse

DEFINE

MEASURE

ANALYSE

Identify the root cause of the problem

IMPROVE

CONTROL

Objectives

- To analyse the process activity and…
  - ➢identify critical factors causing waste and unacceptable variation
- To identify possible **root cause(s)** and…
  - ➢confirm (or validate) them using data (these 'root causes' will form the basis for solutions in the next phase)

Outcomes

- Identified and tested root cause(s)
- Show the desired or '***To be***' state

Analyse

- ***Root Cause Analysis (RCA)***
  - ***5 Whys***
  - ***Fishbone***
- Scatter Diagrams – Correlation and Regression
- Investigating the Process (inc Value Stream Map)

☐Muda (Wastes) in Lean Services

5 Whys

How do you use the 5 Whys?

- By repeatedly asking the question "Why" (five is a good rule of thumb), you can peel away the layers of symptoms which are disguising the *root* cause(s) of a problem

What are the benefits of using 5 Why?

- Help identify the ***root cause*** of a problem
- Determine the relationship between different root causes of a problem
- One of the simplest tools – easy to complete without statistical analysis

When Is 5 Whys Most Useful?

- When problems involve human factors or interactions

Examples of 5 Whys

Business

Why are our sales down?
- Nobody’s buying our product

Why is nobody buying?
- Because our delivery has a poor reputation

Why do we have a poor reputation?
- Because we are always late

Why are we always late?
- Because we do not have enough trucks

Why do we have too few trucks?
- Because we underestimated demand for our product

Technical

Why is there water on the floor?
- Because a pipe in the roof split

Why did it split?
- Because the water in it froze

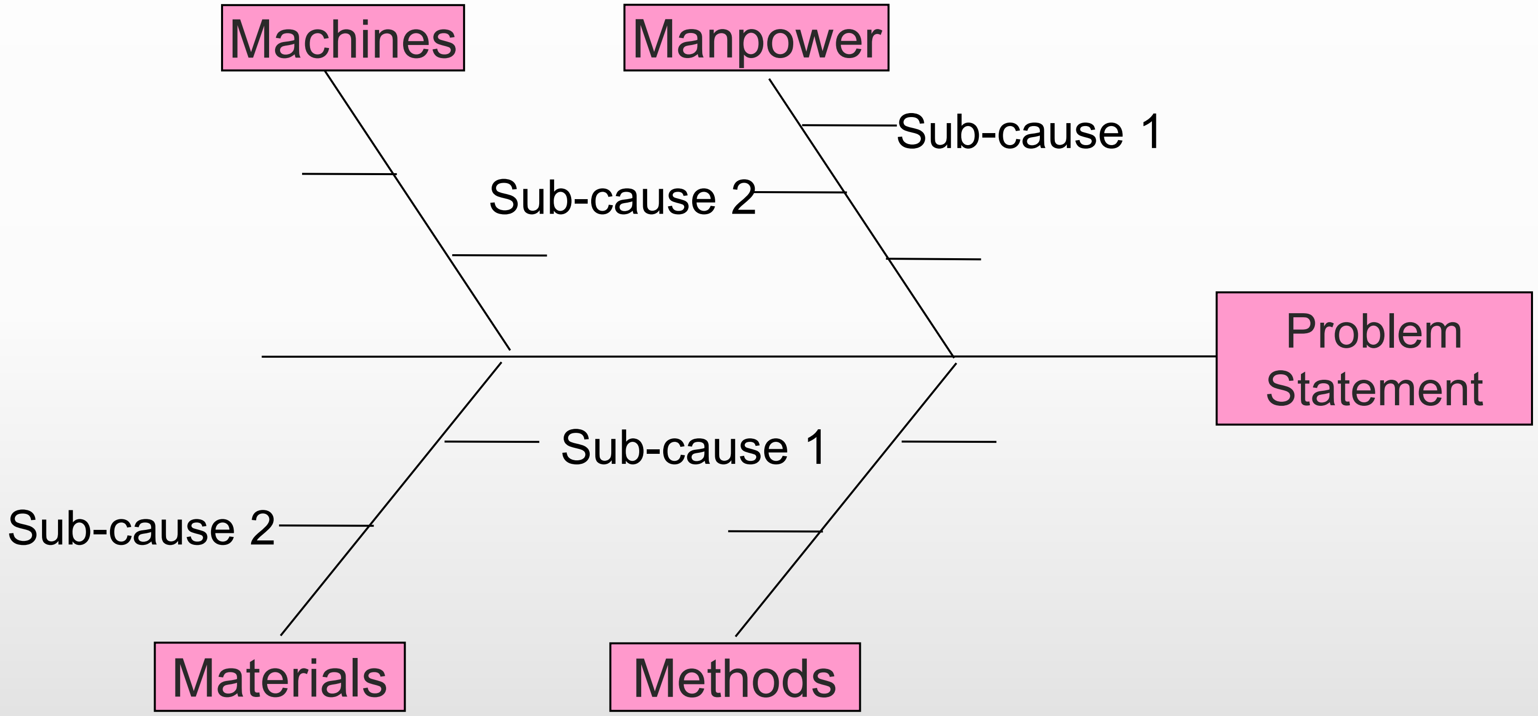
Why did the water freeze?
- Because the pipe is near an air vent and sometimes cold air blows over that section

Why was the pipe routed there?
- The installers did not check for potential drafts

Why did they not check?
- Because their training did not include this

Fishbone (Ishikawa) Diagram

This is a powerful tool used to identify, record and visually represent the possible causes of a problem



Develop initially as a small project team, but then develop it further and validate the causes with input from key operational people – using for example, the 5 whys technique

Fishbone digs down to the real problem. It breaks down what can appear to be an impossible issue, into smaller, more easily handled chunks.

There are 7 Key Steps in using a Fish Bone Diagram

Step 1: Identify the problem (the effect you are trying to remove)

Step 2: Categorise major causes

Step 3: Brainstorm

Step 4: Gather data

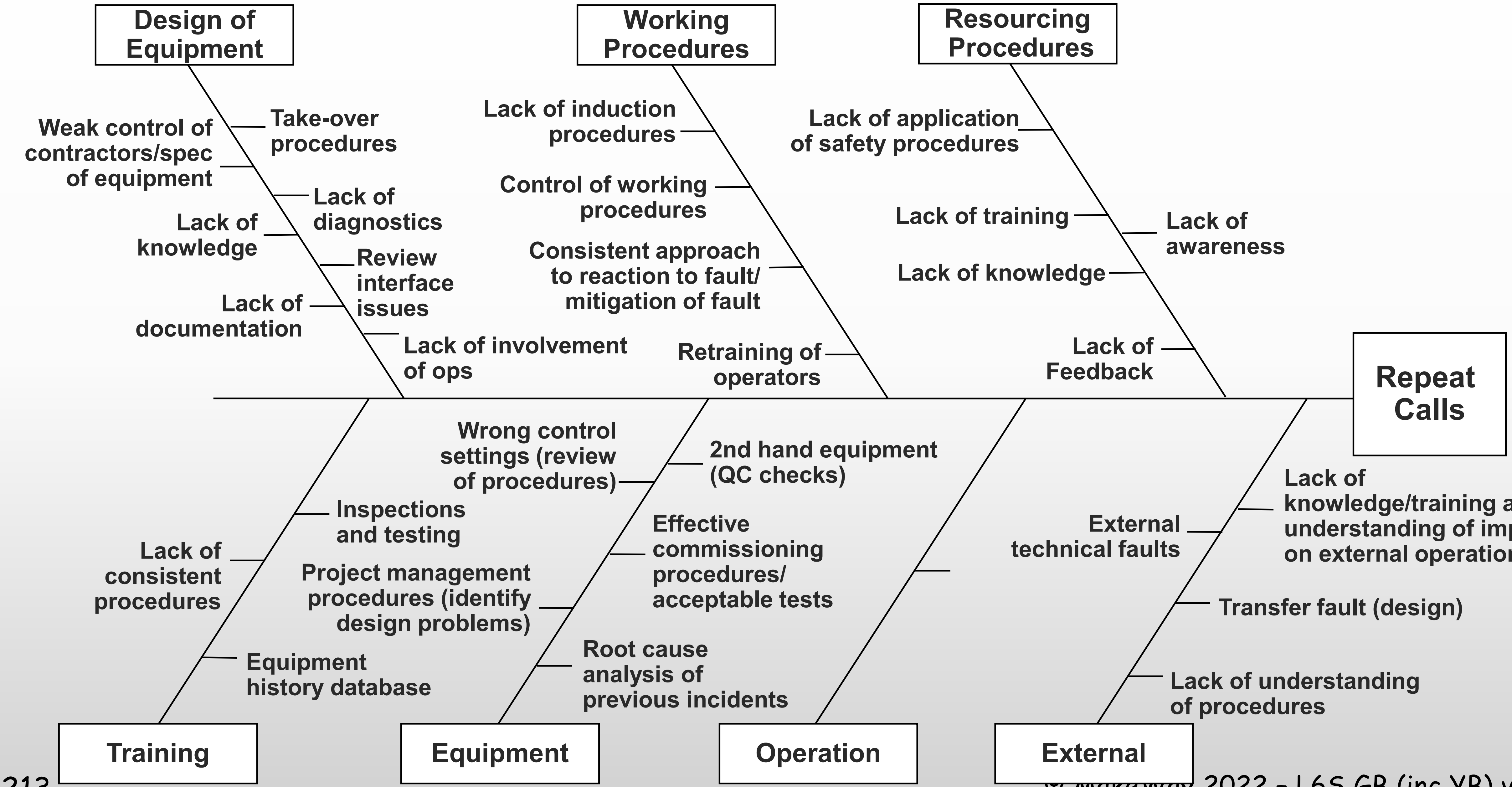
Step 5: Identify the most likely cause

Step 6: Choose the most likely cause

Step 7: Select and test the best solution

Building the Fishbone diagram in a group workshop environment usually gets the best results and helps ensure that all root causes are considered

A cause and effect diagram to probe root causes of repeat calls to a utilities call centre



Design of Equipment
- Take-over procedures
- Weak control of contractors/spec of equipment
- Lack of diagnostics
- Lack of knowledge
- Review interface issues
- Lack of documentation
- Lack of involvement of ops

Working Procedures
- Lack of induction procedures
- Control of working procedures
- Consistent approach to reaction to fault/ mitigation of fault
- Retraining of operators

Resourcing Procedures
- Lack of application of safety procedures
- Lack of training
- Lack of awareness
- Lack of knowledge
- Lack of Feedback

Repeat Calls

Training
- Inspections and testing
- Lack of consistent procedures
- Project management procedures (identify design problems)
- Equipment history database

Equipment
- Wrong control settings (review of procedures)
- 2nd hand equipment (QC checks)
- Effective commissioning procedures/ acceptable tests
- Root cause analysis of previous incidents

Operation

External
- Lack of knowledge/training and understanding of impact on external operations
- External technical faults
- Transfer fault (design)
- Lack of understanding of procedures

Analyse

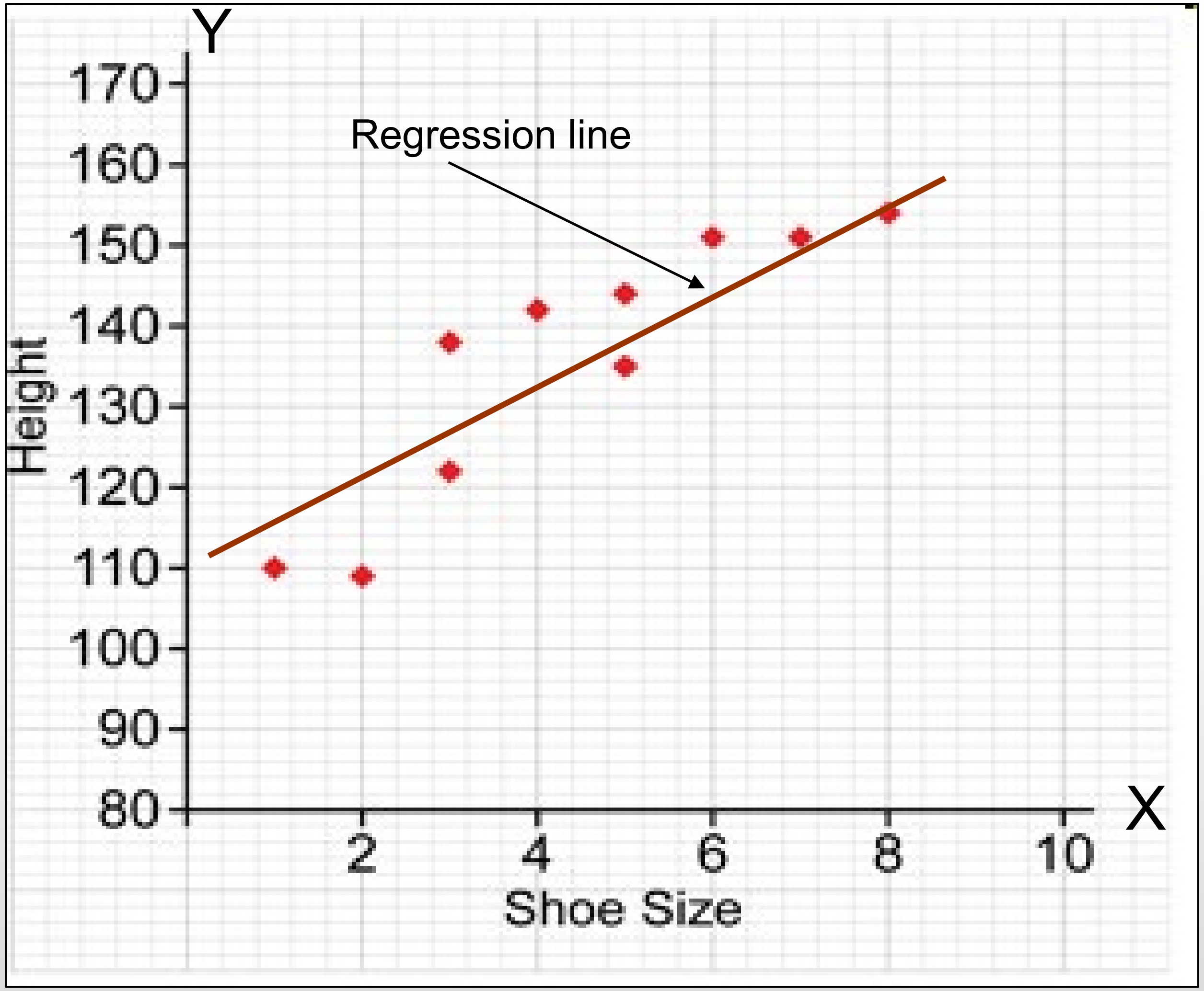
- Root Cause Analysis (RCA)
  - 5 Whys
  - Fishbone
- ***Scatter Diagrams – Correlation and Regression***
- Investigating the Process (inc Value Stream Map)
  - ❑Muda (Wastes) in Lean Services

Regression

Using Linear Regression, draw a line through the data points so that 50% of the plots are on either side of the line – there needs to be an obvious direction to draw the line

We can talk about '***strong correlation***' where the plots are all close to a line – and '***loose correlation***' where the lines are more widely scattered

Regression lines can be ***positive*** or ***negative*** and cut the Y axis at the ***intercept***



Correlation and Causation

Linear regression can be used to investigate two variables in two ways:

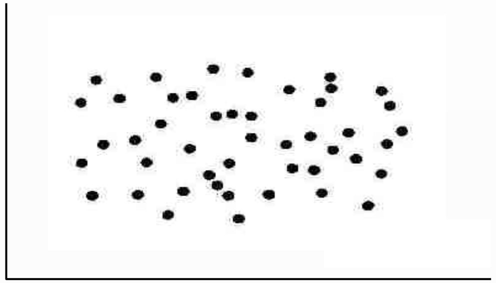
- Are the variables related in some way? (do they alter in a way that seems linked?)
- To make a forecast about the state of one variable given the other

In L6S, we are often looking to see if an input variable (an ‘X’) has an effect on an output variable (a ‘Y’) – however, we cannot say absolutely that just because two variables seem to have a strong correlation, that the change in one, caused the change in the other (there may be a common cause)

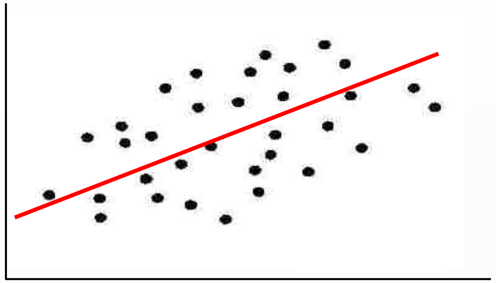
Correlation does not prove causation

Regression analysis with scatter diagrams

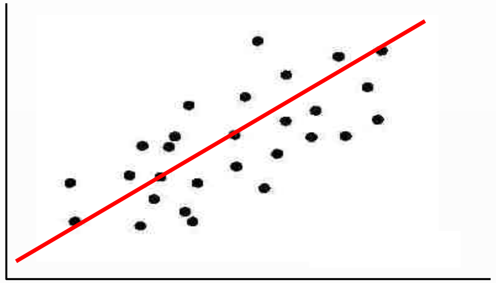
No Correlation
Correlation Coefficient=0



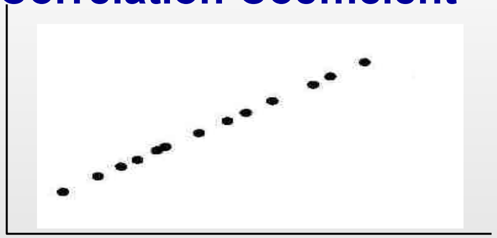
Moderate Positive Correlation
Correlation Coefficient=+0.6



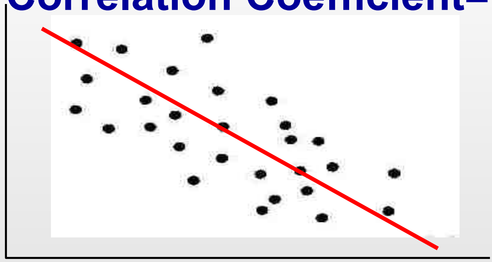
Strong Positive Correlation
Correlation Coefficient=+0.8



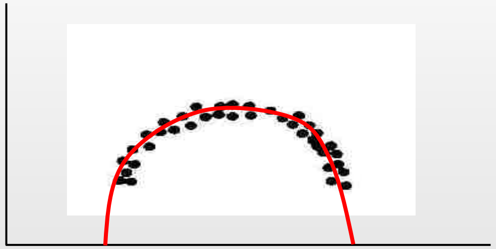
Perfect Positive Correlation
Correlation Coefficient=+1.0



Strong Negative Correlation
Correlation Coefficient=-0.8



Non-linear Correlation
Correlation Coefficient=0



If the relationship is strong enough, then the next step could be to use that information to predict or estimate the values of one value from the other variable with which it is paired. This is called ***Regression Analysis****.*

See Annex – calculation for Pearson's correlation coefficient (R)

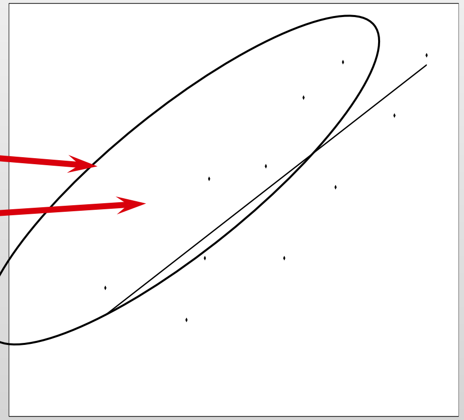
Summary: Correlation and Regression Analysis

What Does It Do?

- Scatter diagrams portray the *relationship of two quantitative variables*
- Correlation analysis measures the influence one variable has on another
- Regression analysis is used when good correlation between two variables exists
- Regression analysis determines the equation of the linear relationship

Correlation Analysis measures the strength of linear relationship

Regression Analysis models the linear relationship



Analyse

- Root Cause Analysis (RCA)
  - 5 Whys
  - Fishbone
- Scatter Diagrams – Correlation and Regression
- ***Investigating the Process (inc Value Stream Map)***

☐Muda (Wastes) in Lean Services

Investigating and Understanding the Process

If the process is visible:

Process map at high level

Use the Process Stapling technique to follow the process; recording individual process steps, *UDOs and other metrics as specified in your data collection plan

Ask operators questions

Note metrics, materials, machines, **WIP and finished goods etc

Record on data collection forms

If the process is not visible:

Create detailed process map

Include UDOs and other metrics of interest

Make the process map available to operators and solicit corrections

Analyse portions of process which are visible

Utilise VoC surveys to collect key data points

Validate findings with operators

***UDO (Undesirable Observation) – any observation about the process that is not ideal**
****WIP (Work In Process inventory) – inventory that is contained in the process**

Investigating the Value Stream Map

1. Where do you see waste in this process and what types of waste do you see?
2. What counter-measures could be taken to reduce the most significant forms of waste?
   a) Get management approval
   b) Communicate to all areas before visit
   c) Make introductions when you get there
   d) Remember, the workers are the experts for their tasks!
   e) Respect people’s workspace
   f) Explain your purpose

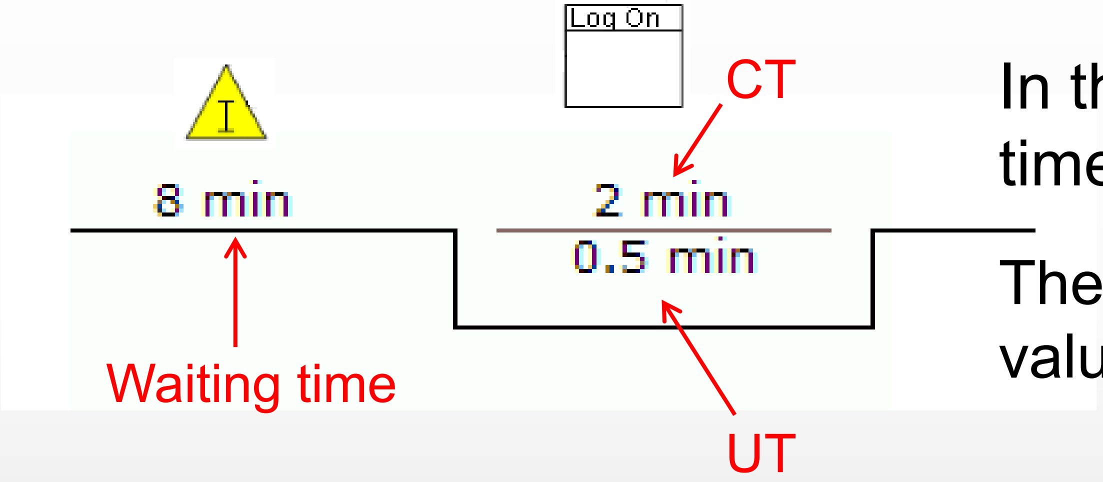
Analyse: 8 Wastes [MUDA] in Lean Services

DOWNTIME

1) **D**efects
2) **O**ver-production
3) **W**aiting
4) **N**on-Utilised talent (Skills)
5) **T**ransport
6) **I**nventory
7) **M**otion
8) **E**xtra Processing

The ‘Square Wave’

The aim of the Square Wave is to illustrate and compare VA and NVA time in the process. There are several ways to construct a Square Wave – here are two:



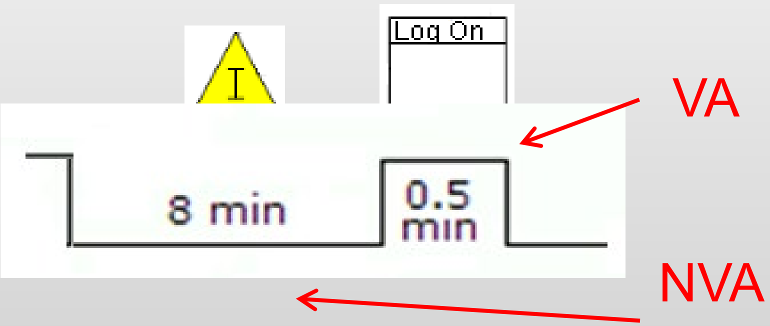
CT

Waiting time

UT

In this example the top line shows the Cycle time or waiting time of a step or process

