bureau tromp
LEAN &
SIX SIGMA

Green Belt Day 1

Lean Six Sigma

Slimmer werken,
blije klanten

15 march 2022

Disclaimer

- We are happy to share our knowledge and resources to help with the implementation of Lean Six Sigma in your organization. To improve ourselves every day, we would appreciate hearing your experiences with Bureau Tromp and suggestions for improvements.

- Please feel free to use the provided sheets for your projects. However, as this material is our intellectual property, it is not meant to share with third parties. If you are planning on organizing training, please reach out to us by sending an email to info@bureautromp.nl or calling 030 227 0000.

- Let us know if you have ideas about how Bureau Tromp can support customers in a new way or how they can benefit from each other.

Bureau Tromp

Slimmer werken,
blije klanten

A short introduction

bureau tromp
LEAN & SIX SIGMA



We would like to know:

- Who you are… (hobby, family etc)
- What do you do?
- Do you have an idea for an improvement project?
- What are your expectations for the training?



Slimmer werken,
blije klanten

Rules

bureau tromp
LEAN & SIX SIGMA









Slimmer werken,
blije klanten

About Bureau Tromp

bureau tromp
LEAN & SIX SIGMA



Our goal is to help companies put their customers first. We do this by advising and teaching organizations to work smarter using the Lean and Six Sigma methodology.

Slimmer werken,
blije klanten

About Bureau Tromp

Training the entire organization:

Management commitment during Lean Six Sigma projects



- Master Black Belt
- Black Belt
- Green Belt
- Orange Belt
- Yellow Belt

Champion Belt



Top Down



Bottom Up

Broad support for Lean Six Sigma projects in the organization

Process Mining	Robotic Process Automation	Agile Scrum

Slimmer werken, blije klanten

Conditions for certification

- You will receive the Green Belt theoretic certification when you meet the following conditions:
  - 80% attendance at five training days
  - Passing the theoretical exam (+70%)

- You will receive the Green Belt practice certification when you meet the following conditions:
  - Performing at least one project individually or in a small group
  - Demonstrating a saving of E25.000
  - Presentation and defending your results
  - A project intake and six project coaching sessions are planned to support you during the project.



Slimmer werken, blije klanten

IASSC ACCREDITED

Necessities

Needed to follow the training:

- Laptop with MS Office or Mac OS X
  - To install Minitab
- Minitab
  - Download from internet
  - 30 days free trial
  - Not needed directly on day 1 and 2!



Slimmer werken,
blije klanten

About Bureau Tromp

We offer an integral solution:

In-Company and Open Enrollment

Project Management	Coaching	Consultancy
Together with your employees we work on Lean Six Sigma projects. Our goal is to share knowledge so you can set up projects in the beginning.	An experienced Lean Six Sigma consultant by your side who supports you during your Lean Six Sigma project. We support you in applying theory into practice.	Are your employees running out of time? Our experienced Black Belt consultants can execute your continuous improvement projects.

Slimmer werken, blije klanten

Training schedule

Day	Morning	Afternoon
1	Kick-off Introduction to Lean Management Lean management principle 1: Value	Introduction to Six Sigma Business game
2	Lean Six Sigma DMAIC structure Six Sigma: Define phase	Lean Management principle 2: Value Stream Mapping
3	Six Sigma basic statistics	Six Sigma: Measure phase
4	Six Sigma: Analysis phase	Lean Management principle 3 and 4: Flow and Pull
5	Six Sigma Analysis: Minitab	Six Sigma: Improve phase
6	Six Sigma: Control phase Change Management	Theoretical Exam Wrap-up

Slimmer werken,
blije klanten

Lean Food Bank



Slimmer werken,
blije klanten

What is Lean Six Sigma?

bureau tromp
LEAN & SIX SIGMA

Methodology for process improvement

- Customer-oriented:
  - Within organizations: internal customers (colleagues, co-workers)
  - Outside organizations: external customers (buyers)

- Applicable in different ways:
  - A ‘toolbox’ consisting of different sets of techniques
  - A structured approach for process optimisation

- Creating a culture of continuous improvement.

Lean Six Sigma is the combination of Lean Management and Six Sigma

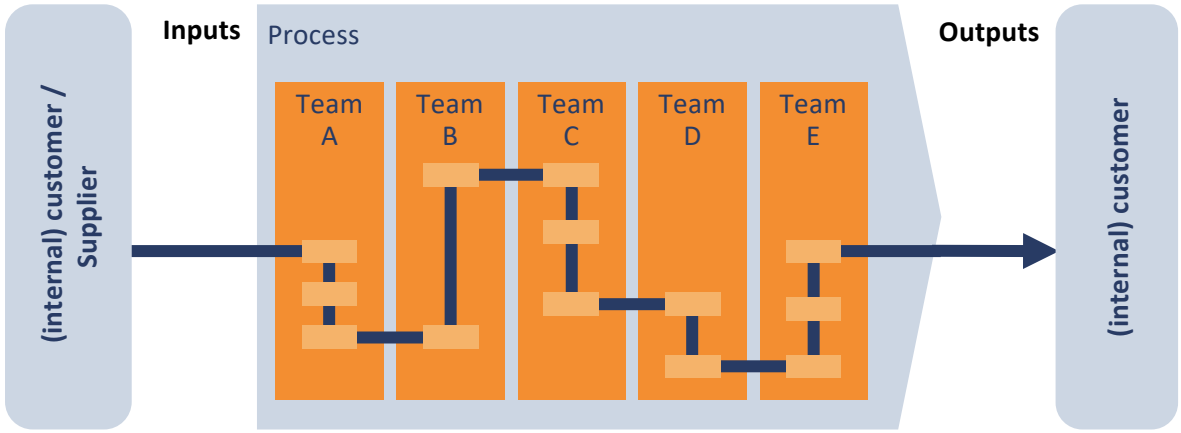


Slimmer werken, blije klanten

What is a process?

A process consists of:

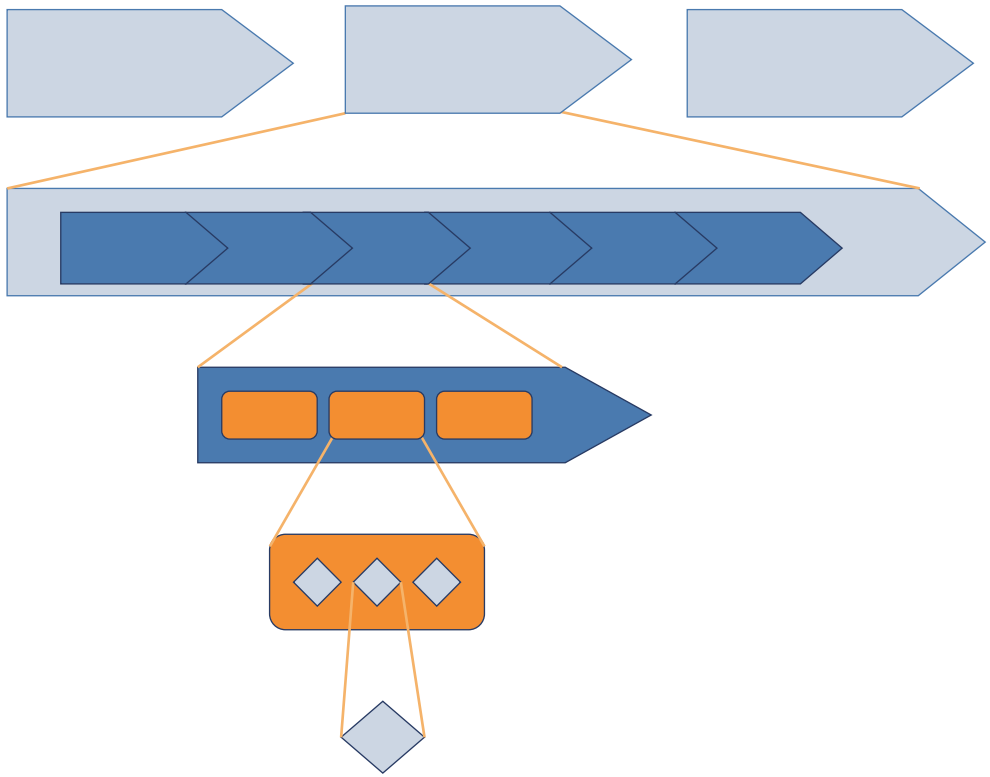
- Inputs and outputs;
- A set of activities (process steps);
- Activities consists of several proceedings;
- Activities accross multiple departments, individuals and/or teams.