The bottom line indicates a process with the top value showing CT and the bottom UT for that step



VA

NVA

In this example the top line shows VA time while the bottom line indicates NVA time. An attempt is made to keep the lengths of the two lines in proportion

(This is the method used in our examples)

Creating an Improved Process

Examine the ‘As Is’ (‘current state’) process map and investigate the areas of potential waste

Perform a *Root Cause Analysis (RCA)* to identify the true cause(s) of the waste

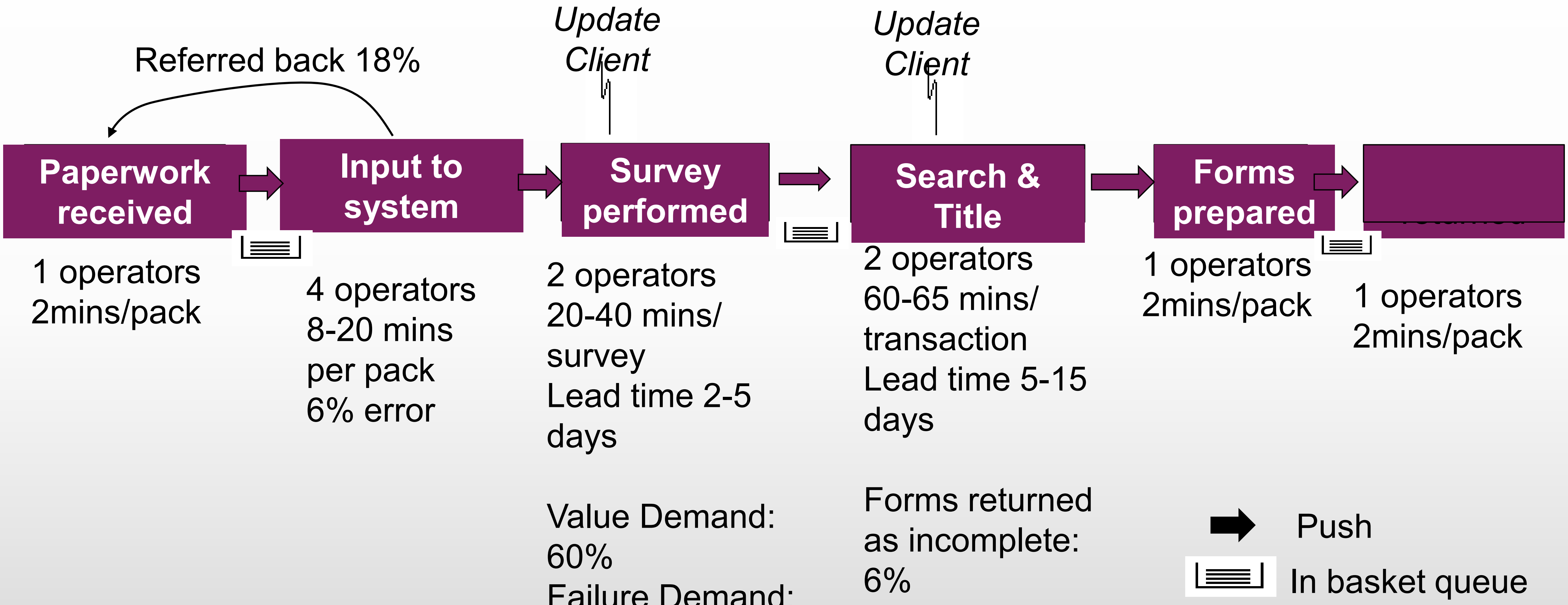
Estimate how much the waste is costing

Consider if it is practical and feasible to remove or reduce the waste at this time

- Team skills/ complexity of the rectification
- Potential cost of action
- Company culture

Re-draft the VSM illustrating how the process would look with the selected wastes removed (the ‘to be’ / ‘desired’ or ‘future state’)

Transactional VSM: Funding Application



Referred back 18%

Update Client

Update Client

Paperwork received

1 operators
2mins/pack

Input to system

4 operators
8-20 mins
per pack
6% error

Survey performed

2 operators
20-40 mins/
survey
Lead time 2-5
days

Value Demand:
60%
Failure Demand;
40%

Search & Title

2 operators
60-65 mins/
transaction
Lead time 5-15
days

Forms returned
as incomplete:
6%

Forms prepared

1 operators
2mins/pack

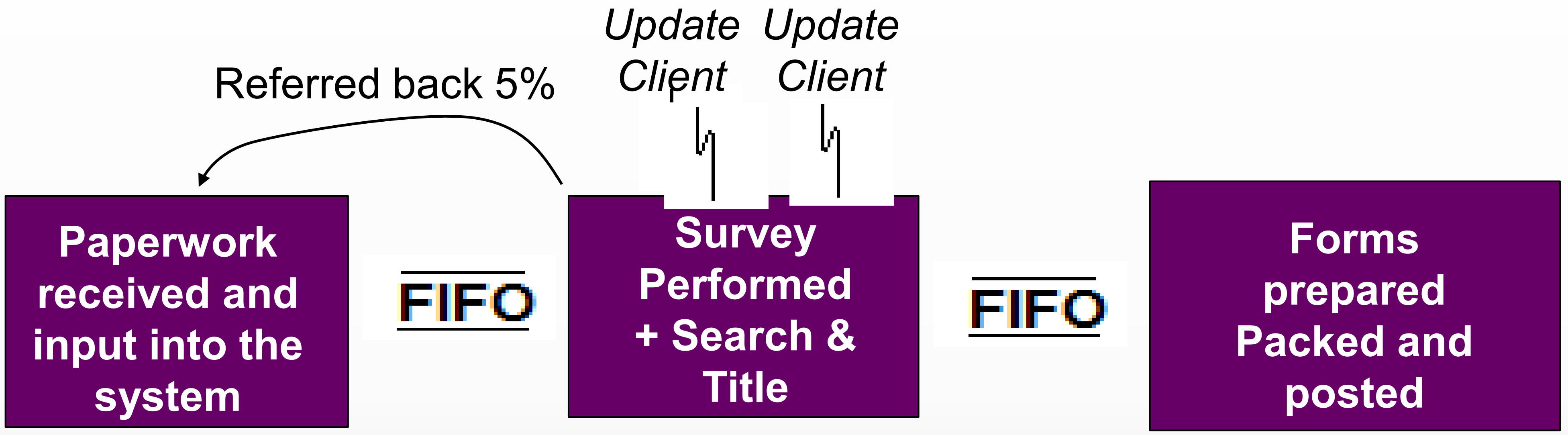
1 operators
2mins/pack

➡ Push

▤ In basket queue

Can you spot any potential waste?

Transactional VSM: Funding Application (To Be)



3 operators
10-12mins/pack

4 operators
20-40 mins/ survey
Lead time 2-5 days

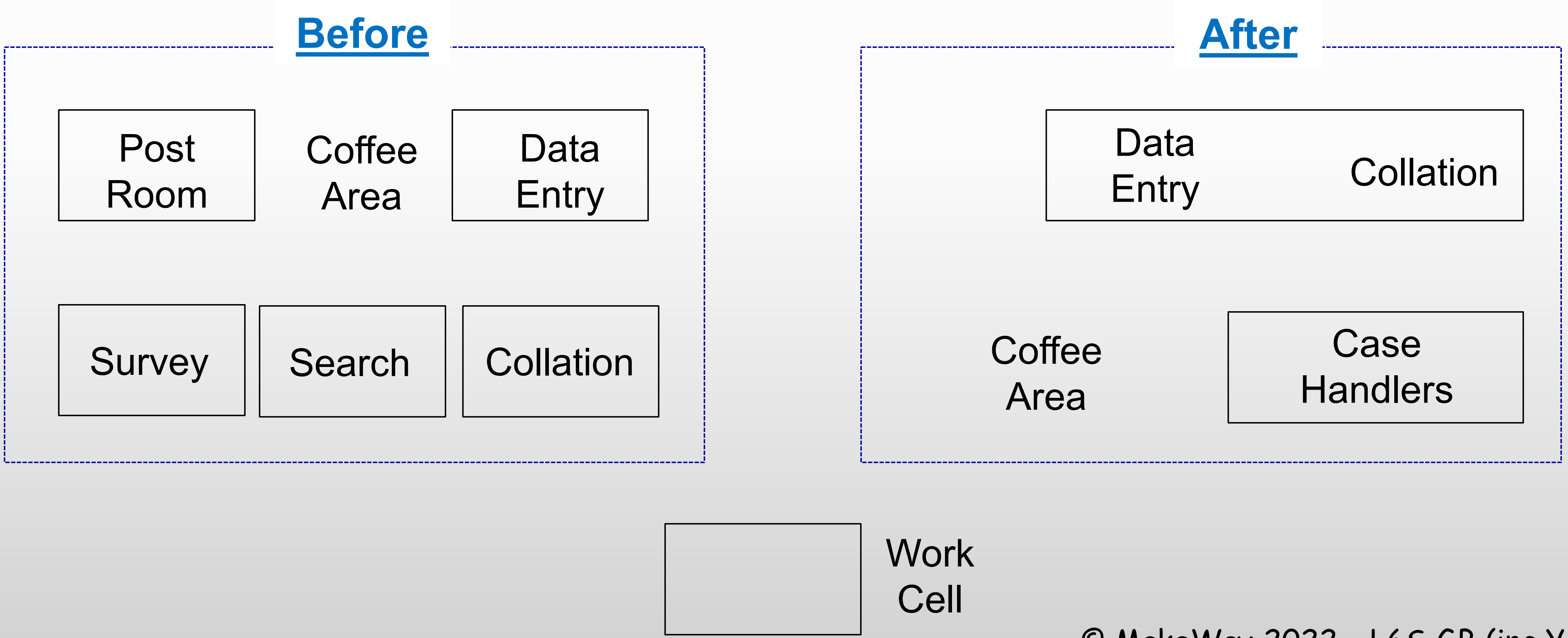
Value Demand: 95%
Failure Demand; 5%

1 operators
3 mins/pack

FIFO First In First Out

Layout Diagrams

- A useful accompaniment to a VSM
  - Shows the physical layout of the process
  - Can also be used as Current and Future state



How the New Process Works

There is no post room and we only now have two work cells

Paper documents are received unpacked and then immediately entered into the system. Checking occurs as the data is entered. Having one person do the work this way minimises mistakes and documents “getting lost” between teams

Each funding application is assigned to a “Case Handler” (the Investment Officer) with one person now responsible for the whole of the technical work. This is better for the customer and once again reduces mistakes made at handover

Once the technical work has been performed the completed documentation is handed over to the Admin Team who pack up the documentation, check it is all there, then put it in an envelope and dispatch it

Just changing the work flow will have a big effect on reducing waste. Also the original VSM highlighted some areas of waste formation. The team worked on these using standard Lean techniques reducing waste further

Analyse Phase – Review Questions

- ☐ What is the difference between value-added steps and non-value-added steps?
- ☐ What are the eight deadly wastes in Lean services?
- ☐ What is the *Five Whys* trying to discover?
- ☐ When would you use a *Fishbone*?
- ☐ How does the VSM help with process improvement?

DMAIC

- Define
- Measure
- Analyse
- ***Improve***
- Control

Improve

DEFINE

MEASURE

ANALYSE

IMPROVE

Implement and verify the solution

CONTROL

Objectives

- To identify the best ways of removing or reducing the root causes identified in the analyse phase
- To perform pilot trials and implement the selected solutions
- To plan how the results will be evaluated in the next phase

Outcomes

- Selected interventions
- Piloted fixes
- Implemented fixes
- Control plan

Improve

- ***Identify and Select Solutions***
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢5S
  - ➢Mistake Proofing: Poka Yoke
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

Identify and Select solutions

Identifying solutions to the root causes identified in the Analyse phase

Propose solutions and evaluate the options identified

Select and develop the most appropriate solution

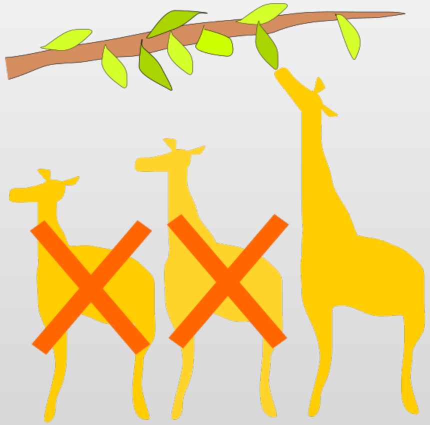
Piloting a proposed change and evaluating the results is something you should consider carefully

Identifying Potential Solutions

A number of methods can be used to explore the solution options. These include;

- Brainstorming (E.g. *The Six Thinking Hats*)
- Benchmarking
- Review of previously identified solutions
- Various other techniques, such as the *Pugh Matrix*

Often the difficulty of this phase is not coming up with the ideas for improvement but deciding which ones to implement…



Improve

- ***Identify and Select Solutions***
  - ***Brainstorming*** / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢5S
  - ➢Mistake Proofing: Poka Yoke
  - ➢SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

Brainstorming – The Six Thinking Hats

White Hat – Obtain and record available information and identify further information that may be needed (be objective!)

Red Hat – Using intuition and emotion, it allows for the expression of feelings without justification or prejudice

Yellow Hat – Taking a positive view, look for benefits to support a position (even the critics are encouraged to do so)

Black Hat – This relates to caution (risk assessment) and it is used for critical judgment (be careful of overuse!)

Green Hat – This is for creative thinking and so it is used to generate new ideas (put on the thinking cap!)

Blue Hat – This is about process control of other hats; it invariably summarises, concludes and draws the conclusion

Improve

- ***Identify and Select Solutions***
  - Brainstorming / Fishbone
  - ***Prioritisation Tool: Pugh Matrix***
- Implementing Solutions
  - ➢5S
  - ➢Mistake Proofing: Poka Yoke
  - ➢SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

Example Pugh Matrix

	Solution/Ideas				Weighting
Criteria	A	B	C	D	
Meets food hygiene standards	+	+	s	s	4
Low maintenance	s	-	s	s	2
Quick to implement	+	-	s	-	1
Simple to operate	-	-	s	+	3
Positives (weighted score)	+5	+4	0	+3	
Negatives (weighted score)	-3	-6	0	-1	
Weighted score	+2	-2	0	+2	

Prioritisation Tool: Pugh Matrix

What it is

- A weighted matrix which compares solutions/ideas against set criteria
- Allows a group to compare possible solutions and develop or improve them at the same time
- One solution is chosen as the 'standard' (benchmark/baseline) and then the other solutions are contrasted with it
- Comparison leads to identification of ways to improve or extend

How to…

1. Agree solutions/ideas, criteria and weighting values
2. Choose the 'benchmark' solution
3. Compare and contrast each solution with the benchmark deciding if it is…
   - The same (s)
   - Better (+)
   - Worse (-)
4. Calculate the weighted sums (+ & -)
5. Investigate how the solutions can be improved by adopting/combining features – possibly resulting in a 'hybrid' solution
6. Re-run against a different 'benchmark' as necessary

When to Use a Decision (Pugh) Matrix

- When a list of options must be narrowed to one choice
- When the decision must be made on the basis of several criteria
- After the list of options has been reduced to a manageable number by list reduction
- Typical situations are:
  - When one improvement opportunity or problem must be selected to work on
  - When only one solution or problem-solving approach can be implemented
  - When only one new product can be developed
  - When you wish to explore combining several suggestions

DEFINE

Class Exercise

Pugh Matrix

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- ***Implementing Solutions***
  - 5S
  - Mistake Proofing: Poka Yoke
  - SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

Implementing Solutions

Addressing the root cause(s) may require the formation of dedicated implementation projects

These can range from small highly informal Kaizens, to high budget, high risk activities that demand a stringent control framework

Documentation and training should be designed and implemented here

Implementation – Solution Selection

There are usually a number of options for attacking root causes

Each will have different:

- Benefits
- Costs
- Risks
- Effects on the organisation

Typically, these are detailed in a **Business Opportunity**

Selection of the implementation solution should be based on the most 'attractive' Business Opportunity

The decision needs to be made by the appropriate level of management

Process Levelling in the Office (1)

Single piece flow

- Treat documents as individuals / small batches
- Check each one after working on it
- Handle documents in the order that they are received (no ‘cherry picking’)
- Do away with priority requests, but train people not to procrastinate

Poka Yoke

- Use templates and checklists to make sure documents completed before sending

Pull

- Wherever possible do not allow work to be sent before acknowledgment from downstream of the previous batch
- If an upstream person has work piling up this should trigger an investigation and re-work of the process

Process Levelling in the Office (2)

JIT / Automation

- Have your staff keep the workplace tidy
- Think about having a scheduled 5S session at the end of a week
- Have staff re-order supplies at this point and check for maintenance issues
- Assign staff ‘owners’ to critical machinery such as printers and photocopiers
- Have them as the point of contact with service and teach them to manage consumables

Peaks and troughs

- Forecasting, cross-training and scheduling
- Assign a ***Water Spider*** to handle the unexpected

Putting it all Together

How could a Lean Manager adopt the techniques discussed so far to make their people more efficient?

This section builds on previous discussions such as Lean Management and Lean Cells

EXAMPLE: ***The purchasing department consists of 6 staff members and a Manager***

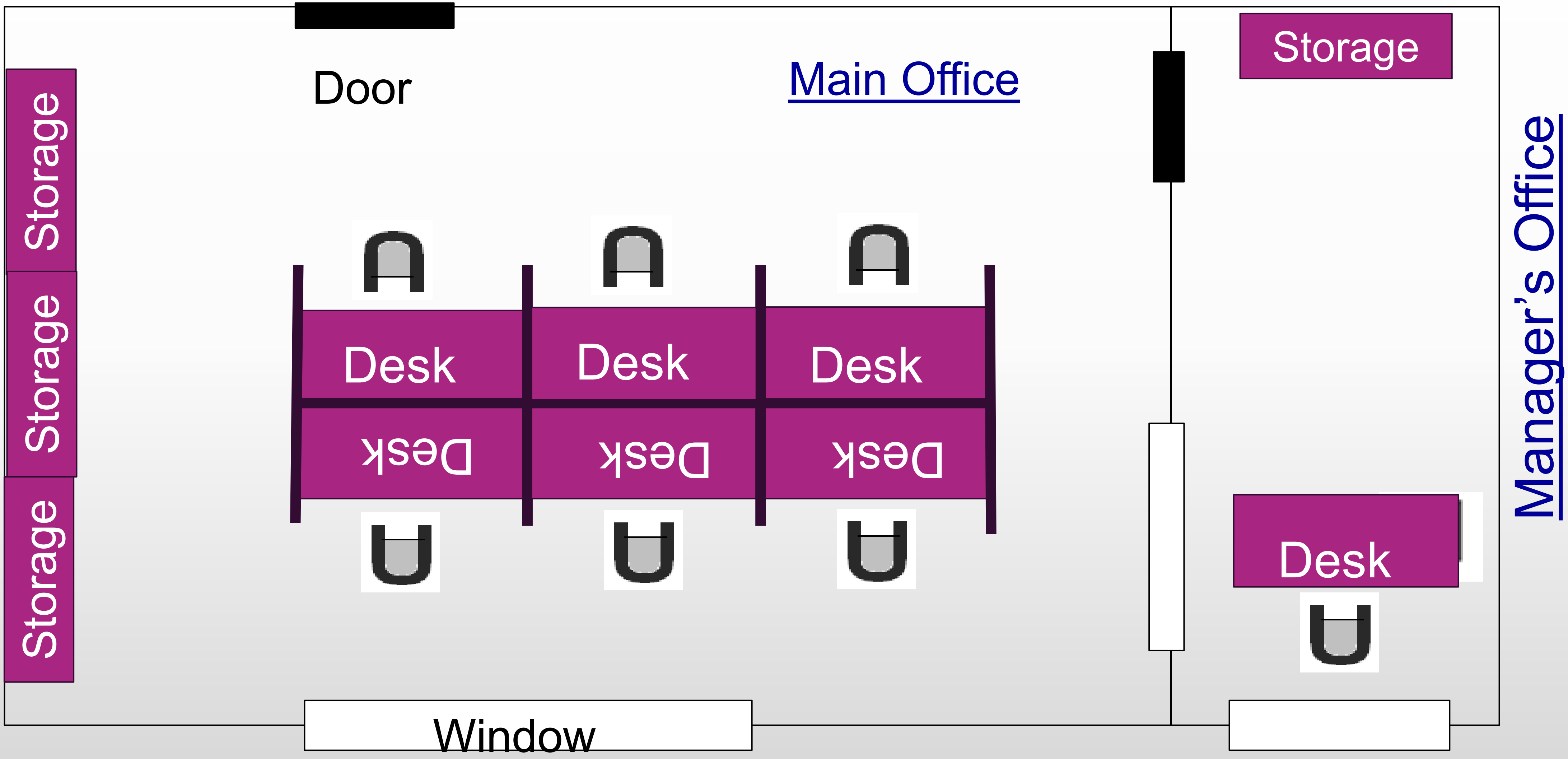
- **The team is involved in:**
  - Tendering and coordinating the requirements from the various regional offices
  - General purchases (office supplies, cleaning etc)
  - Often new purchasing requirements are given to the team at short notice

Purchasing Department: Before Lean

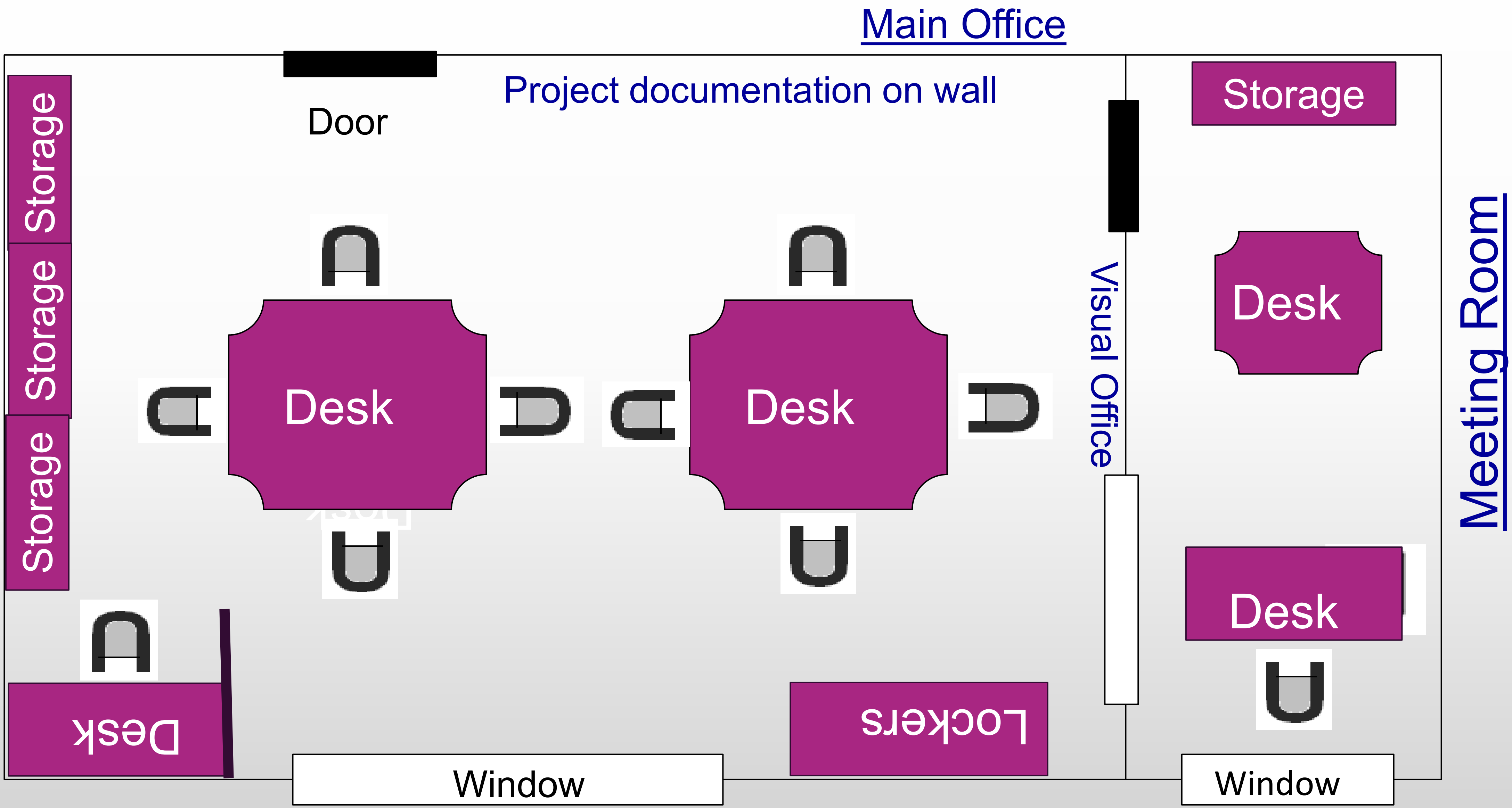
Six people plus a Manager

The Manager:	**The Team:**
• Sits in their own office – asks staff to come in, but rarely goes into Gemba • Directs team in daily work • Tasks individuals with specific areas of responsibility • When necessary forms ad-hoc teams to solve new purchasing requests • Has a nominated assistant (Senior Purchaser)	• Have their own goals • Have their own workspace complete with padded walls so they can pin up charts etc • Have their own desk with drawers, phone and computer • Co-operate on the tea rota and occasionally go for a drink on Friday

The Lean Office: How it was



The Lean Office: Putting it all together



Purchasing Department: The Lean Environment (physical)

Instead of padded sections, the department has a number of shared tables with phones/power etc

Staff are issued with Laptop computers and are encouraged to change their seating on a daily basis

People might work together for a morning or a few days as they work on an issue

There is a ‘do not disturb’ desk for someone who needs to work on a task undisturbed, otherwise people feel free to approach other team members

The walls are used for project improvement documentation and to display visual controls

Walls also have a to-do list (Kanban board?)

Purchasing Department: The Lean Environment (People)

Team use *Plan-Do-Review*

First thing Monday morning 'kick-off' with Manager – agrees HPC

- Staff agree tasks, Team Leader and 'Water Spider'
- Process Levelling rules apply

Wednesday team Stand-up meeting

Last thing Friday – review of week's work then tidy office (5S)

Team form 'ad-hoc' groups to tackle issues:

- Work
- Improvements

Overhead for the above is paid for in productivity

Manager is available and plugged into team (in Gemba) but has more time for Managerial work

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢ ***5S***
  - ➢ Mistake Proofing: Poka Yoke
  - ➢ SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

DEFINE

Class Exercise

5S

The Steps of 5S

Seiri (Sort): Clean up and sort all material, equipment and unnecessary information

Seiton (Set in Order): Make necessary input available in a logical order and available

Seiso (Shine): Ensure any input is ready to be used

Seiketsu (Standardise): Identify standard activities and practices and means to monitor them (eg inspections)

Shitsuke (Sustain): Introduce and support a mind set of continuous improvement

A place for everything and everything in its place, clean and ready to use

What is 5S?

The 5S is a simple tool to

- introduce discipline in the organisation of physical space and processes
- improve the environment
- raise morale
- increase workplace safety
- improve productivity and response times
- impress your customers
- highlight where to remove waste and non value add activities

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢5S
  - ➢***Mistake Proofing: Poka Yoke***
  - ➢SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

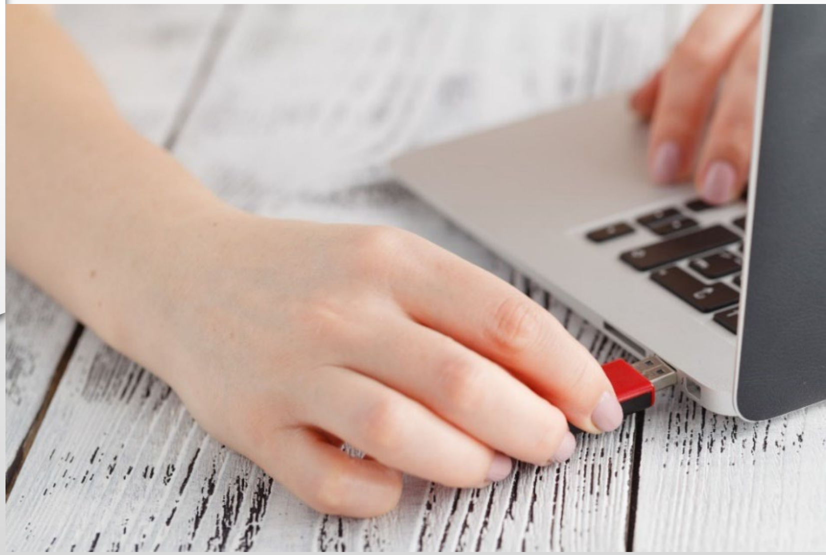
Mistake Proofing: Poka Yoke

Poka Yoke can be translated as "**Mistake Proofing**"

The objective was to eliminate errors before they occur, rather than finding and fixing them

The ideal Poka Yokes are:

- Inexpensive
- Simple and easy to implement
- Developed by every employee



Two Main Types of Poka Yoke

The original objective was to eliminate errors and fix them before they occurred. However, this purpose has changed somewhat as the Poka Yoke concept evolved

Many people split Poka Yoke into two main types:

- **Shut out type:** Physically preventing an error being made (preferable)
- **Attention type:** Highlighting that an error has been made (acceptable)

Poka Yoke 3 Golden Rules

Do not accept defects from your suppliers

Do not create defects yourself

Do not pass on a defect to your customer

When to use Poka Yoke

- When a process or product is likely to have error or may go wrong.
- Some of the errors that are captured by Poka-Yoke are when the process operations are sub- standard or not operated at their standard operating procedure (processing errors).

Advantages of Poka Yoke:

Mistake Proofing advantages include:

- Only simple training programs are required
- Inspection operations are eliminated and the process is simplified
- Relieves operators from repetitive tasks of typical visual inspection
- Promotes creativity and value adding activities
- Results in defect free work
- Requires immediate action when problems arise
- Provides 100% inspection internal to the operation

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢5S
  - ➢Mistake Proofing: Poka Yoke
  - ➢***SMED / Quick Changeover***
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Solution Validation

SMED / Quick Changeover

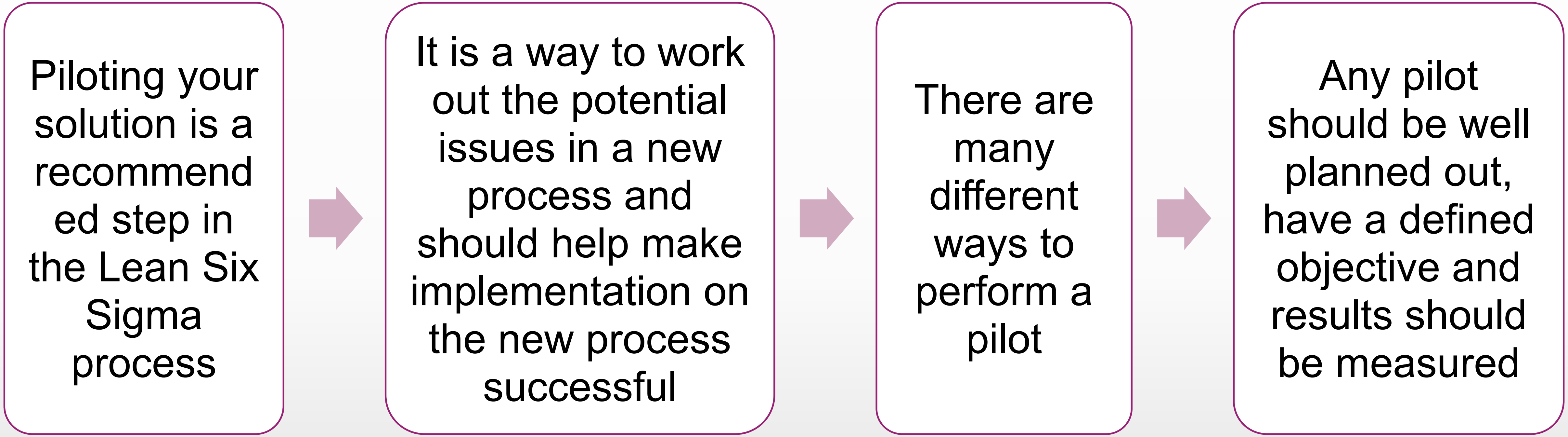
- **SMED (Single Minute Exchange of Die)** a system for dramatically reducing the time it takes to complete equipment changeovers.
  - The faster the changeover times, the less downtime of equipment
  - The essence is for the **SMED** system to convert as many changeover steps as possible to “external” (those that can be performed while the equipment is in operation), as well as simplify and streamline the remaining steps
  - The **Single Minute** stands for a **single** digit **minute** (i.e., less than ten **minutes**)
- It was originally developed by Shigeo Shinjo to improve die and machine tool setups
- Quick changeover is the term used for non-manufacturing process changeovers.
- SMED/Quick Changeover also covers new setup.
- Quick changeover principles can be used and applied in almost any operation or process

Quick Changeover / SMED

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - 5S
  - Mistake Proofing: Poka Yoke
  - SMED / Quick Changeover
- ***Piloting the Solution***
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

Piloting the Solution



Piloting your solution is a recommended step in the Lean Six Sigma process

It is a way to work out the potential issues in a new process and should help make implementation on the new process successful

There are many different ways to perform a pilot

Any pilot should be well planned out, have a defined objective and results should be measured

Types of Pilot Programmes

Proof of concept

Trialling one part of the solution

- Don't forget to use any lessons learnt where necessary

Off-line

- This is performed outside of the key manufacturing or service line in a test environment – useful when process interruption is very expensive and/or disruptive

Specific times

- The pilots are performed during specific windows of time - useful because they allow comparison with the standard process

Customer or item related

- Piloting with specific customers or items

Specific location

- One facility that runs the same processes as others can be used as a test facility – helps to shield the customer from process

Specific aspects of the solution

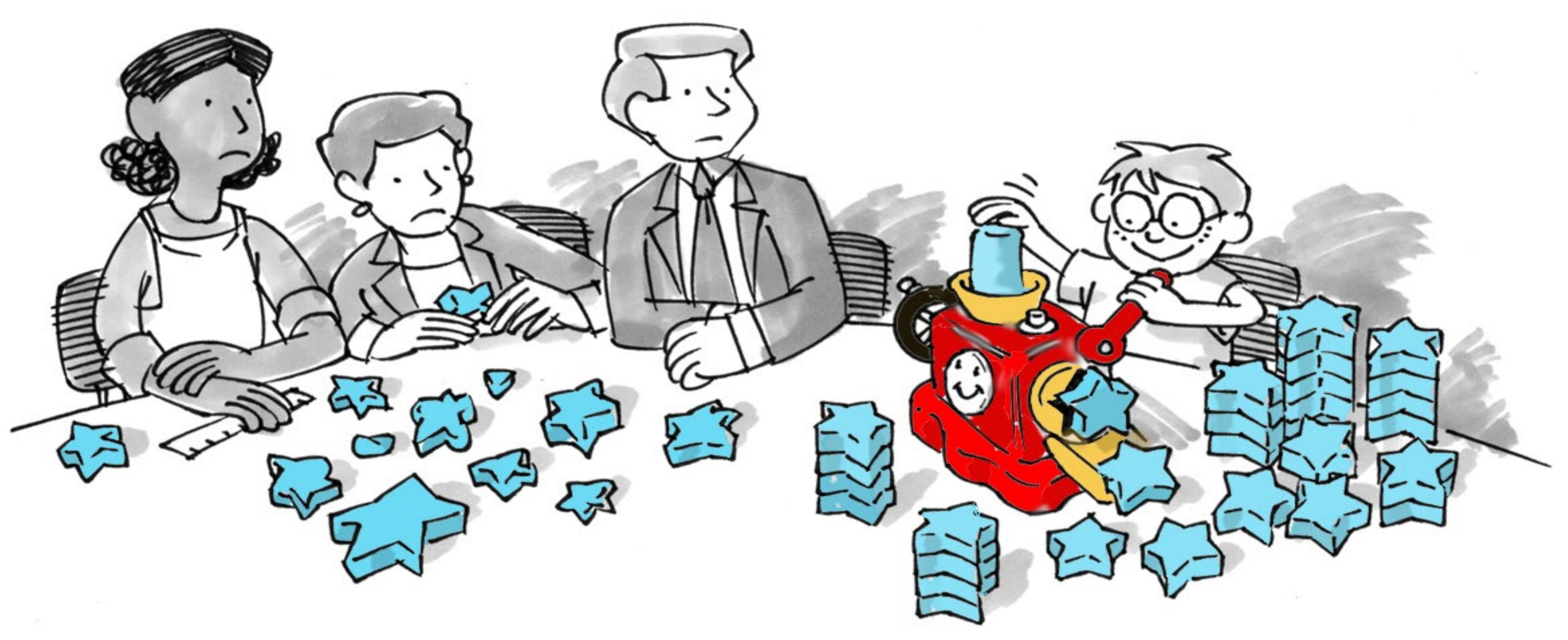
- Certain aspects of concern can be tested in a pilot solution

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢5S
  - ➢Mistake Proofing: Poka Yoke
  - ➢SMED / Quick Changeover
- Piloting the Solution
- ***Standardisation and Documentation***
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

Standardisation and Documentation: Core Principle

‘Nothing happens on a reliable, sustained basis unless we build a system to cause it to happen on a reliable, sustained basis.’



Gather technology and process skill in written form, to make it easier to do the work

Standardisation Goals

- **Goals:**
  - Making sure that important elements of a process are performed consistently to meet requirements
  - Changes are made only when data shows that a new alternative is better
  - Documentation is key
    - **Making sure documentation is up to date and used – encourages on-going use of standardised methods**

Standardised Work

- **Documented procedures that capture best practices (including the time to complete each task)**
  - The *One Best Way*
- **Clear, concise and easy to understand**
  - Pictorial highly recommended
  - OTGIs
- **Must be ‘living’ documentation that is easy to change**
  - Encourage team to discover a better ‘one best way’, and then apply it

On The Ground Instructions (OTGIs)

Follows on from process mapping

Sometimes referred to as ‘SOP’ (Standard Operating Procedures) or ‘Work Instruction’

Process maps describe what is done – OTGIs explain how to do it

Ideally, OTGIs define the ‘one best way’ to perform a task, leading to *Standardised Work* (and thus reducing variance)

Pictures are preferable to written instructions

SOPs and OTGIs

Some people differentiate between SOPs and OTGIs – here is a comparison between the two

Standard Operating Procedures	**On The Ground Instructions**
A formal approach to documenting the ‘one best way’	An informal approach to documenting the ‘one best way’
Defines a standard way to perform a task	Defines a standard way to perform a task or an instruction to be followed
Often forms part of an official document	Usually written within the process as the need is identified
Can be useful in compliance or regulated environments	Helps the team define the ‘One Best Way’ as an ongoing series of actions
To change often requires a formal change control procedure	Changing OTGIs is done when the team recognises a new ‘One Best Way’

Standardisation Benefits

Standardisation helps us compete more successfully in the marketplace by providing:

- Increased reliability
- Reduced costs
- Improved employee performance
- Increased safety
- Processes that remain in control and consistently satisfy customers
- Continuous improvement
- Flexible practices that allow for quick response to customer needs

Standardisation = Standard practices and procedures

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - 5S
  - Mistake Proofing: Poka Yoke
  - SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- ***Communications and Training***
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- Solution Validation

Communications and Training (1)

When you have completed the documentation, you need to make sure that everyone using a common process is trained in the new methods

Even experienced employees need to be trained in the new methods

Plan the training well as this is the secret of a successful implementation

Standardisation ensures a realisation of the benefits obtained by improvement, by establishing supportive systems and structures

Communications and Training (2)

Don’t try to develop a single training session to teach people everything they may ever need to know about the job

- Focus on the most critical aspects of the job
- When you make changes to a process, explain the reasons behind the changes – people resist change for change’s sake
- Combine up-front training with performance support
- Don’t expect everyone to learn everything at once – provide aids
- Remember that most learning will occur on the job

Improve

- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢5S
  - ➢Mistake Proofing: Poka Yoke
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- ***Handling Risk: Failure Mode and Effects Analysis (FMEA)***
- Solution Validation

What is Risk?

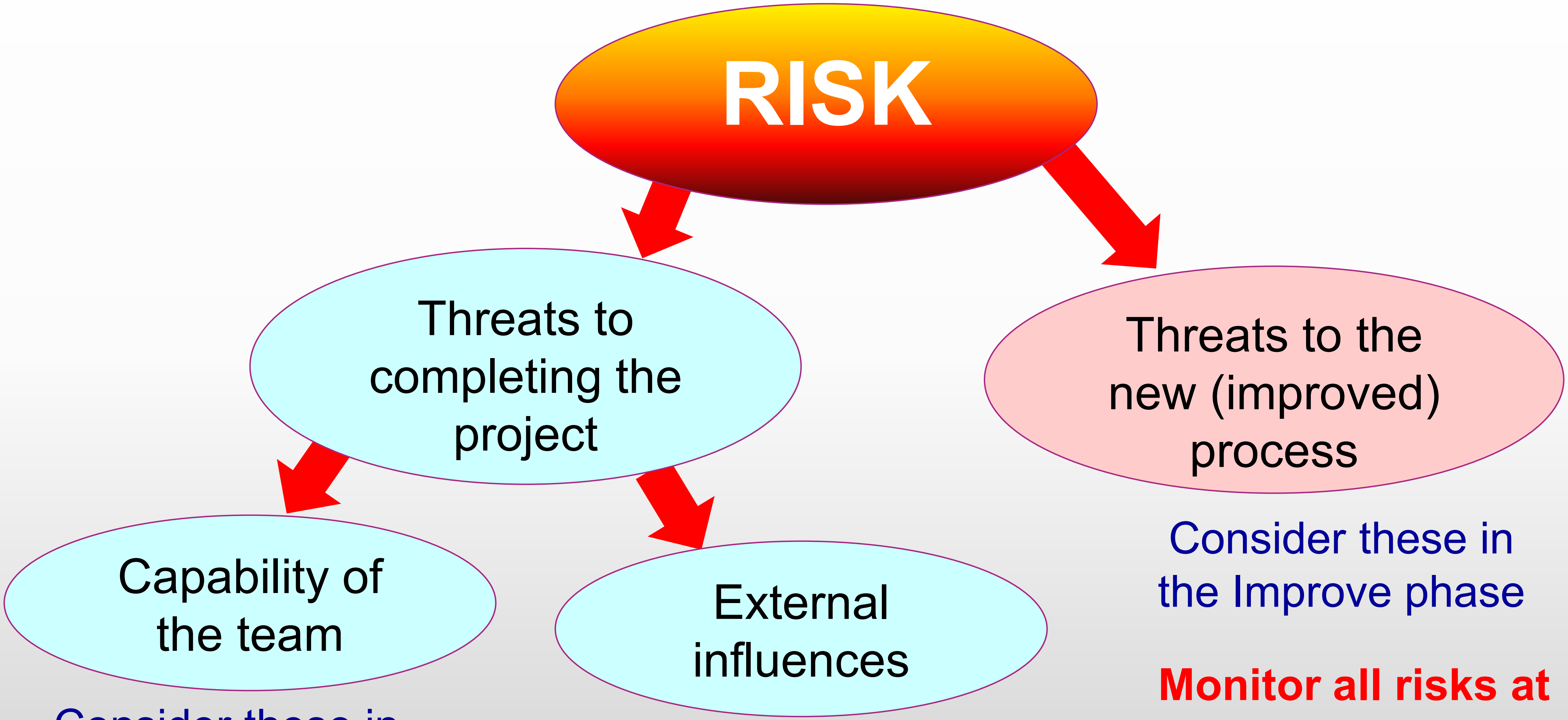
From the perspective of a Green Belt there are two areas of risk to consider:

- The threat that you may not complete what you planned to do (*Project Risk*)
- Potential damage to the organisation (*Business Risk*)

You can handle these! Deal with them promptly

You should not handle these – Escalate promptly!

Threats you can handle



RISK

Threats to completing the project

Threats to the new (improved) process

Capability of the team

External influences

Consider these in the Improve phase

Monitor all risks at all times!

Consider these in the Define phase

Keep a constant look out for these

Examples of Project Risk

The team gets re-deployed and can no longer run the project

The process you are looking to improve becomes obsolete

The team do not have the skills to perform the tasks required (e.g. cannot measure or analyse properly)

The improved process does not work the way the team thought it would

Capability of the team

Availability of the team

External influences

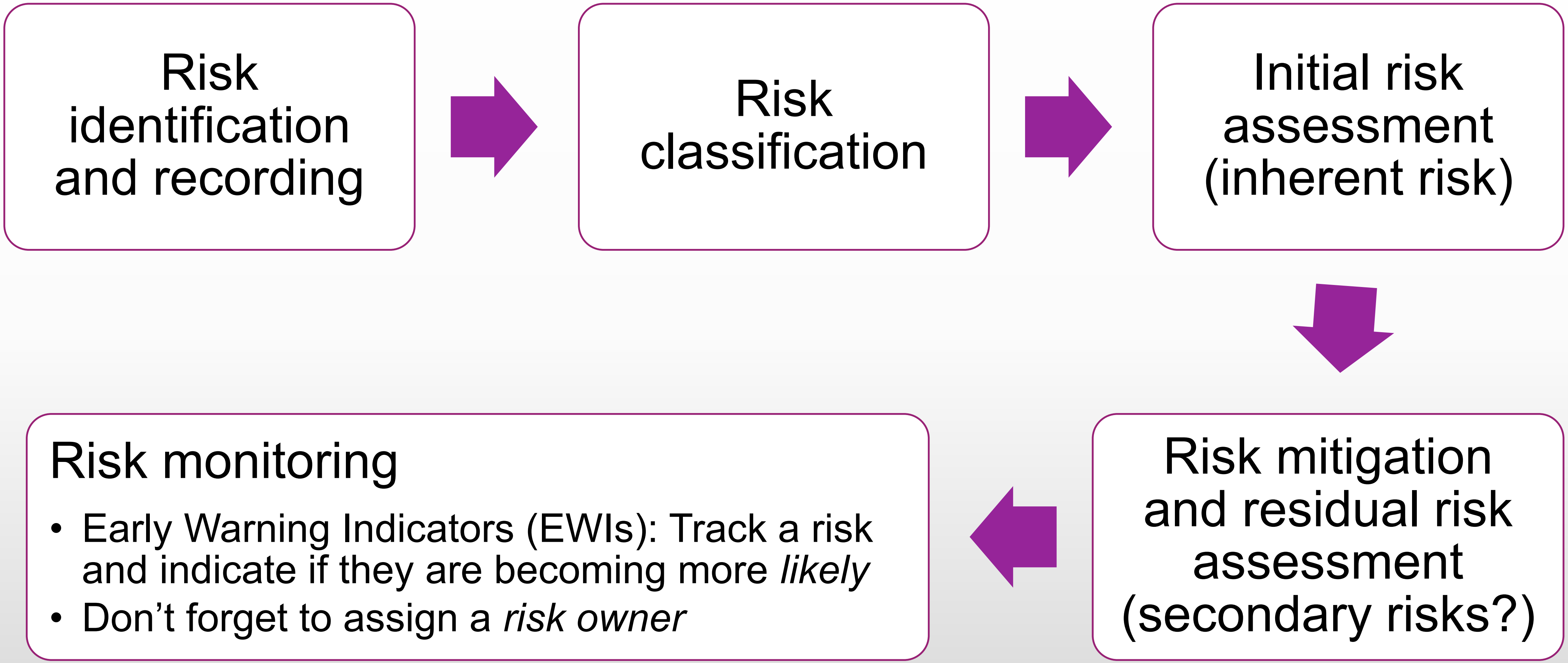
Look for three things

Examples of Business Risk

- Compliance broken
- Reputation damaged
- Huge financial loss

Expect most Business Risk to occur in the Improve phase

A Basic Risk Management Process



Risk identification and recording

Risk classification

Initial risk assessment (inherent risk)

Risk mitigation and residual risk assessment (secondary risks?)