Slimmer werken, blije klanten

What is a process?

Processes at different levels



- Level 1: Chain
- Level 2: Core process
- Level 3: Sub-process
- Level 4: Process step
- Level 5: Activity / task

Slimmer werken, blije klanten

What is Lean?

Lean is doing:

- the right things
- at the right place
- at the right time
- in the right way
- with a minimum of waste.

By:

- **Involving people in our improvement efforts**
  The best ideas for improvement come from employees at the workplace.
- **Continuous improvement**
  Each day, everyone actively contributes in creating value. All these activities add up in creating value for the customer; the rest is waste.

Slimmer werken,
blije klanten

A brief history of Lean

Process improvements go way back in time

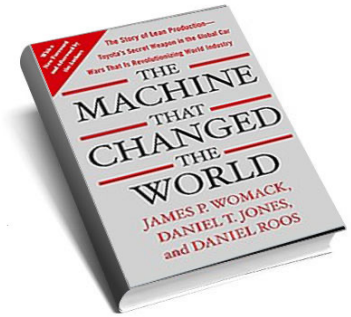
- 1574 – King Henry III of France visits the ‘Arsenale’ (Italy), where a ship ‘rolls off the line’ every day
- 1765 - General de Gibreauval (France) standardises the design of cannon parts
- 1822 - Thomas Blanchard (Springfield arms factory, Connecticut USA) introduces cellular manufacturing with 14 machines
- 1914 – Ford mass production, Highland Park: Continuous flow manufacturing introduced (moving assembly line)
- 1930 – Takt time is introduced in manufacturing the Messerschmitt 109 in Germany
- 1941 - Mitsubishi acknowledges the takt time principle and adopts the methodology to manufacture the Zero in Japan
- 1948 - Toyota decides to use both 'Ford-Flow’ and 'Mitsubishi-Takt’ and provides the foundation to a shift from mass production to Lean production

History of Lean

- Background:
  - Developed by Toyota in the early ‘50s (as the Toyota Production System)
  - Analysed by Womack & Jones
  - Referred to as Lean Management
  - Since ’00 applied in service industry