Risk monitoring

- Early Warning Indicators (EWIs): Track a risk and indicate if they are becoming more *likely*
- Don’t forget to assign a *risk owner*

The management of risk is the responsibility of everyone

FMEA (Failure Mode and Effects Analysis)

FMEA is a tool that allows you to…

Detect and prevent system, product and process problems *before* they occur	Reduce costs by identifying system, product and process improvements early in the development cycle	Create more robust processes	Prioritise actions that decrease risk of failure	Evaluate the system, design and processes from a new vantage point

Failure modes and effects analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, a process, or a service/product

Example of an FMEA template

Failure Modes Effects Analysis

Process or Product Name:	
Process Owner:	

Prepared by:	
FMEA Date (Orig):	

Key Process Step or Input	Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	FREQ	Current Controls	DET	RPN	Actions Recommended	Resp.	Actions Taken	SEV	OCC	DET	RPN
What is the Process Step or Input?	In what ways can the Process Step or Input fail?	What is the impact on the Key Output Variables once it fails (customer or internal requirements)?	How **Severe** is the effect to the customer?	What causes the Key Input to go wrong?	How **often** does cause or FM **occur**?	What are the existing **controls** and procedures that prevent either the Cause or the Failure Mode?	How well can you **detect** the Cause or the Failure Mode?		What are the actions for reducing the occurrence of the cause, or improving detection?	Who is Responsible for the recommended action?	Note the actions taken. Include dates of completion.				
								0							0
								0							0
								0							0
								0							0
								0							0

Calculating Risk Priority Number (RPN)

RPN = severity value x occurrence scale x detection scale

Severity Scale	
5	Possible injury to employee/customer
4	Product unfit for purpose
3	Cause loss of performance
2	Minor loss of performance
1	Be unnoticed

Frequency Scale	
5	Once or more per day
4	Once per week
3	Once per month
2	No more than once per 6 months
1	Less than once per year

Detection Scale	
5	Defect caused by failure is not detectable
4	All units are manually inspected
3	Process is monitored (SPC) and manually inspected
2	SPC is used with an immediate reaction to out of control conditions
1	Defect is obvious and can be kept from affecting the customer

THE KEY

5	Worst case
4	
3	Moderate
2	
1	Best case

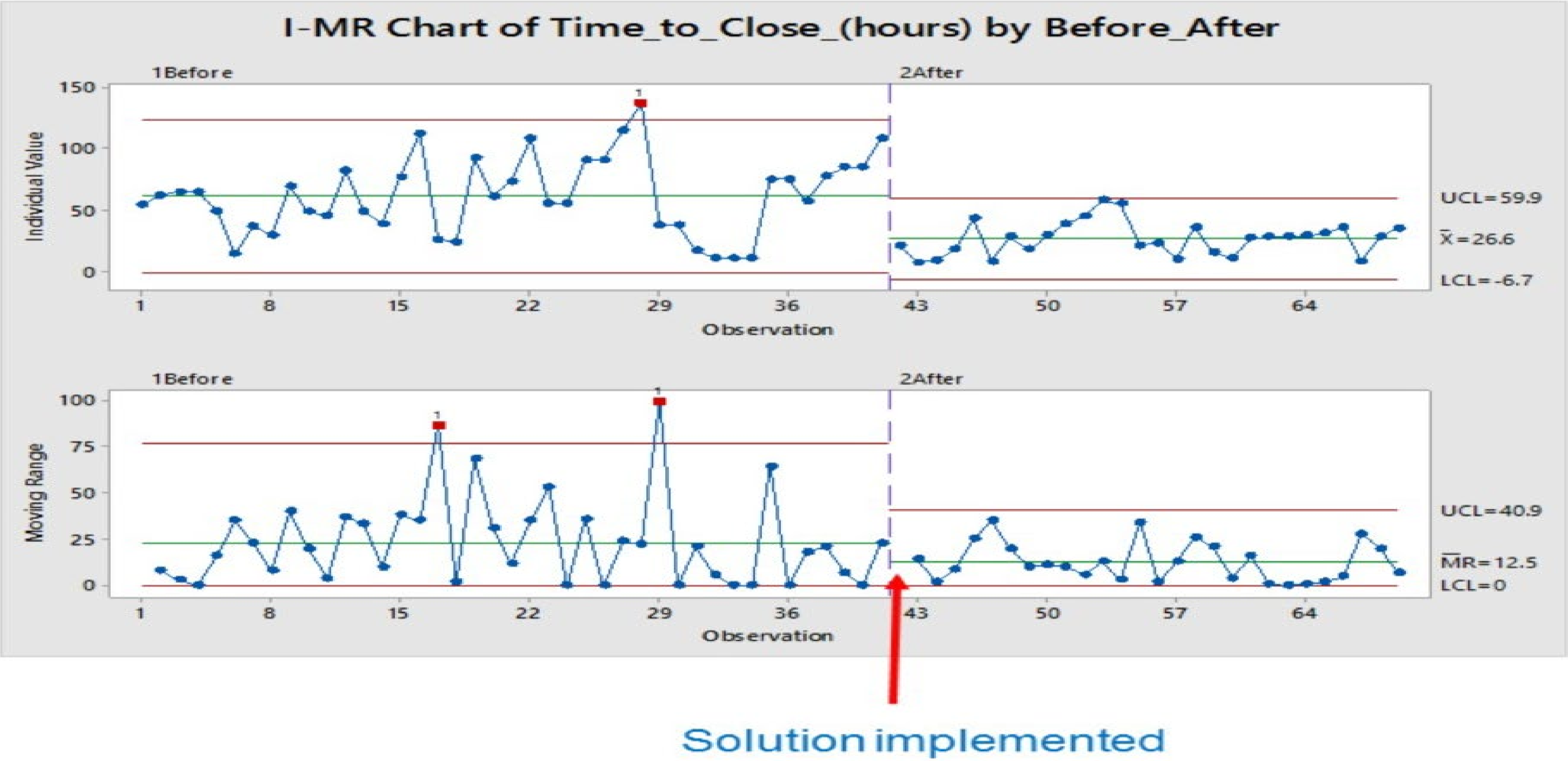
FMEA for a cheque-book printing and delivery process

Process	Type	Phenomenon	Cause	Influence	Detect Method	Severity	Frequency	Detectability	RPN	Remedies for Cause	Flow Out Prevention
Cheque book Delivery		Incorrect Printing	Info Take Incorrectly	Customer Calls to Reorder	Customer Call	1	5	1	5	Double Check Input at Order Point	Customer Approval Checkbox
			Printing Error at Vendor	Customer Calls to Reorder	Customer Call	1	5	2	10	Evaluate Vendor Process/Have Check Point	Penalty to Vendor to Encourage Prevention
			Field Space Limit	Customer Calls to Reorder	Customer Call	1	3	2	6	Ensure Banker Knows Limits; Ultimately Expand Field	Customer Approval Checkbox
		Box Returns	Box Size	Delivery Halted	Box Returned	1	5	2	10	Ensure Oversize Delivery is Possible	Confirm Delivery Mode at Ordering
			Chg of Address	Remailing Required	Post Office Record	1	1	2	2	Confirm Delivery Address at Before Shipping	Email Customer before Shipping to Confirm Address
		Lost Cheques	Order Incomplete	Resubmit Order	Customer Call	1	3	2	6	Track Steps of Check Ordering to Delivery Process	Send Alert when Process Step Overdue

Improve

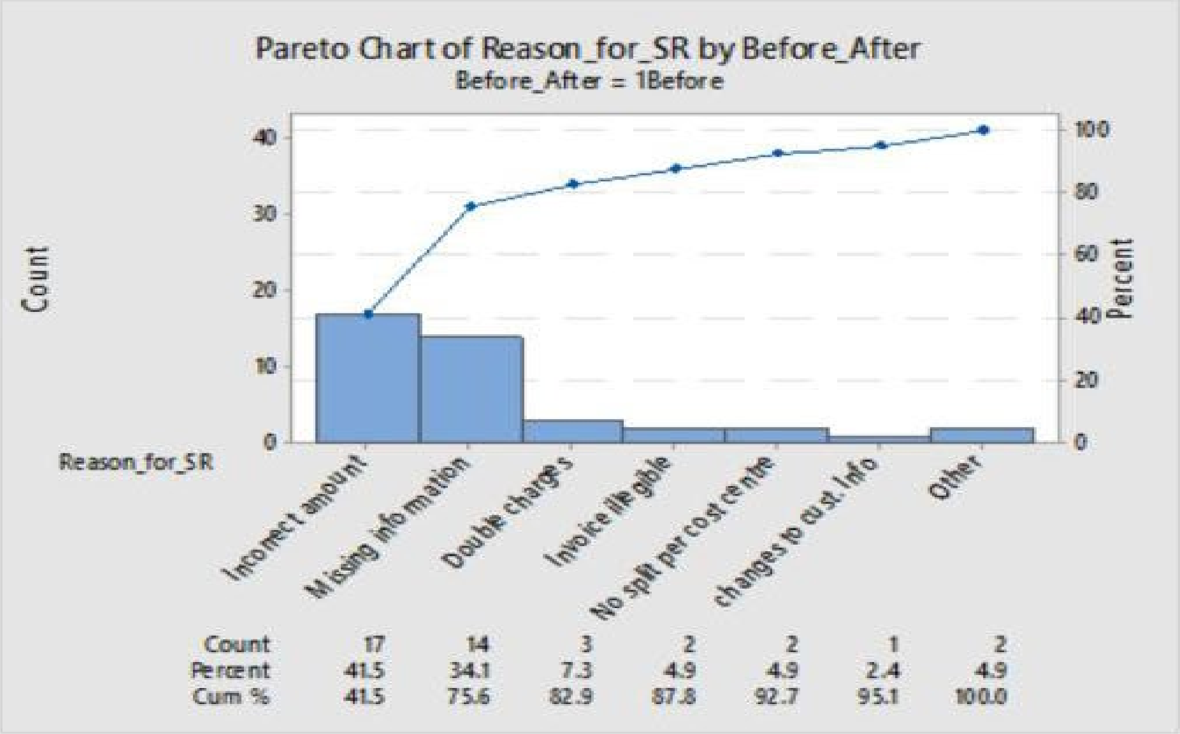
- Identify and Select Solutions
  - Brainstorming / Fishbone
  - Prioritisation Tool: Pugh Matrix
- Implementing Solutions
  - ➢5S
  - ➢Mistake Proofing: Poka Yoke
  - ➢SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Handling Risk: Failure Mode and Effects Analysis (FMEA)
- ***Solution Validation***

Solution Validation – Graphical Example

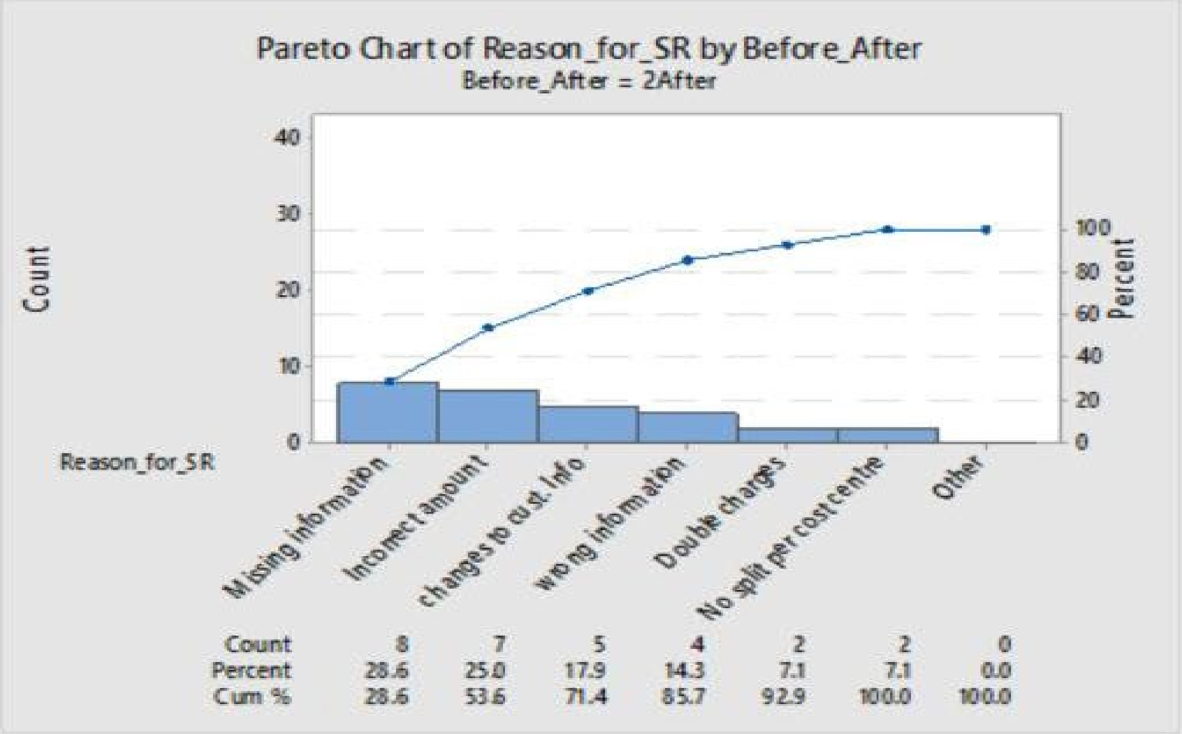


Solution Validation – Graphical Example

Before



After



Percentage of each category has changed but categories themselves not removed. Still work to be done here.

Improve Phase – Review Questions

- ☐ Can you explain the benefits of using the *Six Thinking Hats* as a brainstorming technique?
- ☐ Which tools can help with selecting and/or comparing improvement ideas?
- ☐ Why should you run a pilot?
- ☐ What is the purpose of *Failure Mode and Effects Analysis*?
- ☐ What is *Poka Yoke* (*Mistake Proofing*) trying to do?

DMAIC

- Define
- Measure
- Analyse
- Improve
- ***Control***

Control

DEFINE

MEASURE

ANALYSE

IMPROVE

CONTROL

Maintain the solution

Objectives

- To evaluate the solutions and the plan
- To maintain the gains accomplished by standardising the process and outline steps for on-going improvements, including opportunities for replication

Outcomes

- Embedded change
  - Create/update Standard Operating Procedures
  - Training plans and manuals
  - Updated working practices
- A monitoring system in place (Control Plan)
- Benefits calculated
- Project closed
  - Obtain management sign off
  - Team celebration and disbanded

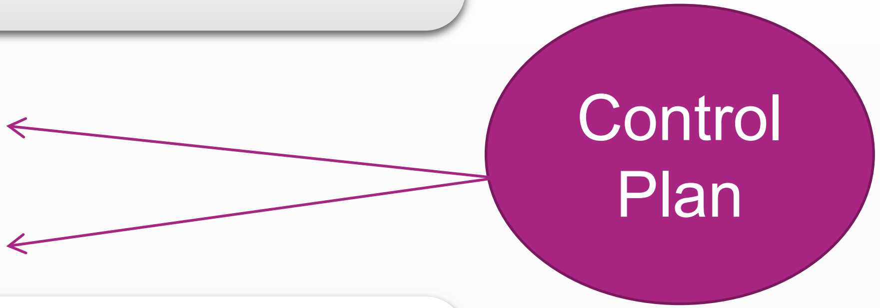
Control

- ***Embed and Sustain the Change***
- Measure the Gain
- Re-baseline the Process and Close the Project

Plan to Sustain

The improved process is given back to the Business and it will need to:

- Monitor the process
- Maintain the process
- Escalate if there are problems



Some training in the process and SPC (Control Charts) may be necessary

- Follow up sessions and meetings may be required

Provision needs to be made for training new people in the new ‘one best way’

Run Charts

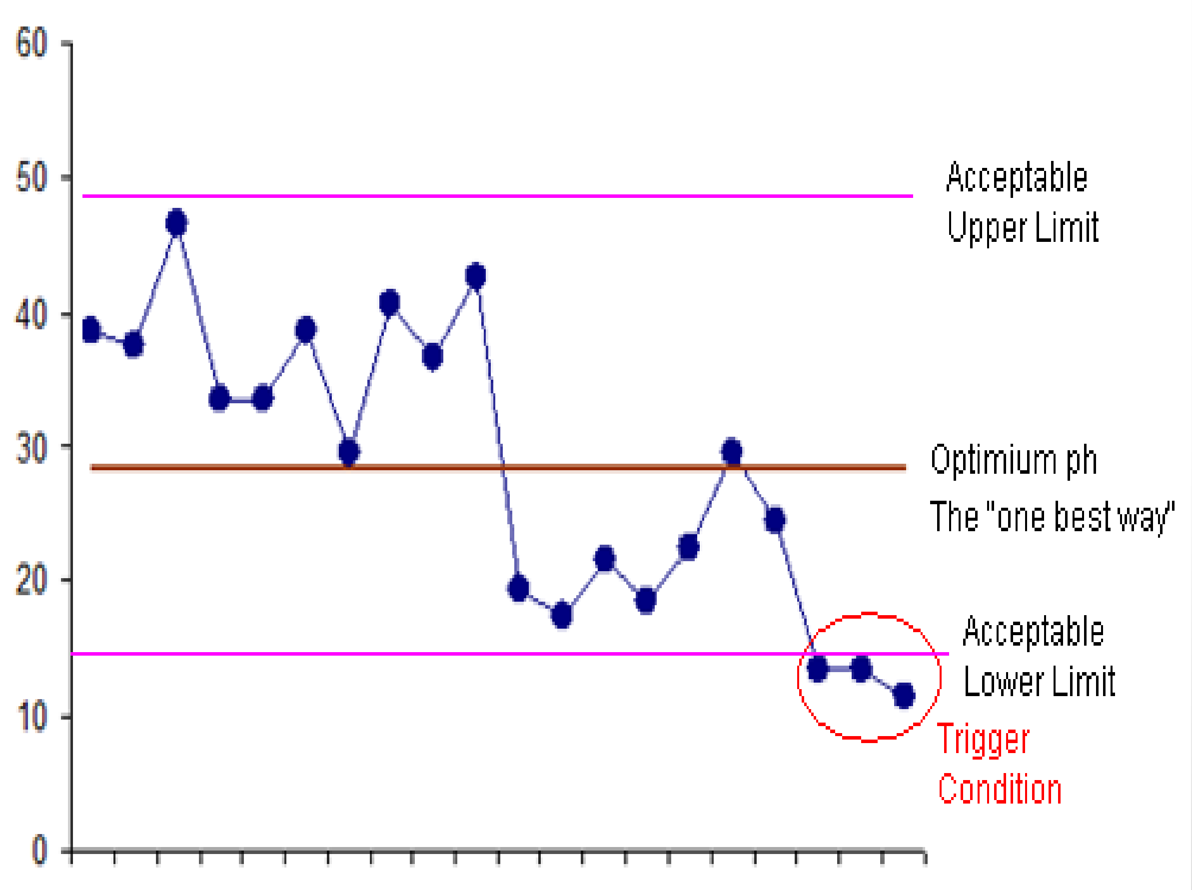
Help to identify trends in data

Link changes in the process to points in time

Do not need the normal distribution

Often used in the Control phase to track process performance

In this case the acceptable values are often ‘hard wired’ onto the chart



Control

- Embed and Sustain the Change
- ***Measure the Gain***
- Re-baseline the Process and Close the Project

Measure the gain

Calculating the savings

- Benefits review
- Benefits assessment

What if the project did not complete?

Calculating the Savings

It is good practice to see if a project has given 'value for money'

- Will we get out more than we spent?
- L6S projects concentrate on 'savings made'

This is often referred to as a *Benefits Review* or a *Benefits Assessment*

Green Belt projects are usually informally managed, so a simple Benefits Assessment will often suffice

However, sometimes an organisation will mandate a more formal Benefits Review

- Standard company procedure
- Agreed calculation methods
- May be performed by external (to the project) audit team
- May include re-assessments at later dates (Post Project Reviews)

Benefits Assessment

Carried out by the Green Belt

May involve or need communicating to:

- Team / Local Champion / Black Belt

An estimation of the savings made over a realistic time period

- Commonly 2, 5 or 10 years
- Period sometimes mandated by organisation

To give an honest picture, costs need to be subtracted from the headline savings

- The costs of running the project
- Any on-going maintenance costs

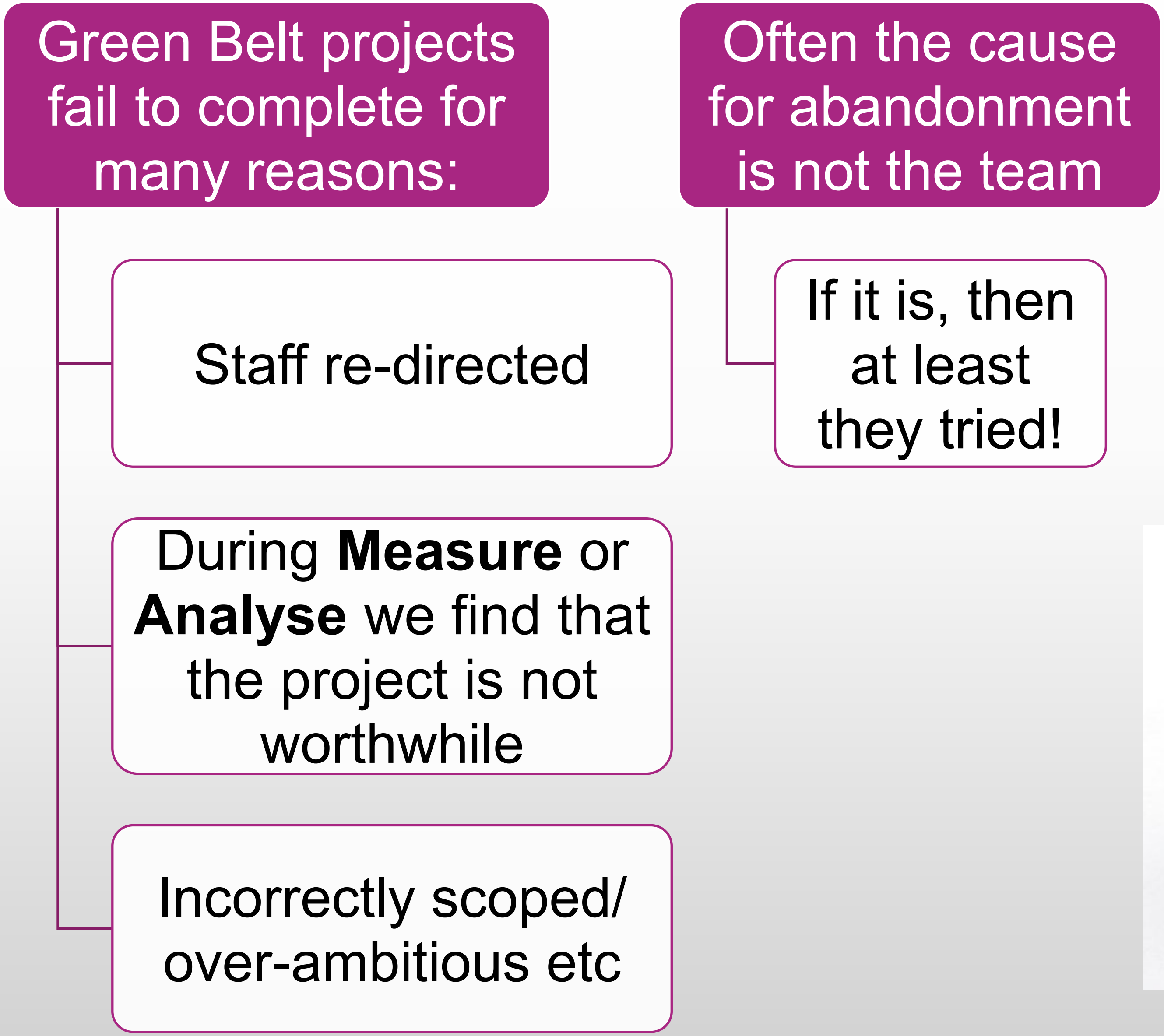
Not a rigorous financial document!