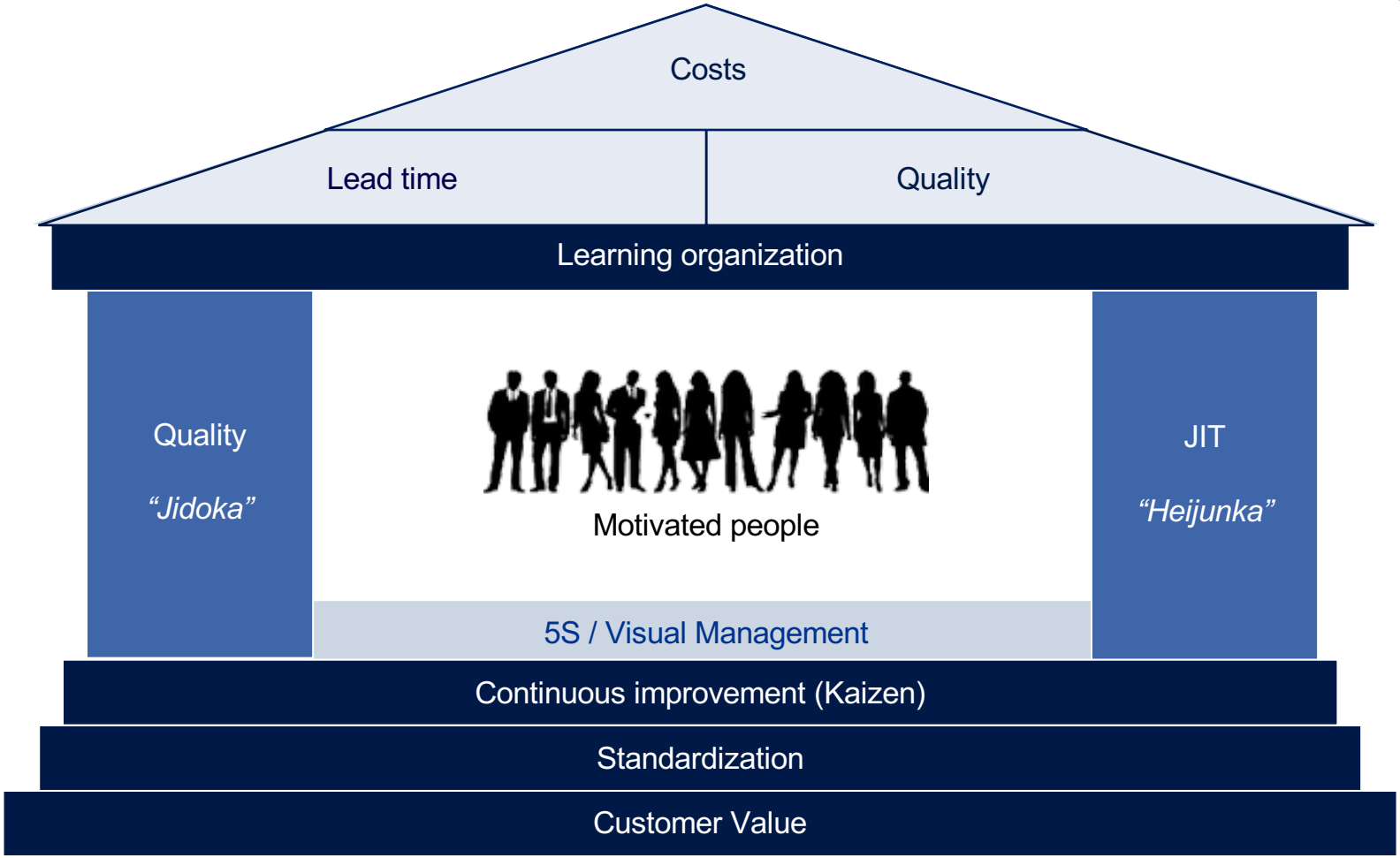


TOYOTA



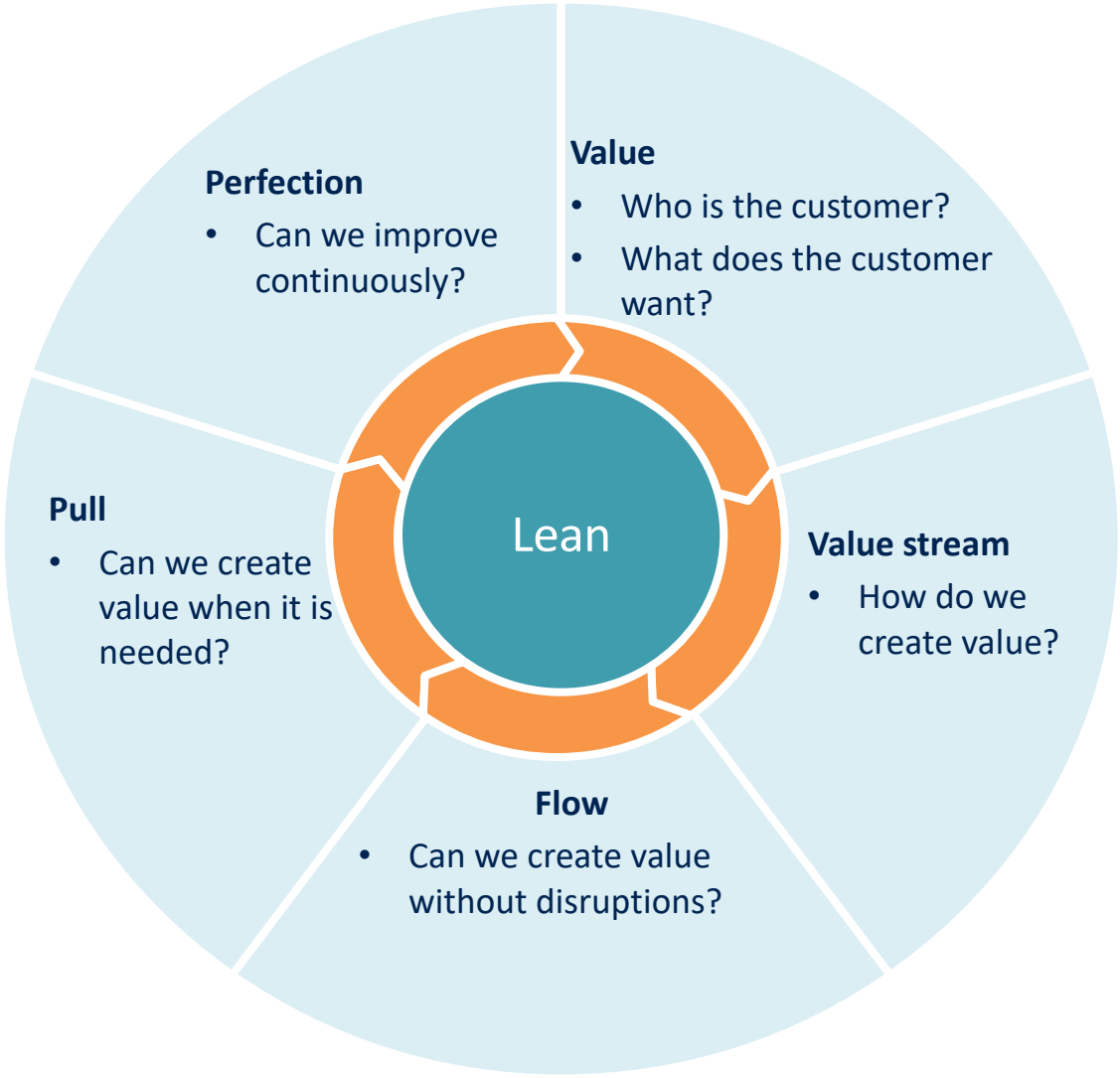
Slimmer werken,
blije klanten

Toyota Production System



Slimmer werken, blije klanten

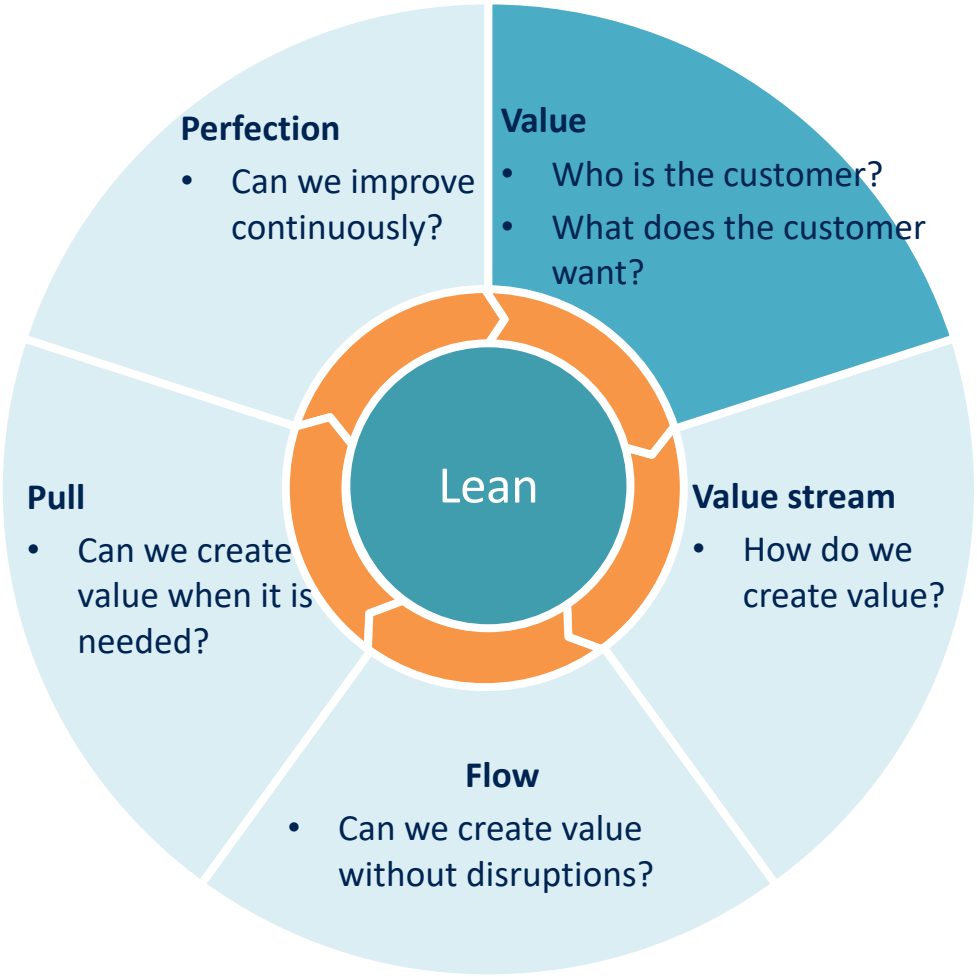
5 Principles of Lean



Slimmer werken, blije klanten

Read more

Principle 1: Value



Slimmer werken, blije klanten

Value

Customer Value Added

- Does the activity add form or functionality to the product or service desired by the customer?
- Does this activity contribute to a competitive distinction: faster, cheaper, more qualitative, etc.?
- Is the customer willing to wait or pay for this activity?

Business Value Added

- Does the activity reduce risk for the organization?
- Does the activity support necessary reports?
- Would the delivery of a product or service to the customer be disrupted if this activity were to expire?
- Is the activity required by law?

Non-Value Added

- Waste

Slimmer werken,
blije klanten

Police are blasted for 'wasting time' after officers are pictured on social media picking up litter rather than tackling crime