Benefits Assessment – An Example

Document process re-design
Methodology: DMAIC
End Date: April 23rd
Savings and costs estimated over 5 years
Staff time estimated @ £20/hour

Saving 1: 1 mins saving per document 40 docs/week = 9600 docs @ 33p per document	+ £3168
Saving 2: New process will stop us losing documents or 'forgetting' them Estimated cost of above is 30 mins per doc Last year we lost or mislaid 17 assuming that we now only lose 2 per year (a saving of £300 per year)	+ £1500
Project Costs: 5 staff members for 10 hours each	- £1000
On-going maintenance costs: None/minimal	
Estimated cost savings over 5 years	+ £3668

What if the project did not complete?



Green Belt projects fail to complete for many reasons:

- Staff re-directed
- During **Measure** or **Analyse** we find that the project is not worthwhile
- Incorrectly scoped/ over-ambitious etc

Often the cause for abandonment is not the team

- If it is, then at least they tried!

So don’t forget to celebrate the team’s achievements and pay special attention to the lessons learned session

Control

- Embed and Sustain the Change
- Measure the Gain
- ***Re-baseline the Process and Close the Project***

Control Plan

The Control Plan identifies the process variables which should be monitored during the control phase, to determine if the process is slipping ‘out of control’ in any way

The Control Plan should list the following:

- What needs to be monitored
- When and how the monitoring should be performed
- Acceptable limits (perhaps using RAG – Red/Amber/Green)
- Correction procedure
- Escalation procedure
- Charts to be maintained (e.g. Control Charts)

Completing Project Activities

The graphic shows a possible work stream to implement when a project is no longer needed

- It has reached a successful conclusion
- It has not reached a successful conclusion

To a certain extent these steps overlap, run in parallel and loop back

Project no longer needed

Project review meeting

Identify and execute *follow-on actions*

Record and circulate Lessons Learned

Optional presentation to BB/ Champions/Management

PPP

Project Review Meeting

A meeting of the whole team

- Perhaps including BB and Champions

Examine team performance

- Positive/Constructive criticism please
- Did we do what we set out to do?
- How did our expectations and plans change?
- What would we change if we could start again?
- How did we work as a team?

From this we can generate a list of *Lessons Learned*

Use the meeting to identify any loose ends (*Follow On Actions*) which need to be performed before we can close the project

Project Closure: Worksheet

FOA (follow-on actions)	Assigned	Done?
Return tools to store	Mat	
Return whiteboard to sales	Lizzie	Y
Clean up space and wall	Tom	
Send Lessons to BB	Denise	
Organise celebrations	Phoebe	

Keep it simple

Lessons Learned

Invaluable way of learning from experience

Most effective when shared

List good ***and*** bad

Some topics to get you started:

- How good was our initial forecast of savings?
- Did our methodology work well – if not, why not?
- How effective was our planning?
- How effective was our teamwork?
- How effective was our communication?

For failed projects

- With hindsight – can we identify any early indicators that indicated the project was not worthwhile?
- ***When*** should we have noticed the project was not worthwhile?

Optional Presentation to BB/Champions/Management

Some organisations mandate this

- Some GBs find it useful anyway

Decide on the agenda and timings

Keep your presentation:

- Clear, Concise and Short

You may wish to review:

- Savings
- Lessons
- Team performance
- What is planned next

Pass on the good news

Control Phase – Review Questions

- ☐ Why is it important to measure the improved process?
- ☐ Before closing the project, what should be handed over to the *Process Owner*?

A Quick Review...

Process Improvement Thoughts

- **A number of options are available to the Lean Six Sigma teams, once root causes of process problems are known**
- **Some examples:**
  - Simplify and remove process steps
  - Redefine roles and organisations
    - Use a customer supplier relations approach
  - Move from sequential to parallel activities
  - Reduce non-value adding activities
  - Automate Steps
  - Remove bottlenecks and ensure continuous flow
  - Reduce dependency on formal inspections
  - Improve the quality of information exchanged between process stakeholders
  - Introduce new techniques and tools
  - Train and educate resources
  - Standardise best practices
  - Introduce measurement and process controls

DMAIC – A SNAPSHOT

DEFINE	MEASURE	ANALYSE	IMPROVE	CONTROL
What exactly is the issue and can we deal with it	Quantify the current state (determine the baseline)	Identify the cause of the problem	Implement and verify the solution	Maintain the Solution
Aim: Clearly state the specific business problem, goal, potential resources, project scope and high-level project timeline	**Aim**: Understand the "As Is" state – how the process is performing and what the magnitude of the problem is	**Aim**: Get to the root cause(s) of the problem and flesh it out	**Aim**: Determine a solution which will solve the identified problem	**Aim**: Ascertain that the action improvements carried out in the *Improve* phase have worked and are well-maintained
What exactly is the issue? Problem/goal statement Business Opportunity Project documentation - other ***Dealing with the issue*** Project charter Project team / Team charter Project management / Project plan Process Definition - SIPOC / High level 'As Is' Process Map Stakeholder Management (inc communication plan) VoC - CTQ / Customer requirements / Customer/Feature diagrams / Kano	***Quantify the current state*** Operational definitions Data collection method/plan Data collection form Sampling (and frequency) ***Is data representative/relevant?*** SPC / KPIs Spaghetti diagrams Pareto Charts Gemba walk / Process stapling Histograms ***What is current status of process?*** Establish baselines Current VSM (As Is) Process Capabilty (Cp / Cpk) Yield / DPMO / Process Sigma Quick wins identified/proposed	***Move from subjectivity to fact*** SPC - Analyse Identified/tested root causes Brainstorming Select probable root causes Validated root causes 5 Whys / Fishbone Affinity Diagrams Lean process analysis Regression Analysis Correlation Tools ***Impact of change on Process*** VSM target (To be) Process capability (To be) FEMA	***What solutions are available and what is best for the process?*** Consensus tools Problem solving 5S / Poka Yoke Brainstorming ***What is the cost/benefit/risk?*** Assessment criteria Root cause analysis / FMEA Statistical data analysis ***Implementing the 'fix'*** Implementation schedule/events Pilot plan / Action plans OTGIs Validation of benefits Control plan	***Has it been embedded in BaU?*** SPC Visual management Continuous kaizen, 5S etc Standard Operating Procedures Updated working practices Training manuals / Training plans ***How will progress be monitored?*** Visual management Process control systems ***Was the project goal achieved?*** Benefit measurement Key Performance Indicators (KPIs) ***Close the project*** Project report (inc lessons learned) Team celebration / Team disbanded ***Continuous/Ongoing Improvements...***

What next?

Specify the Next Problem

Now, submit the following information:

1) Your name
2) Proposed GB project
3) Project Sponsor
4) Estimated timeline for the project

To enable your desired results…

Contact Us!

training@makewayglobal.com

Follow Us!

LinkedIn: https://linkedin.com/in/makewayglobal

Twitter: @makewayglobal

Instagram: makewayglobal

Facebook: facebook.com/makewayglobal

Feedback on Google and Trust Pilot

To improve supporting you better, please give reviews

- ☐ **Google Reviews Link: https://goo.gl/XwXwDt**

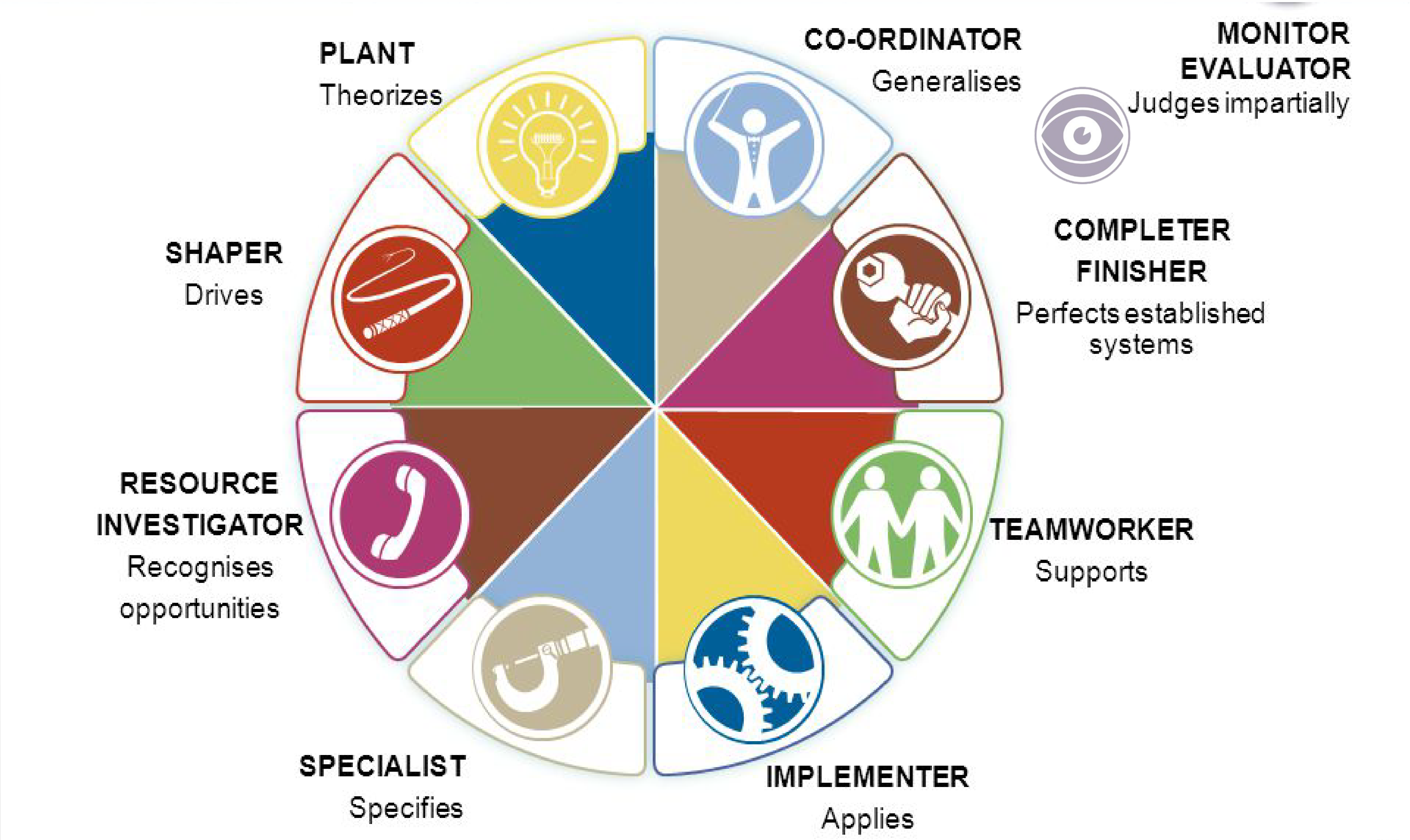
and

- ☐ **Trust Pilot Link:**

https://www.trustpilot.com/review/www.makewayglobal.com

ANNEX

The Belbin Team Roles



PLANT
Theorizes

CO-ORDINATOR
Generalises

MONITOR EVALUATOR
Judges impartially

SHAPER
Drives

COMPLETER FINISHER
Perfects established systems

RESOURCE INVESTIGATOR
Recognises opportunities

TEAMWORKER
Supports

SPECIALIST
Specifies

IMPLEMENTER
Applies

The Belbin Team Roles

Key Points

- ➢Dr Meredith Belbin’s 9 clusters of behaviour
- ➢A diverse mix of behaviours
- ➢Each team needs the 9 roles to be a High Performance Team (HPT), but not 9 people!
- ➢Each team role has its strengths and weaknesses with equal importance

Plant

- Tends to be highly creative and good at solving problems in unconventional ways.
- **Strengths:** Creative, imaginative, free-thinking, generates ideas and solves difficult problems.
- **Allowable weaknesses:** Might ignore incidentals, and may be too preoccupied to communicate effectively.
- **Don't be surprised to find that:** They could be absent-minded or forgetful.

The Belbin Team Roles

Shaper

- Provides the necessary drive to ensure that the team keeps moving and does not lose focus or momentum.
- **Strengths:** Challenging, dynamic, thrives on pressure. Has the drive and courage to overcome obstacles.
- **Allowable weaknesses:** Can be prone to provocation, and may sometimes offend people's feelings.
- **Don't be surprised to find that:** They could risk becoming aggressive and bad-humoured in their attempts to get things done.

Resource Investigator

- Uses their inquisitive nature to find ideas to bring back to the team.
- **Strengths:** Outgoing, enthusiastic. Explores opportunities and develops contacts.
- **Allowable weaknesses:** Might be over-optimistic, and can lose interest once the initial enthusiasm has passed.
- **Don't be surprised to find that:** They might forget to follow up on a lead.

The Belbin Team Roles

Specialist

- Brings in-depth knowledge of a key area to the team.
- **Strengths:** Single-minded, self-starting and dedicated. They provide specialist knowledge and skills.
- **Allowable weaknesses:** Tends to contribute on a narrow front and can dwell on the technicalities.
- **Don't be surprised to find that:** They overload you with information.

Implementer

- Needed to plan a workable strategy and carry it out as efficiently as possible.
- **Strengths:** Practical, reliable, efficient. Turns ideas into actions and organises work that needs to be done.
- **Allowable weaknesses:** Can be a bit inflexible and slow to respond to new possibilities.
- **Don't be surprised to find that:** They might be slow to relinquish their plans in favour of positive changes.

The Belbin Team Roles

Teamworker

- Helps the team to gel, using their versatility to identify the work required and complete it on behalf of the team.
- **Strengths:** Co-operative, perceptive and diplomatic. Listens and averts friction.
- **Allowable weaknesses:** Can be indecisive in crunch situations and tends to avoid confrontation.
- **Don't be surprised to find that:** They might be hesitant to make unpopular decisions.

Completer Finisher

- Most effectively used at the end of tasks to polish and scrutinise the work for errors, subjecting it to the highest standards of quality control.
- **Strengths:** Painstaking, conscientious, anxious. Searches out errors. Polishes and perfects.
- **Allowable weaknesses:** Can be inclined to worry unduly, and reluctant to delegate.
- **Don't be surprised to find that:** They could be accused of taking their perfectionism to extremes.

The Belbin Team Roles

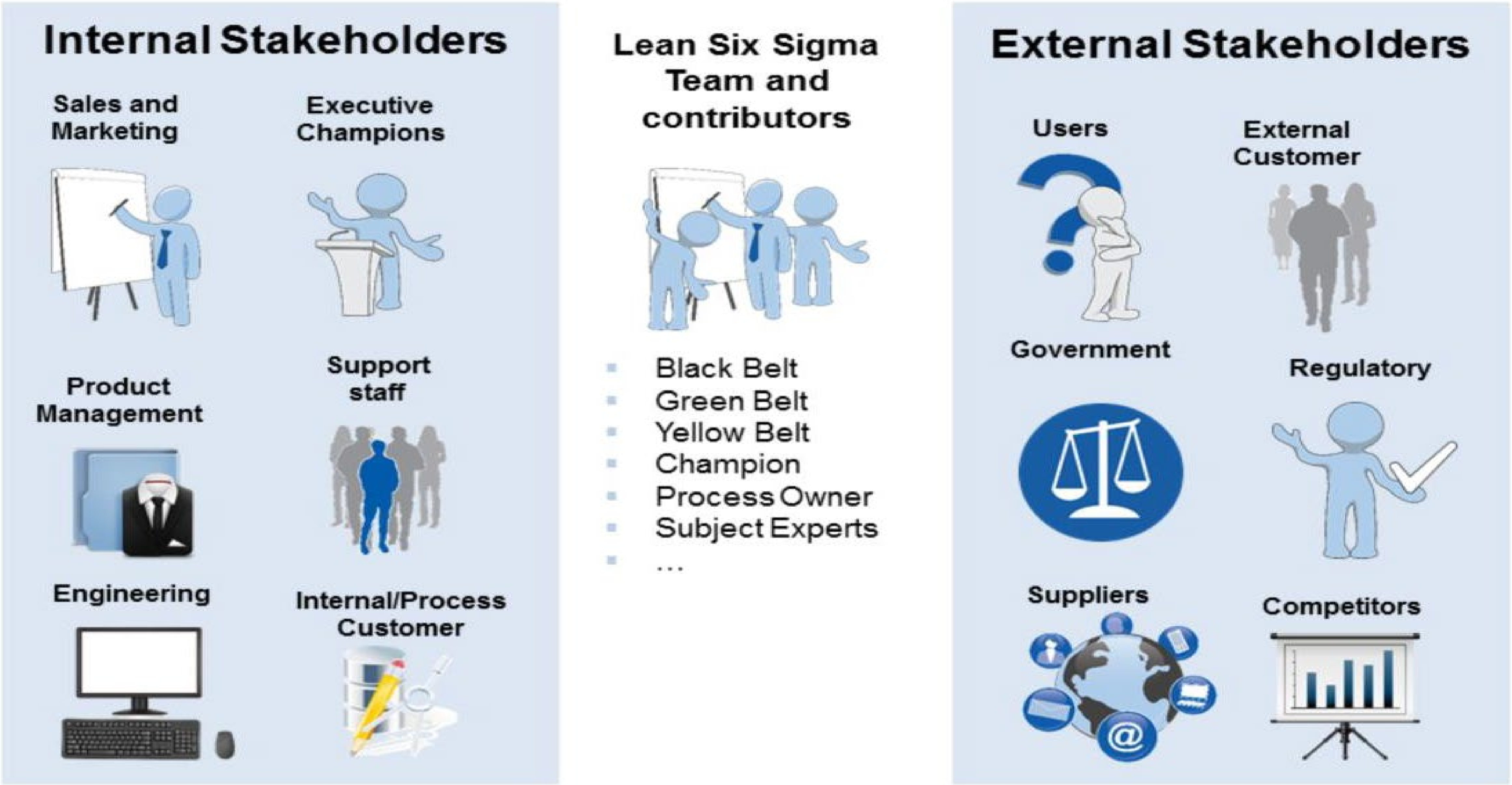
Co-ordinator

- Needed to focus on the team's objectives, draw out team members and delegate work appropriately.
- **Strengths:** Mature, confident, identifies talent. Clarifies goals.
- **Allowable weaknesses:** Can be seen as manipulative and might offload their own share of the work.
- **Don't be surprised to find that:** They might over-delegate, leaving themselves little work to do.

Monitor Evaluator

- Provides a logical eye, making impartial judgements where required and weighs up the team's options in a dispassionate way.
- **Strengths:** Sober, strategic and discerning. Sees all options and judges accurately.
- **Allowable weaknesses:** Sometimes lacks the drive and ability to inspire others and can be overly critical.
- **Don't be surprised to find that:** They could be slow to come to decisions.

Stakeholder Analysis



Internal Stakeholders

- Sales and Marketing
- Executive Champions
- Product Management
- Support staff
- Engineering
- Internal/Process Customer

Lean Six Sigma Team and contributors

- Black Belt
- Green Belt
- Yellow Belt
- Champion
- Process Owner
- Subject Experts
- …

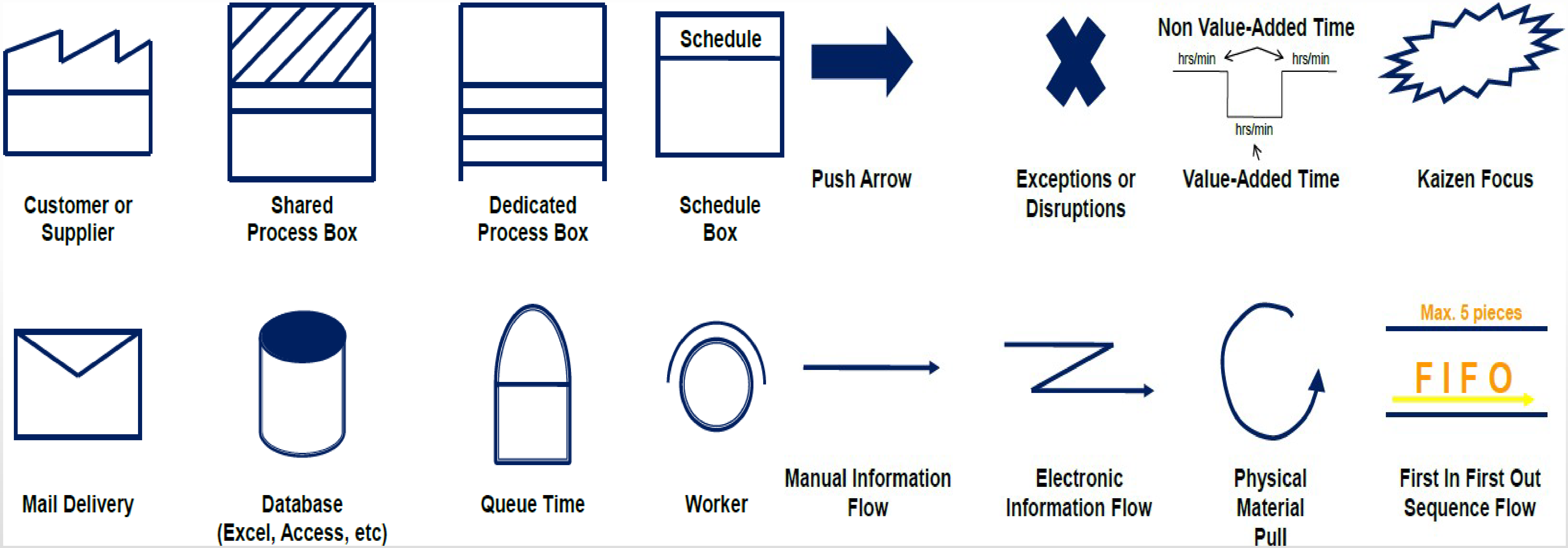
External Stakeholders

- Users
- External Customer
- Government
- Regulatory
- Suppliers
- Competitors

Data Collection Methods

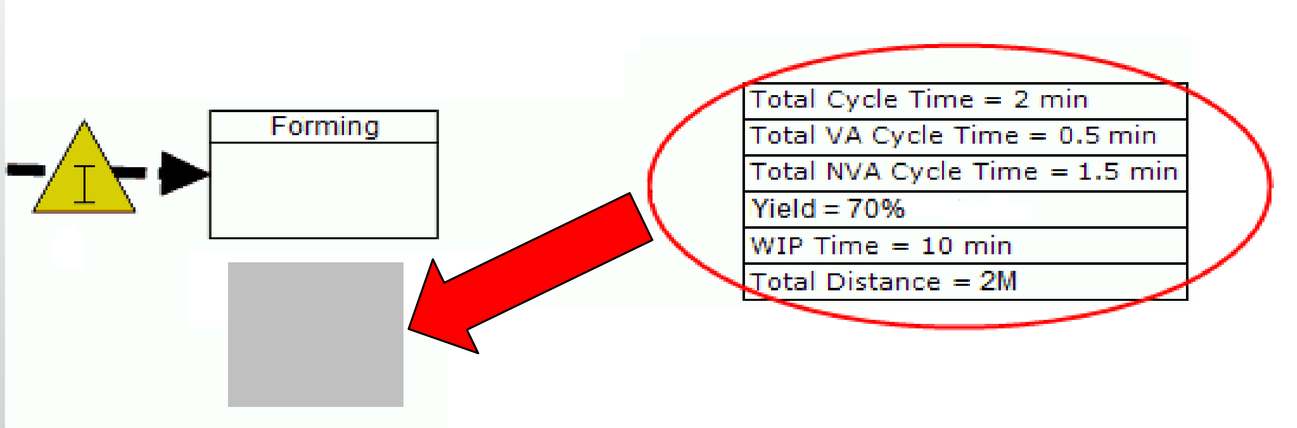
Method	Timeline	Data	Cost	Advantages	Disadvantages
Telephone Survey	2 - 4 weeks	Quantifiable (Objective)	High	Data can be generalised to larger population	Low flexibility
Mail Survey	Months	Quantifiable (Objective)	Low	Low cost and data can be generalised	Low response rates
Focus Group (in person)	1 day	Qualitative (Subjective)	Low - Medium	Can be customised / More indepth answers	Cannot be generalised
Focus Group (online)	1 day	Qualitative (Subjective)	Low - Medium	Can be customised / No travel required	Cannot be generalised
One-on-One Interviews	Several days	Qualitative (Subjective)	Low - Medium	Can be customised	May be difficult to obtain cooperation
User Testing	Months	Both	Medium	Provides input on user-friendliness	Appropriate only for specific topics
Customer Complaints	Months	Qualitative	Low	Provides specific input	Cannot always be generalised

Typical icons used in VSM



Process Boxes

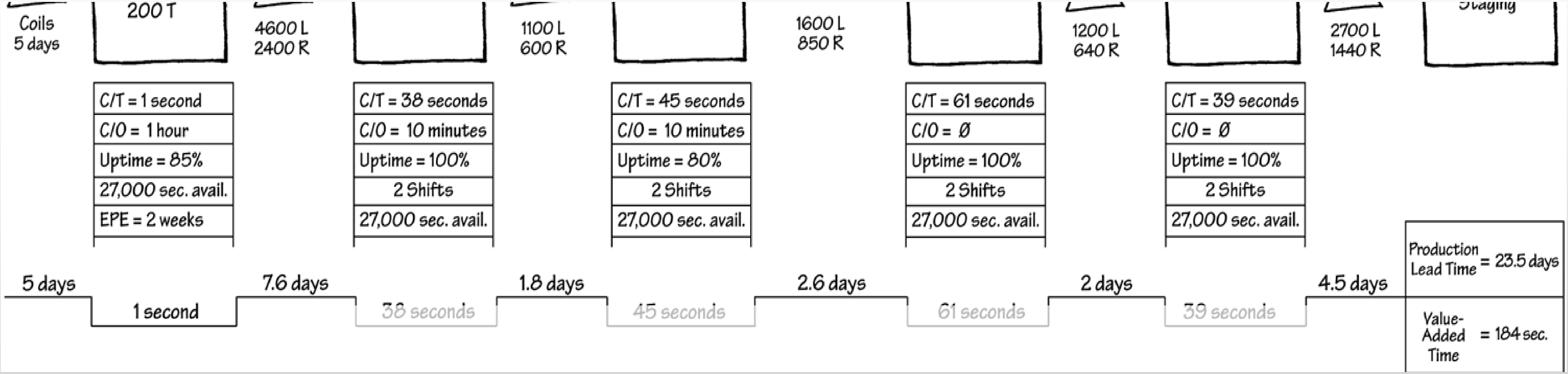
- The process box of a VSM is used by the team to record relevant information describing the process
- The aim is to capture data so that waste can be pinpointed
- Anything that will help should be recorded by the team
- The next few slides give examples of the common metrics often used in process boxes…



Total Cycle Time = 2 min
Total VA Cycle Time = 0.5 min
Total NVA Cycle Time = 1.5 min
Yield = 70%
WIP Time = 10 min
Total Distance = 2M

Data Box

- **The Data Box stores process information**
  - **Cycle Time (C/T)**: Rate at which a part or product is completed by a process
  - **Available Work Time**: Per shift of a process (in seconds, minus break, meeting, and cleanup times)
  - **Quality Level**: % First Time Yield or Throughput Yield
  - **Number of Operators**: Required personnel for a process



Useful VSM Metrics (1)

Takt Time	The maximum amount of time available to complete a piece of work and still meet customer demand. Takt time works best when the tasks to do the work are easily standardised and repetitive
Unit Time (UT)	The time it takes to create part of a deliverable (service or product) – total VA The time it would take a worker to complete the activity if the work was not interrupted
Cycle Time (CT)	Time it takes to perform all the work needed to create a product The elapsed time from when the work is first made available to the producer (person or department etc) until that work is ready to be handed over CT = Combined UT + Waiting/delays (or VA+NVA)

The above are measured in time units – depending on the situation, the team should select applicable units such as seconds, minutes, hours, days etc

Activity Ratio (AR)	(Total UT/CT) x 100 The % of CT in which value added work is performed *To put it another way, waste time in a process = 100-AR*

Useful VSM Metrics (2)

First Time Yield (FTY)	The % of product which is right first time (i.e. requires no re-work). This is usually assigned to each Cell or Unit, allowing us to calculate Rolled Throughput Yield (RTY). *FTY is often referred to simply as 'Yield' or sometimes as 'First Time Quality' – Be careful with the term Yield as it can have several meanings!*
Rolled Throughput Yield (RTY)	The probability that a process with more than one step will produce a defect free unit. It is the product of yields for each process step of the entire process. For any process, it is ideal for that process to produce its output without defects and without rework.

The above are measured in percentages

First-Time Yield (FTY) – example

FTY Calculation:

1000 units have entered the process (WIP)

Scrap products = 47 **‘Rejects’**

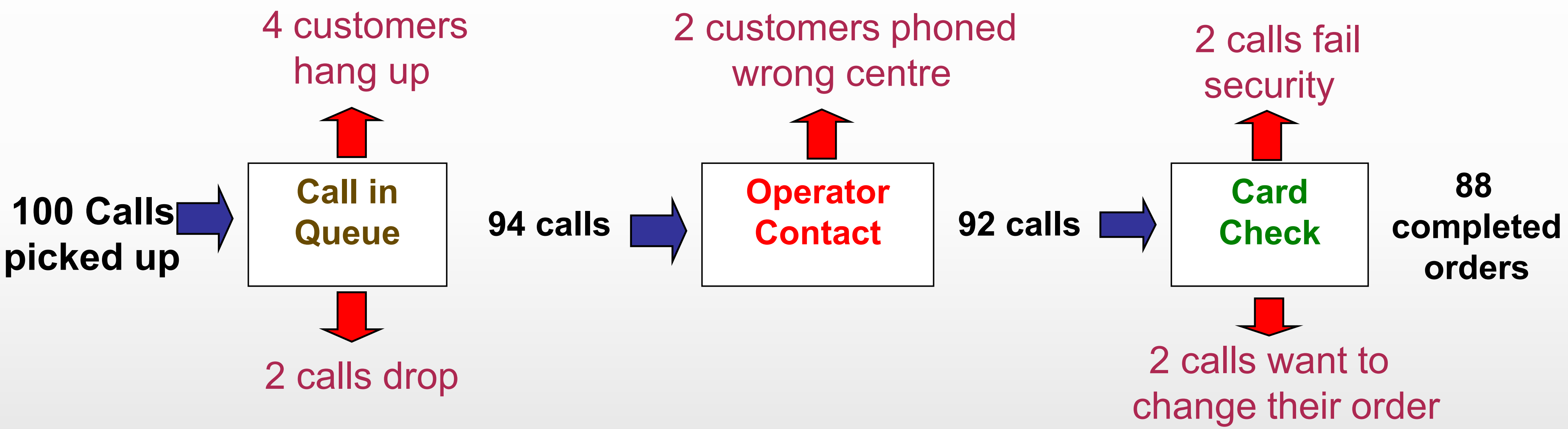
$$\boxed{\text{First-Time Yield (FTY)}} = \frac{1000 - 47}{1000}$$

$$= \mathbf{95.3\%}$$

Rolled Throughput Yield (RTY)

The percentage of units which goes through the complete process without requiring rework or failing to complete any process step

Insurance Call Centre process



4 customers hang up

2 customers phoned wrong centre

2 calls fail security

100 Calls picked up

Call in Queue

94 calls

Operator Contact

92 calls

Card Check

88 completed orders

2 calls drop

2 calls want to change their order

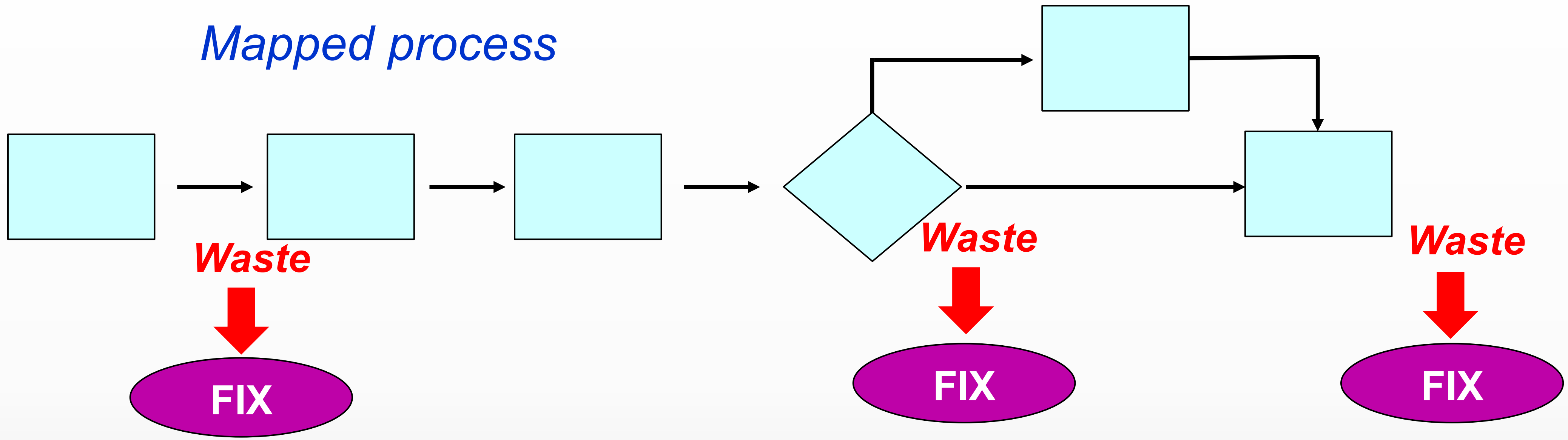
RTY Queue = 100 * (94/100) = 94%

RTY Operator = 100 * (92/94) = 98%

RTY Card Check = 100 * (88/92) = 96%

Rolled Throughput Yield (RTY) = 94 * .98 * .96 = **88%**

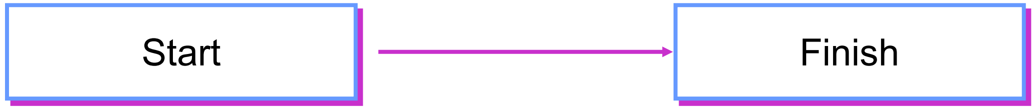
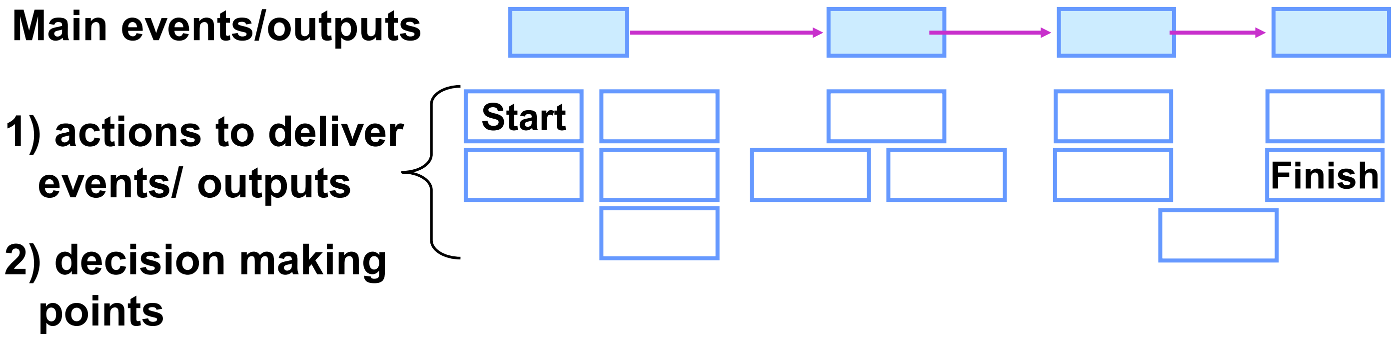
The Aim of Value Stream Mapping



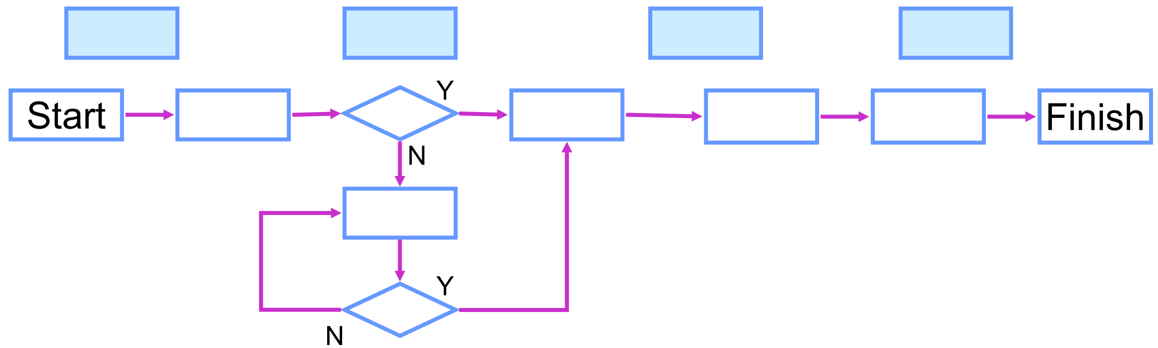
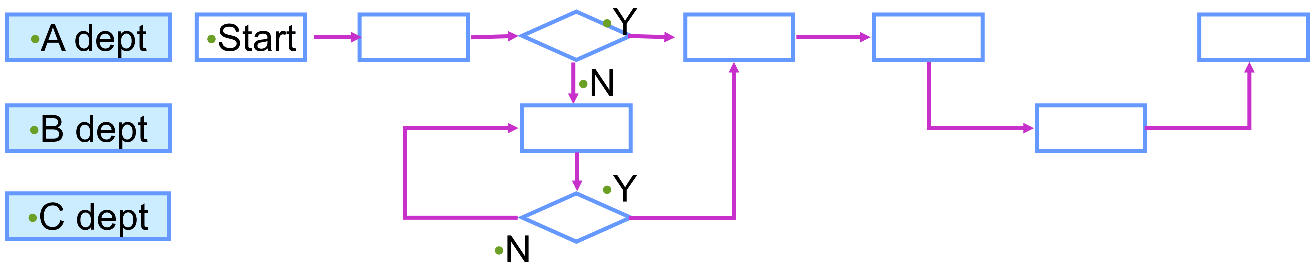
Value Stream Mapping helps us understand how a process works (both the physical process and the communication flows) so that we can identify areas of **waste** and then remove them

The VSM is a Lean technique

Steps for Building a Value Stream Map (1)

Steps	Illustrations
Step 1: **Determine the range of process** Decide which process to cover Determine the starting point and the terminal point of the process ***(A SIPOC is useful for this)***	'Process XXX' Covers from XXX's order placement to its shipment 
Step 2: **Clarify each step of the process** Follow the order of the process – identify the main events/outputs first Next, put the actions and decision-making points on post-its and place on the map	

Steps for Building a Value Stream Map (2)

Steps	Illustrations
Step 3: **Build the basic Process Map** Now arrange the post-its in the order of operation Rearrange the post-its in the order that they are practiced! *(Possible waste here!)*	
Step 4: **Identify the departments, functions or people conducting the actions** Swim lane diagrams Responsibility charts *(You now have your basic Process map)*	

Steps for building a Value Stream Map (3)

•Steps	•Illustrations
Step 5:	

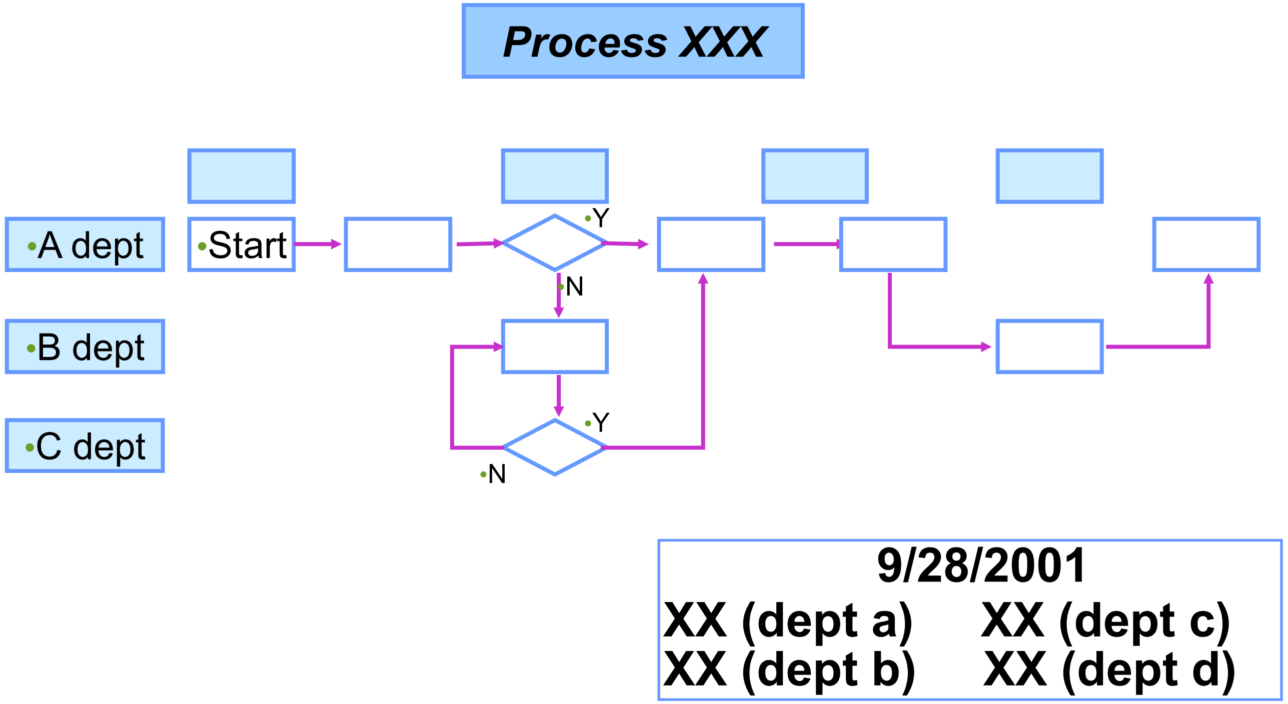
Verification of the process map

Ask operations and stakeholders to look through the map

Rectify necessary points so that their opinions are reflected

Hopefully, you now have a valid Process Map

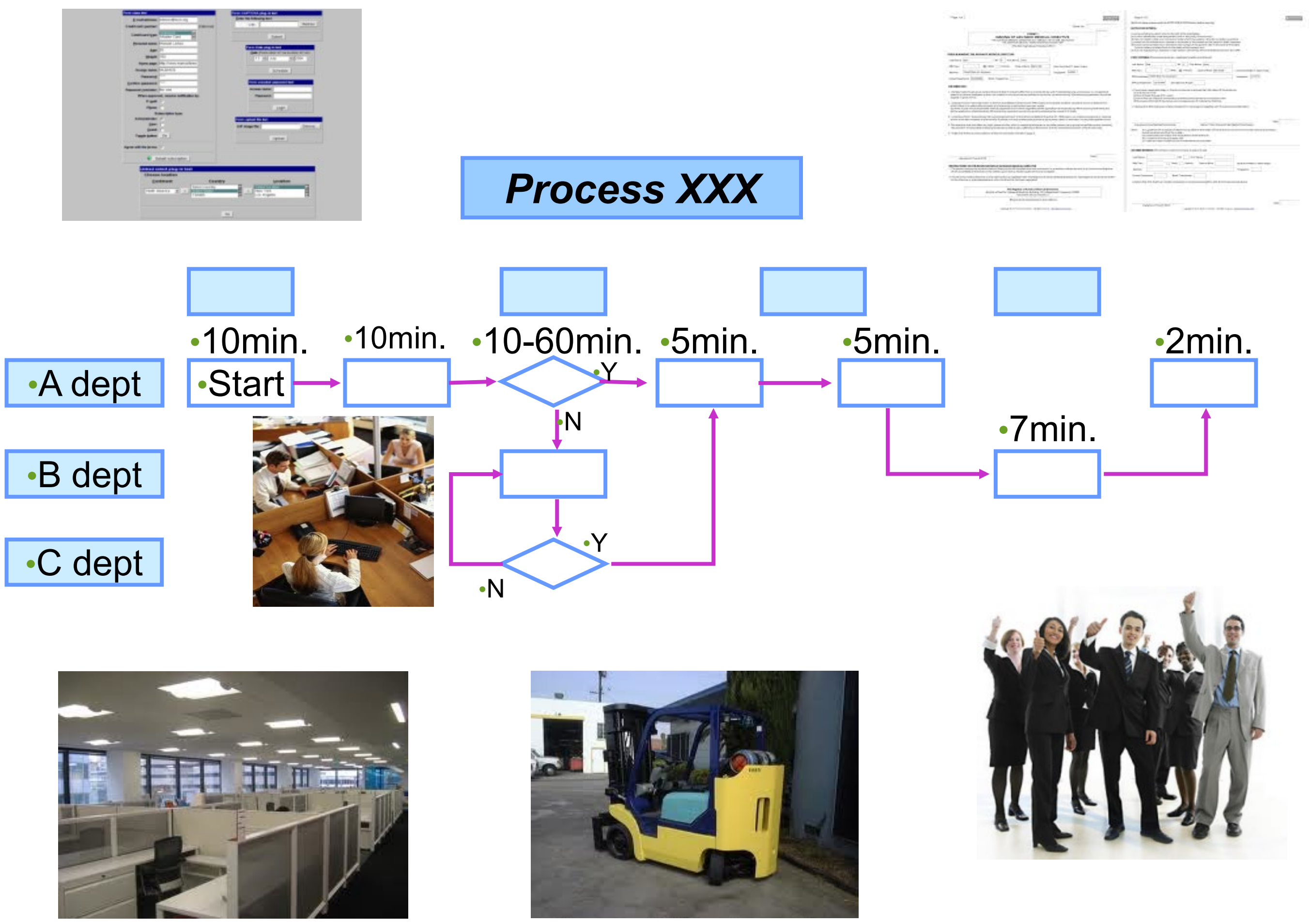
Fill in the title, the date the map was produced and participants' names



9/28/2001
XX (dept a) XX (dept c)
XX (dept b) XX (dept d)

•N

Steps for Building a Value Stream Map (4)

Steps	Illustrations
Step 6: **Add in the value stream** Add in man-power, lead time, cost and additional information/data (including communication lines) Look for wasted steps, time, distance, movement etc Identify non-value adding activities See what is going on in the gaps If you have not done so already, bring the map alive with pictures, data forms etc	

Top Tips (1)

Don't create a finished paper from scratch. Use pencil to do the first draft

- Makes it easier to correct mistakes
- Sends a message that this is not a ‘done deal’, but a ‘let's discover this together’ process

Disagreement about how the function is completed is OK

- It is probable that different people perform the same function differently – that is a significant finding!! Capture it on your VSM

Make not knowing the answer to every question OK

- It almost always happens that a question will be asked that no one can answer off the top of their heads
- Be sure participants understand that the steady stream of questions is not an attempt to trick or humiliate them
- Sometimes participants get rattled when every answer they provide is greeted with another question

Top Tips (2)

Ask for hard copy and completed examples

- All key documents should be obtained with ‘live’ information if possible
- Ask for a printed copy of significant computer screens if the function is ‘on-line’ or interactive between user and system

No value judgments (yet)

- The process of creating the initial paper should be a fact gathering exercise
- The evaluation of the information comes later
- At this point, all ideas are good ideas

Start process steps with an action verb

State the action taken or task performed at each step

Top Tips (3)

Identify one stream of activity and do it start to finish – then integrate other streams within it:

- Experience has shown that participants may become confused when trying to understand and document several different flows simultaneously
- By choosing just one and working through it from start to finish similarities and differences between flows can more readily be identified, and the meeting more easily controlled:
  - ❖ *Note: the group typically will need to be reminded of this several times.*

Top Tips (4)

Write explanations directly on the continuous process paper

- The only paper attached to the brown paper should be ‘live’ documents and their post-it note critique
- Or use different coloured post-it notes to identify explanations
- Be careful – post-its don’t always stay stuck!

Specify percentages for ‘yes’ or ‘no’ decision points:

- Each time the process can split into more than one path, document the frequency or percentage each path is taken

Use arrows to show the flow

The brown paper should be easily understood without lengthy explanations

Run Charts

A run is defined as one or more consecutive data points on the same side of the median

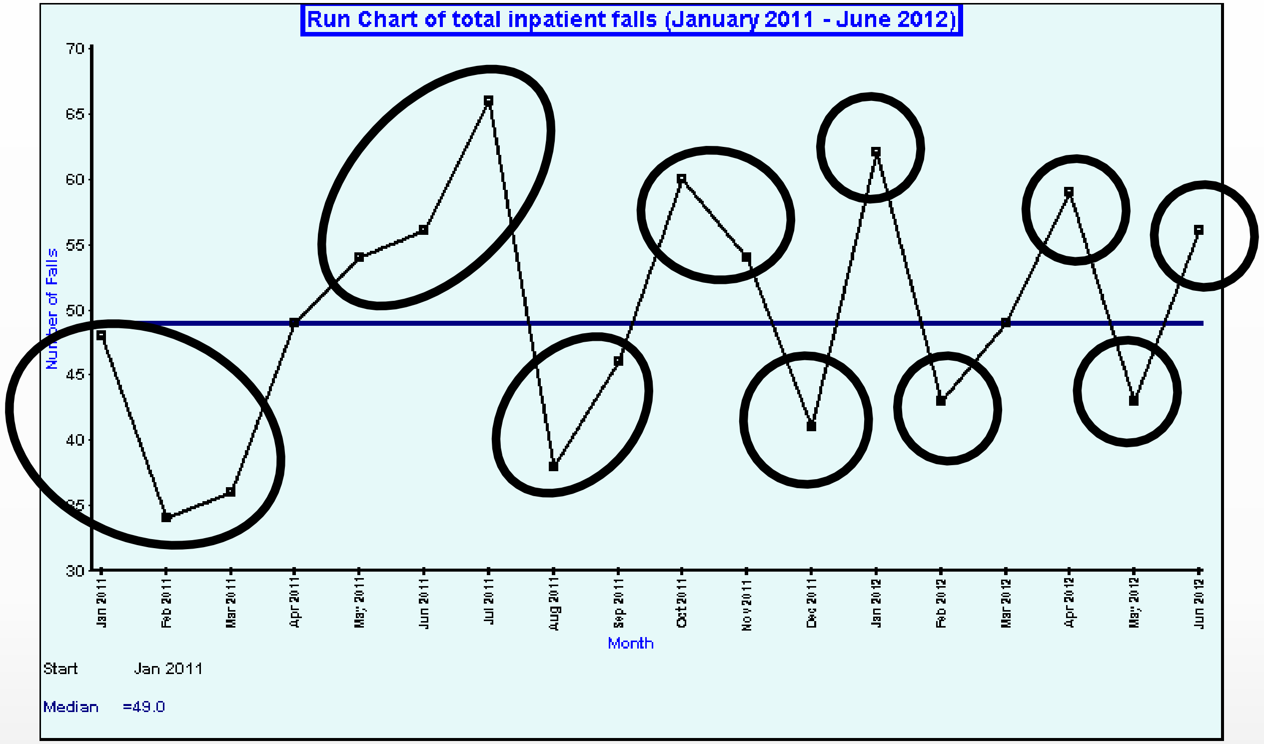
Help to identify trends in data

Link changes in the process to points in time

Do not need the normal distribution

Often used in the Control phase to track process performance

In this case the acceptable values are often ‘hard wired’ onto the chart



In this chart, there are 10 runs.

- A run could have a single point, or many points chart
- Notice that the runs exclude any points that are on the median line.

Process Capability

In a nutshell

Cp

(Potential Process Capability)

Cpk

(Actual Process Capability)

Summary

Prerequisite : Process Stability (Control charts)

Process Capability

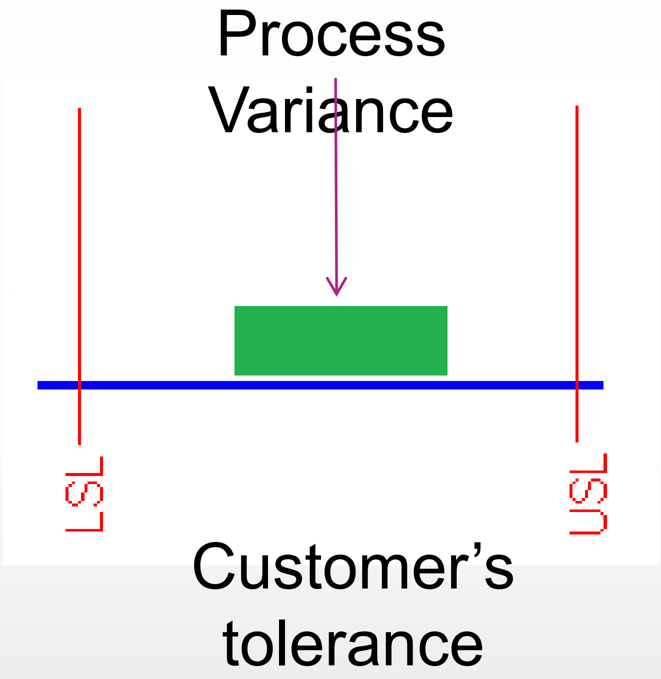
Process Capability examines how the process variance (VoP) fits within the tolerance set by the customer (VoC)

- Tolerance is the difference between the LSL and the USL (Lower and Upper Specification Limits – **NOT** to be confused with UCL and LCL)

To satisfy a customer we should not deliver products which are outside of either specification limit – this is the definition of a ***Capable Process***

There are two indicators for capability:

- Cp
- Cpk



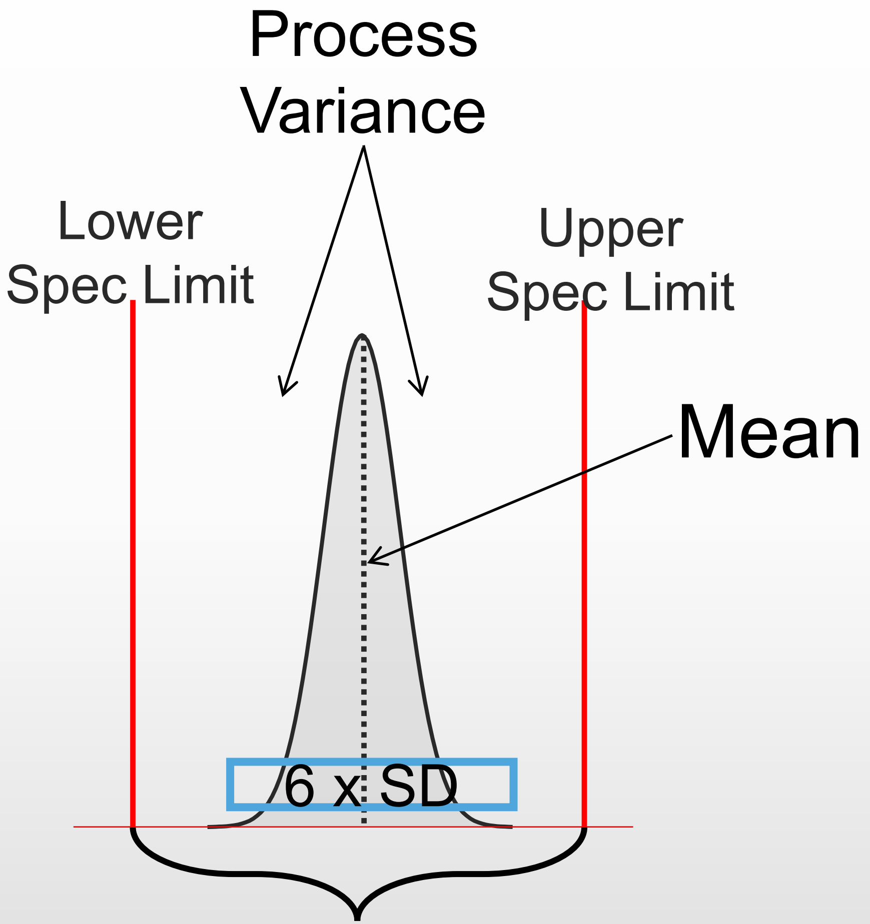
Cp: Potential Capability (1)

Cp metric measures the *potential capability* of the process

Contrasts the variation in process outputs as a proportion of the acceptable Tolerance Range set by the customer

Assuming the mean of the process variance is *positioned centrally* this indicates how likely the supplier is to meeting the specifications laid down by the customer

- Mean is the mid value of the sample



Cp = Tolerence/(6 x SD)

(Tolerence = USL-LSL)

Cp: Potential Capability (2)

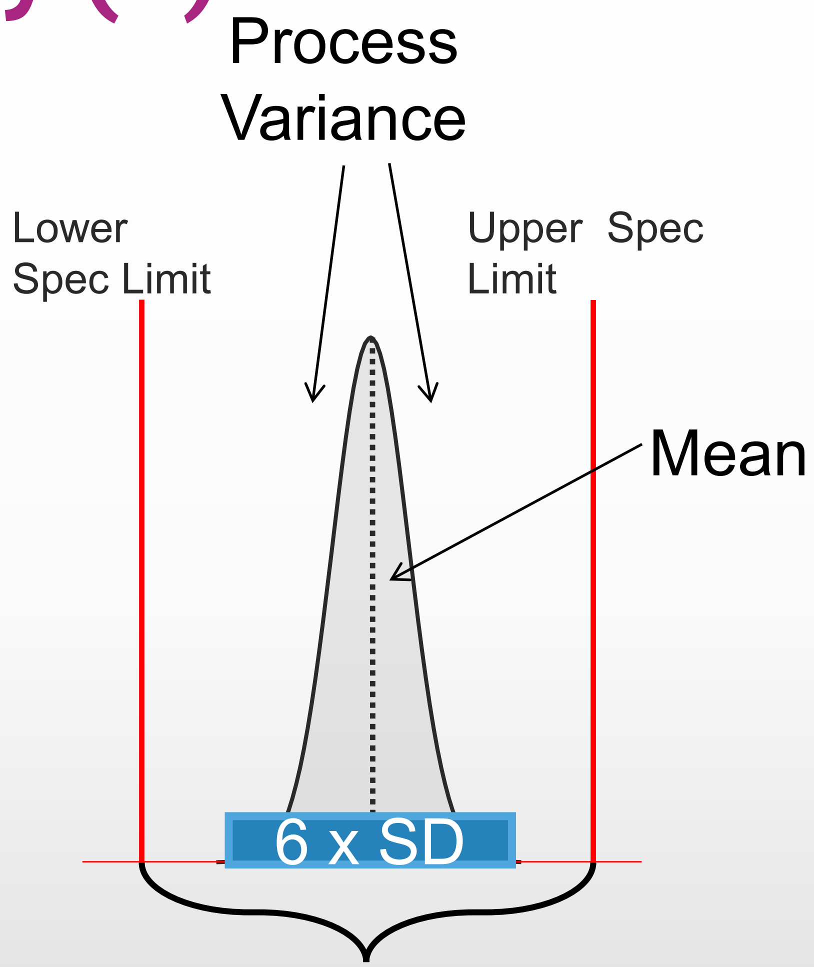
The range of variance in a process is considered to be 6 x SD (Standard Deviation)

The Customer's Tolerance Range is the difference between the maximum permitted value and the minimum permitted value that they will accept from a supplier or process

SD is dependent on the variation within a process (both Common and Special Cause)

As the amount of variance in a process increases Cp falls

- **So, reducing variance reduces SD and increases Cp**



Cp = Tolerance/(6 x SD)

(Tolerance = USL-LSL)

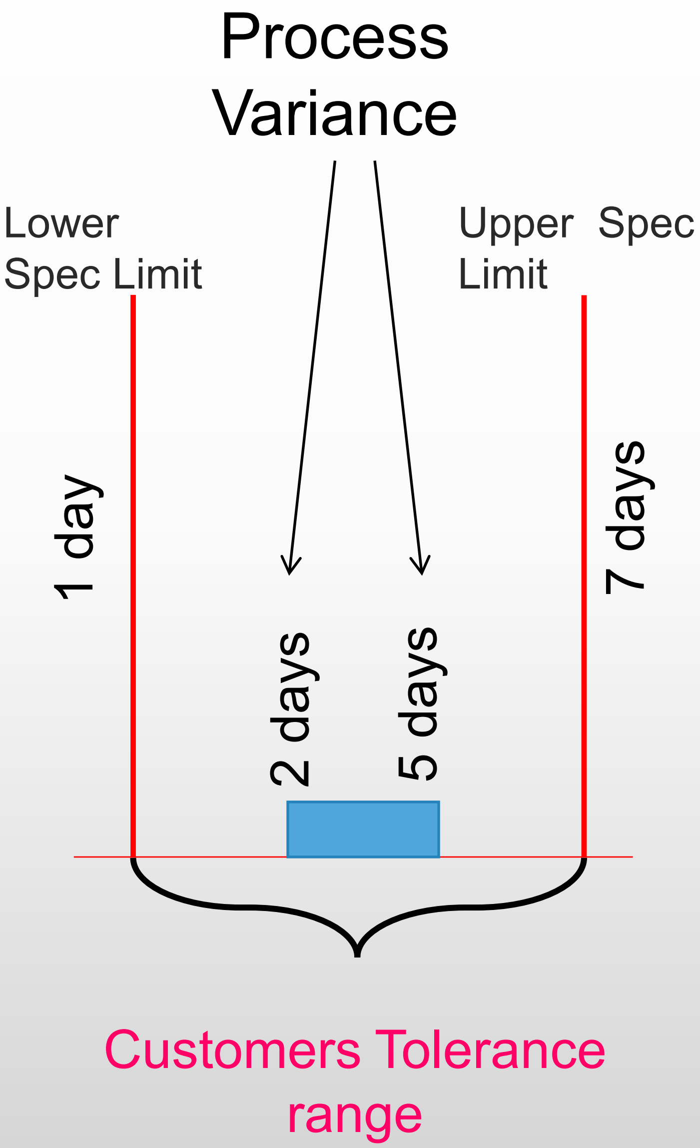
Cp: Example

A line manager requests some reports within 4 days but will accept them between 1 and 7 days

The reporting employee has an average length (Mean) of 3 days to produce the reports and this can be anywhere between 2 and 5 days; thus the total variance range is 3 days

3 days fit between the 6 days tolerance range twice

Cp=2

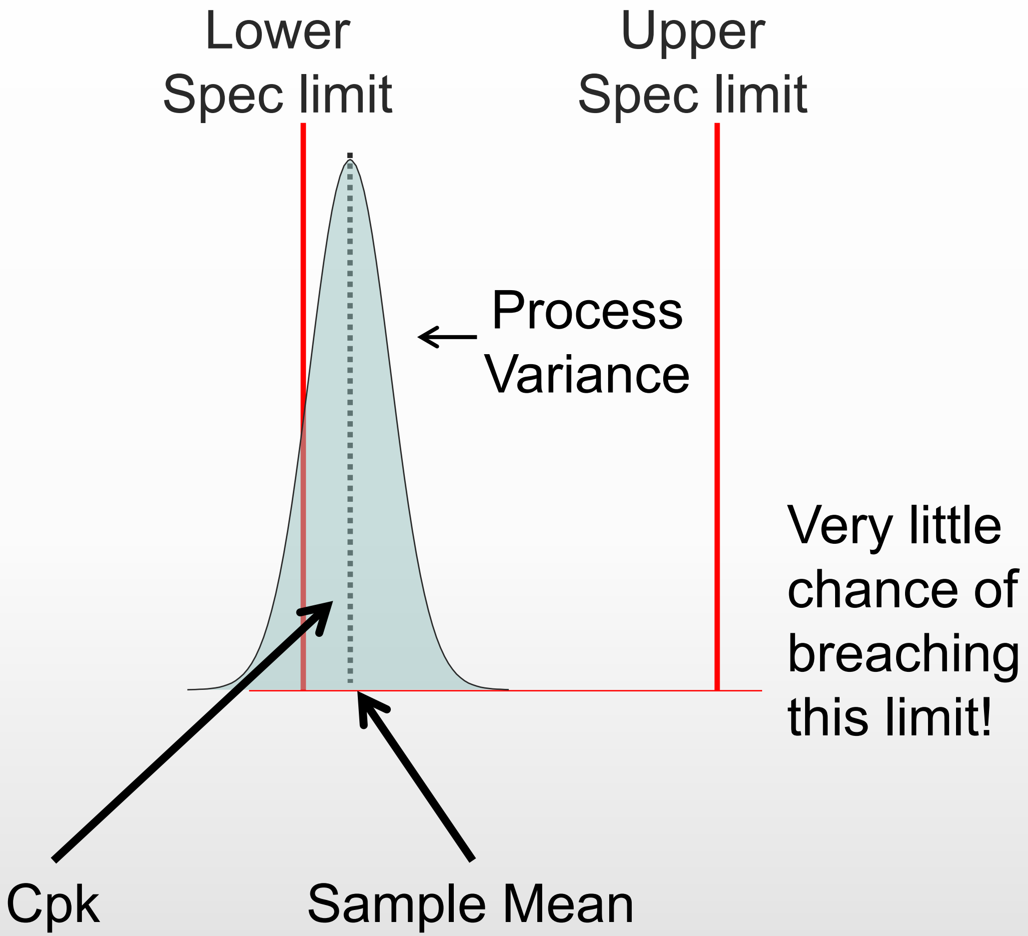


Cpk: Actual Capability (1)

Cpk reflects the actual capability of the process by measuring the same ratio as the Cp, but only to the nearest specification limit as this is the limit that is likely to be failed first

Cpk therefore takes into account the 'centering' of the process

- As with Cp, as the process variance increases Cpk falls
- As the off-set of the process mean increases Cpk falls



Cpk is based on SD of the sample:

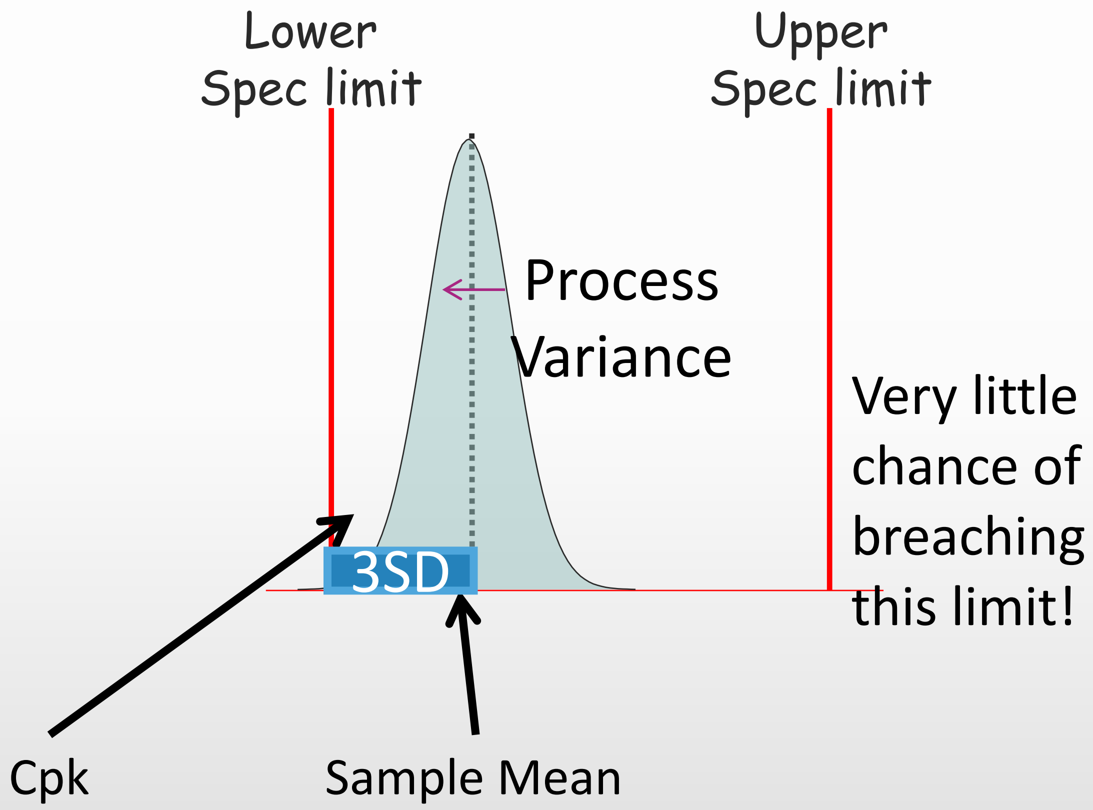
Cpk = (nearest SL – sample mean)/(3 x SD)

Cpk: Actual Capability (2)

Cp assumes that the process is perfectly centred so is a theoretical measure of how capable the process could be if set up correctly

Cpk reflects the actual capability of the process

- As process variance increases Cpk falls
- As the off-set of the process mean increases Cpk falls



Lower Spec limit

Upper Spec limit

Process Variance

Very little chance of breaching this limit!

3SD

Cpk

Sample Mean

Cpk is based on SD of the sample:

Cpk = (nearest SL – sample_mean)/(3 x SD)

Process Capability Summary

Cp (potential capability)

- How the process variance compares to the Specification Limits
- How many times the process can fit between the Specification Limits
- Good Cp= 1.33

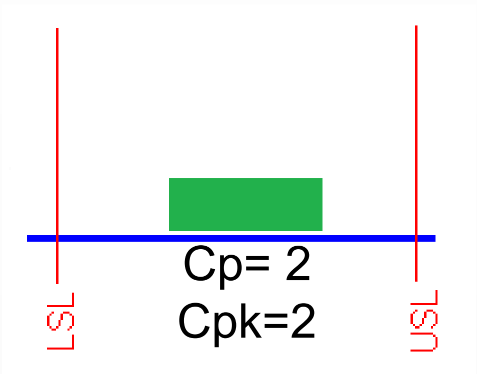
Cpk (actual capability)

- How well the process is centred and if the process is likely to breach a Specification Limit
- Good Cpk= 1.33

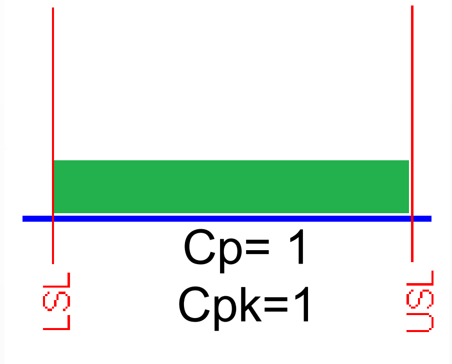
🟩 Process variance

A six sigma capable process will have Cp = 2.0, Cpk = 1.5 and DPMO = 3.4

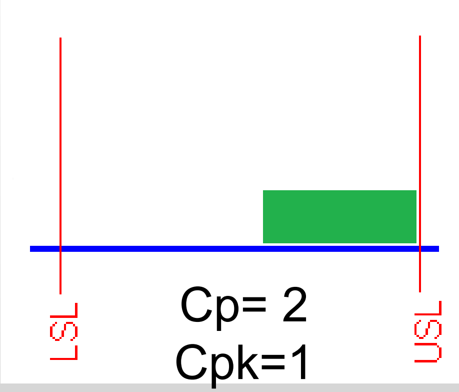
Process centred and variation is half of the tolerance



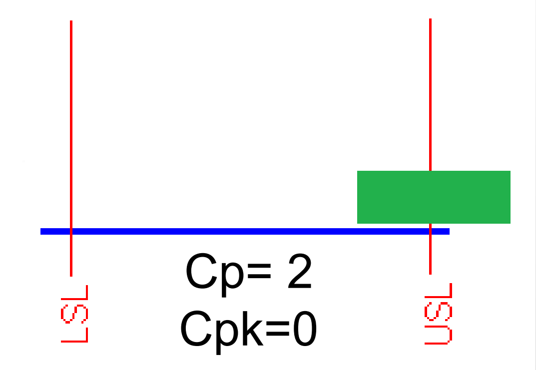
Process centred and variation is the same as the tolerance



Process offset and variation is half of the tolerance



Process offset with half outside the USL and variation is half of the tolerance



Understanding the Values: Cpk

The Cpk value indicates how much process variation can widen before breaching the nearest specification limit (SL)

Cpk = 0.5 means the process is 50% over one Specification Limit

→

Cpk = 1 means the process is butting up against the closest Specification Limit

→

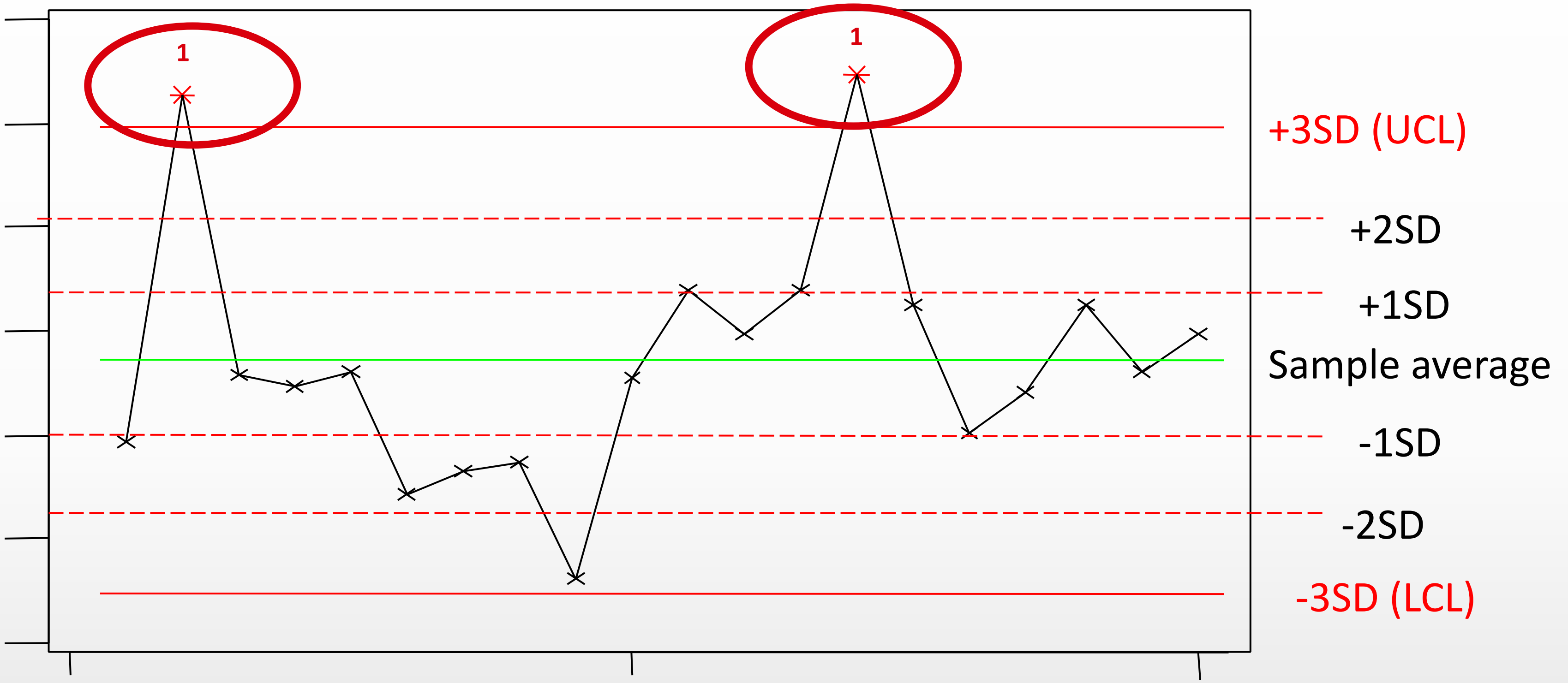
Cpk = 2 means your width (variance/ range) can grow 2 times before touching the nearest Specification Limit

→

Cpk = 3 means your width (variance/ range) can grow 3 times before touching the nearest Specification Limit

The same is broadly true for Cp with a perfectly centred process

Using Control Charts and SD to Identify if a Process is in Control

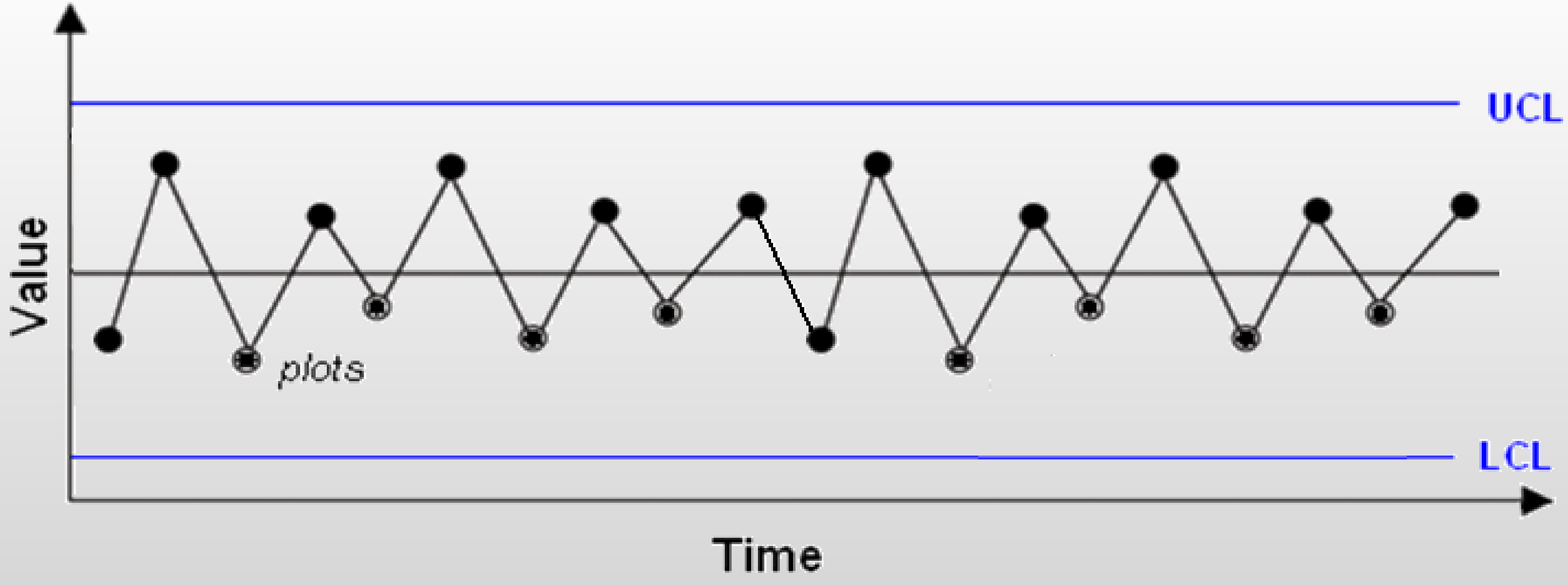


If a system is ***In Control*** (ie only *Common Cause* variation exists) then it should follow the Empirical rule and also should not exhibit any patterns in the data (plots should be random)

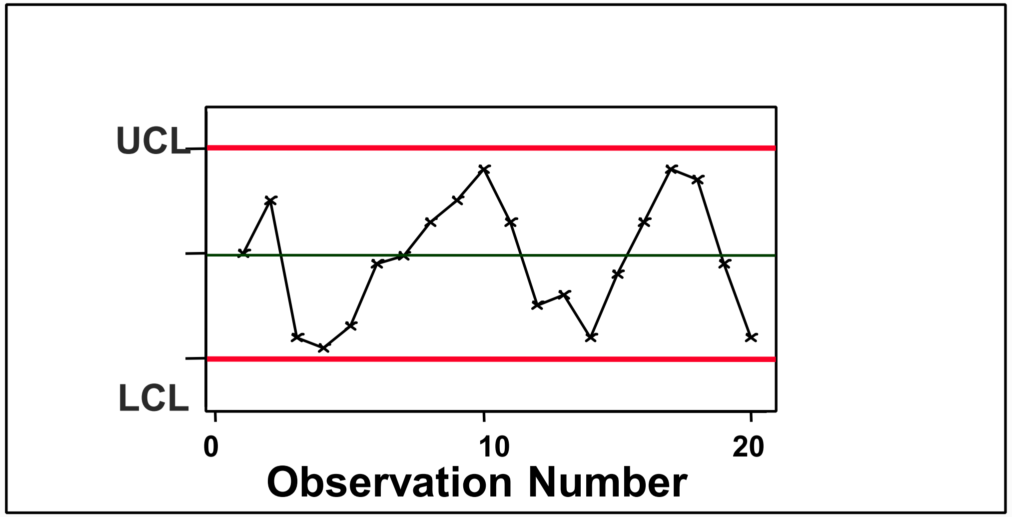
So plots above or below the UCL and LCL respectively, or patterns in the data indicate ***possible*** *Special Causes*, which are adding variation to the process

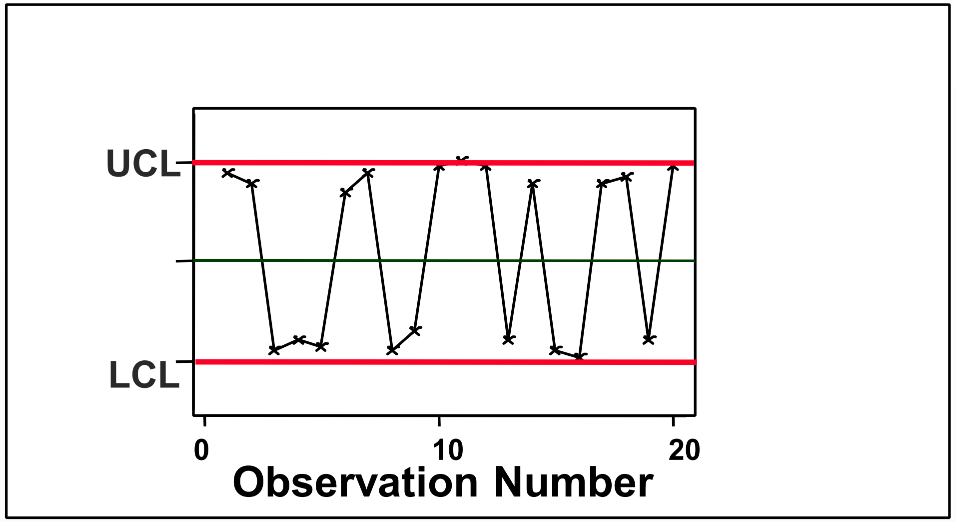
In Control

- A process is said to be '***in control***' when it only contains common cause variation
- Look at the following control chart – is the process that it is measuring 'in control'?



Trending Rules





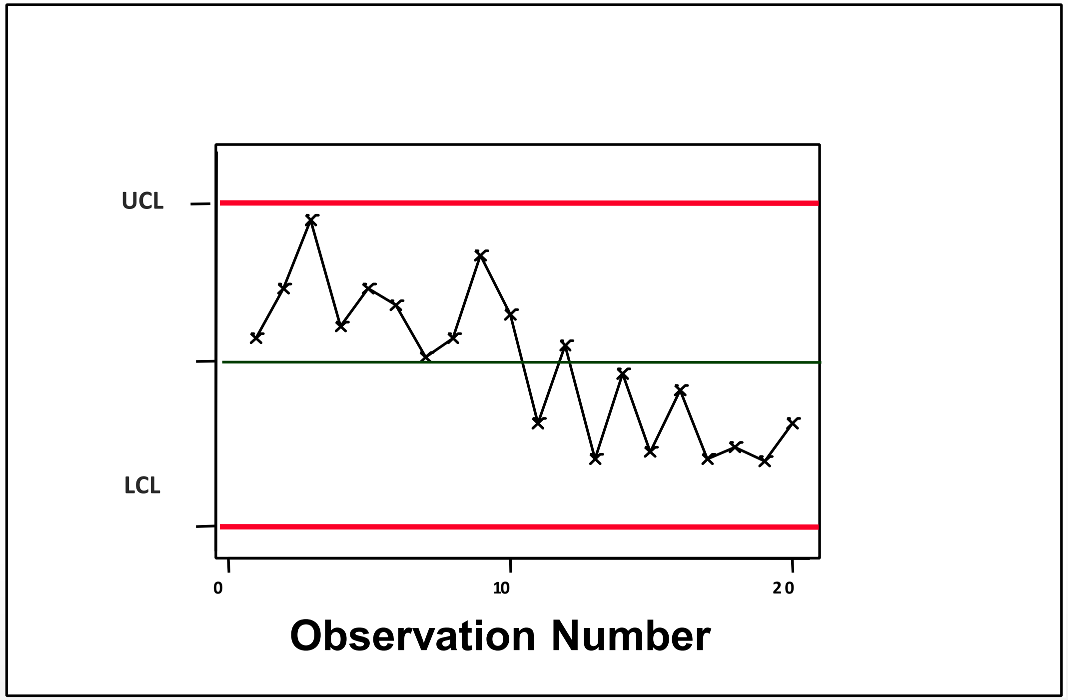
Seasonal Trends:

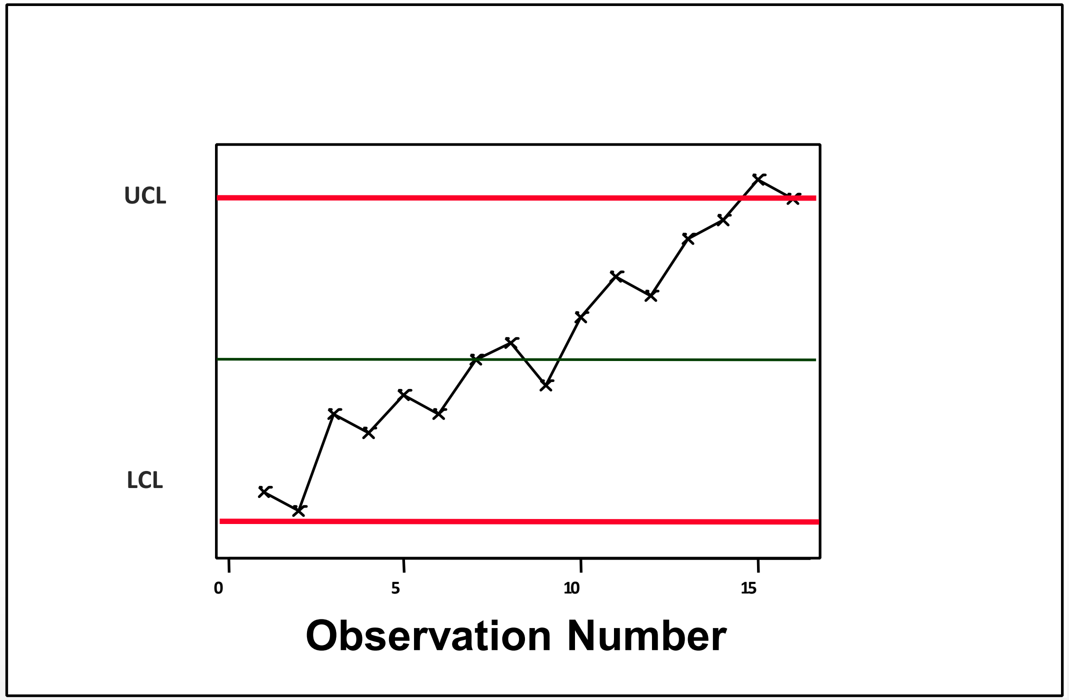
These could be caused by systemic changes like: temperature, operator fatigue, holidays etc.

Mixtures:

A clear indication is when most of the points are close to the control limits, and almost no points are near the centre line. These are usually due to under-estimating the process variability or “over-control”, where operators intervene with the process frequently trying to respond to inherent variability instead of assignable causes. This also occurs when controlling two processes on the same chart.

Trending Rules





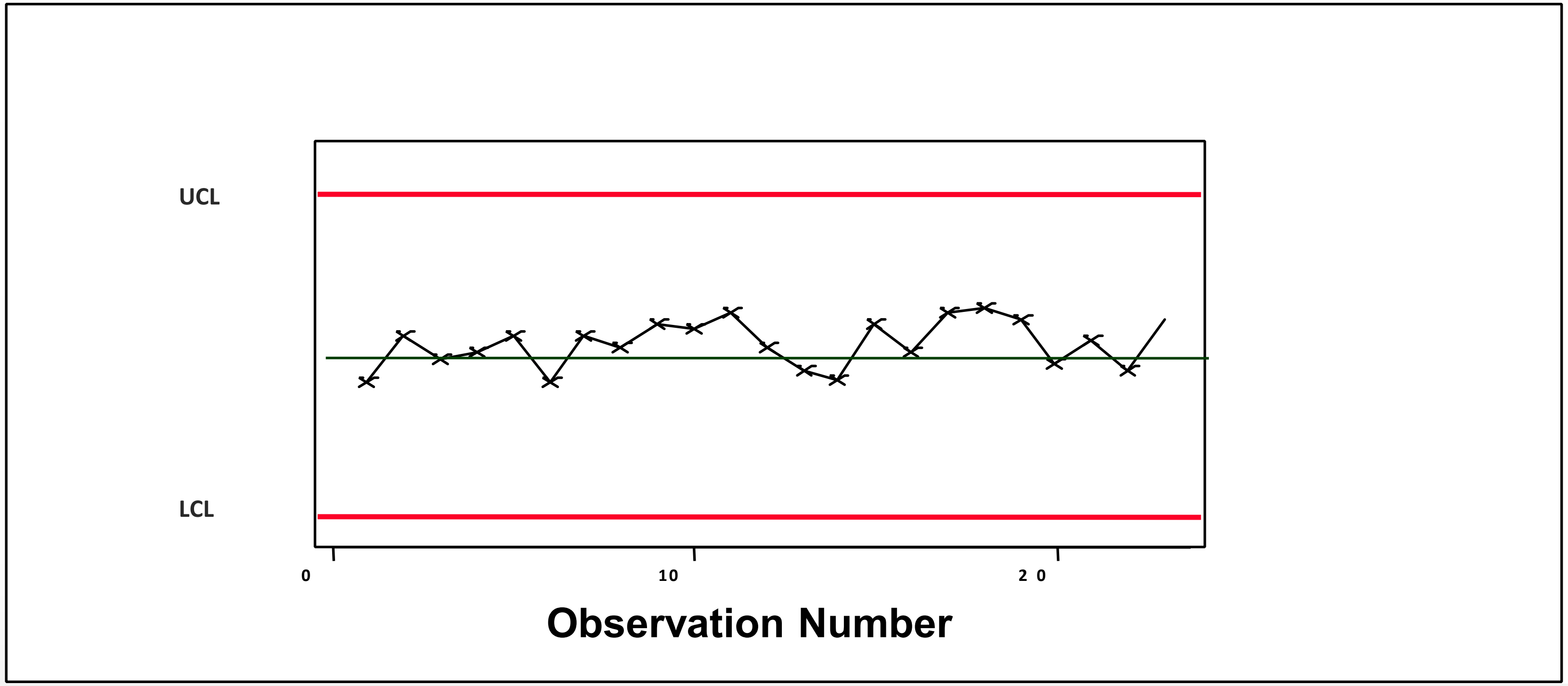
Changes in Process Means:

These are usually due to the introduction of new operators, procedures etc. Can also happen because of process changes.

Upward/Downward Trends:

Continuous trending in the same direction. These are usually caused by a drift in execution or component wear among others.

Trending Rules



‘White Space’:

- Points tend to cluster around the mean. Usually caused by:
  (1) Incorrect control limits (overestimating process variability)
  (2) Continuous improvements paying-off
- Limits should be recalculated when this situation is found

Pearson’s correlation coefficient (R)

Pearson's correlation coefficient (R) indicates the strength and direction of the linear relationship between two variables

The value of R ranges from -1 to +1
The closer R gets to 1 the stronger the correlation

0 is the midpoint – there appears to be NO LINEAR correlation

0 to +1 implies a positive correlation (as one variable increases so does the other)

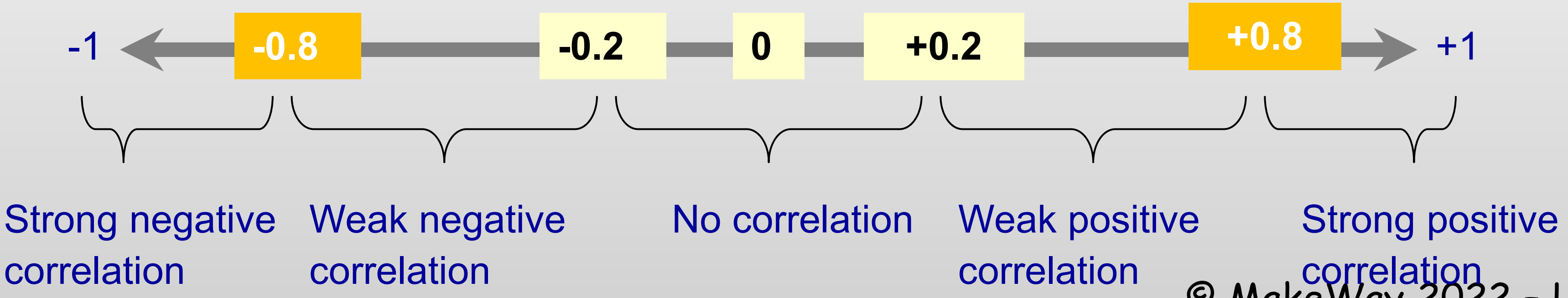
0 to -1 implies a negative correlation (as one variable grows the other shrinks)

Many statistical packages will calculate the R value for you

This includes Excel and scientific calculators

As Green Belts, we will stick to visual estimations (see next slide)

L6S Guidelines for correlation coefficient – ‘R’



10 Steps to Successfully Create an FMEA (1)

List the key process steps in the first column

List the potential failure mode for each process step. In other words, figure out how this process step or input could go wrong.

List the effects of this failure mode. If the failure mode occurs what does this mean to us and our customer… in short what is the effect?

Rate how severe this effect is. With 1 being not severe at all and 10 being extremely severe. Ensure the team understands and agrees to the scale before you start. Also, make this ranking system 'your own' and don't bother trying to copy it out of a book.

Identify the causes of the failure mode/effect . Rank it as you did the effects in the occurrence column. This time, as the name implies, we are scoring how likely this cause will occur. So, 1 means it is highly unlikely to ever occur and 10 means we expect it to happen all the time.

Identify the controls in place to detect the issue and rank its effectiveness in the detection column. Here a score of 1 would mean we have excellent controls and 10 would mean we have no controls or extremely weak controls. If a SOP is noted here (a weak control?) you should note the SOP number.

10 Steps to Successfully Create an FMEA (2)

Multiply the severity, occurrence, and detection numbers and store this value in the RPN (risk priority number) column. This is the key number that will be used to identify where the team should focus first. If, for example, we had a severity of 10 (very severe), occurrence of 10 (happens all the time), and detection of 10 (cannot detect it) our RPN is 1000. This means all hands on deck… we have a serious issue!

Sort by RPN number and identify most critical issues. The team must decide where to focus first.

Assign specific actions with responsible persons. Also, be sure to include the date for when this action is expected to be complete.

Once actions have been completed, re-score the occurrence and detection. In most cases we will not change the severity score unless the customer decides this is not an important issue.

Feedback on Google and Trust Pilot

To improve supporting you better, please give reviews

- ☐ **Google Reviews Link: https://goo.gl/XwXwDt**

and

- ☐ **Trust Pilot Link:**

https://www.trustpilot.com/review/www.makewayglobal.com

Yellow Belt Exam

Personal study time

All the best…