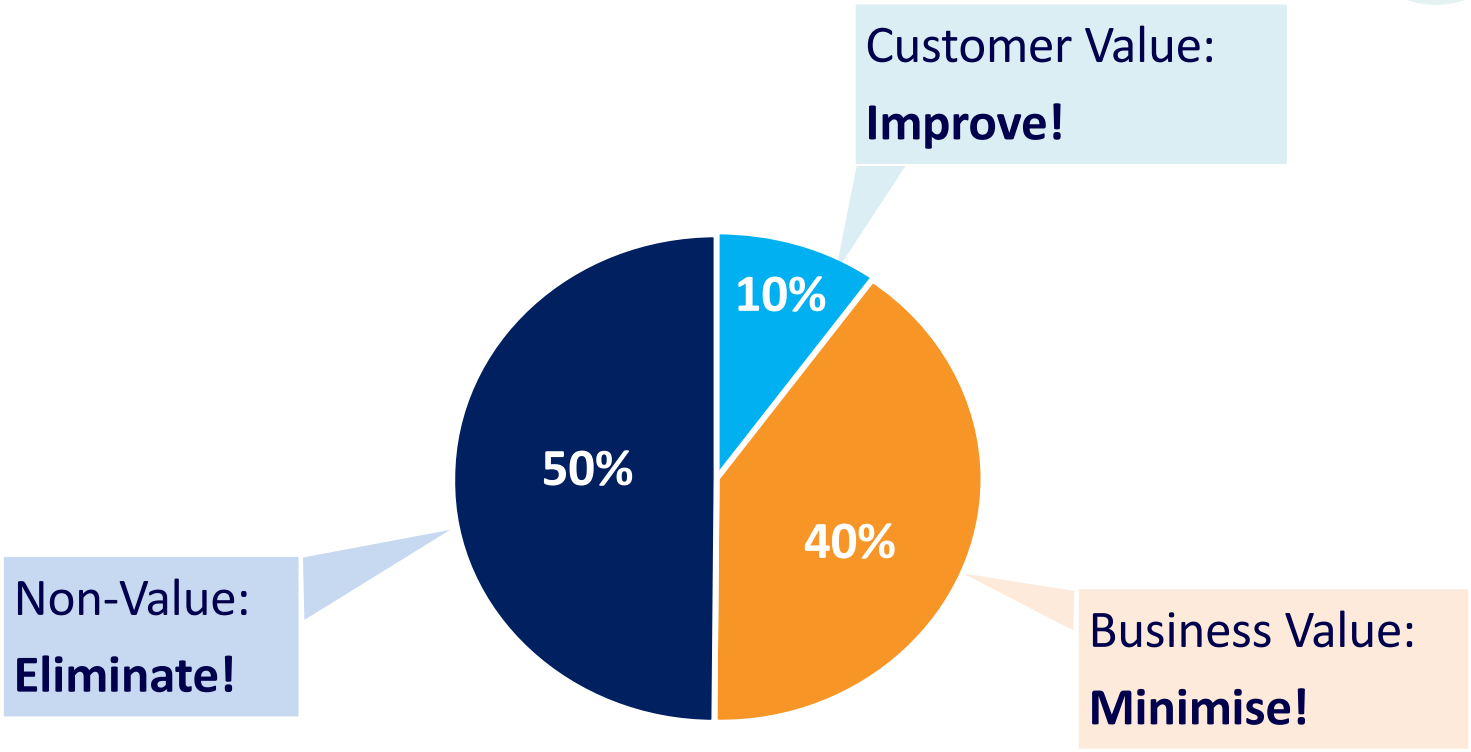
- **Longton Police posted photos of themselves carrying out menial tasks online**
- **Comes as crime risen 13% in a year and police don't have suspect in 41% cases**
- **Staffordshire Police had quarter of officers cut in 5 years and faces £13.7m cuts**

By CHARLIE BAYLISS FOR MAILONLINE
PUBLISHED: 20:35 GMT, 16 March 2018 | **UPDATED:** 01:47 GMT, 17 March 2018

Share 74 shares 69 View comments

Police have been criticised for failing to tackle rising crime after they shared photographs of themselves laughing while picking up litter.

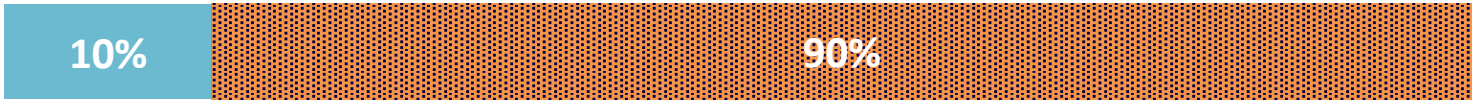
What is the ratio?



Slimmer werken,
blije klanten

Rule of thumb: Waste

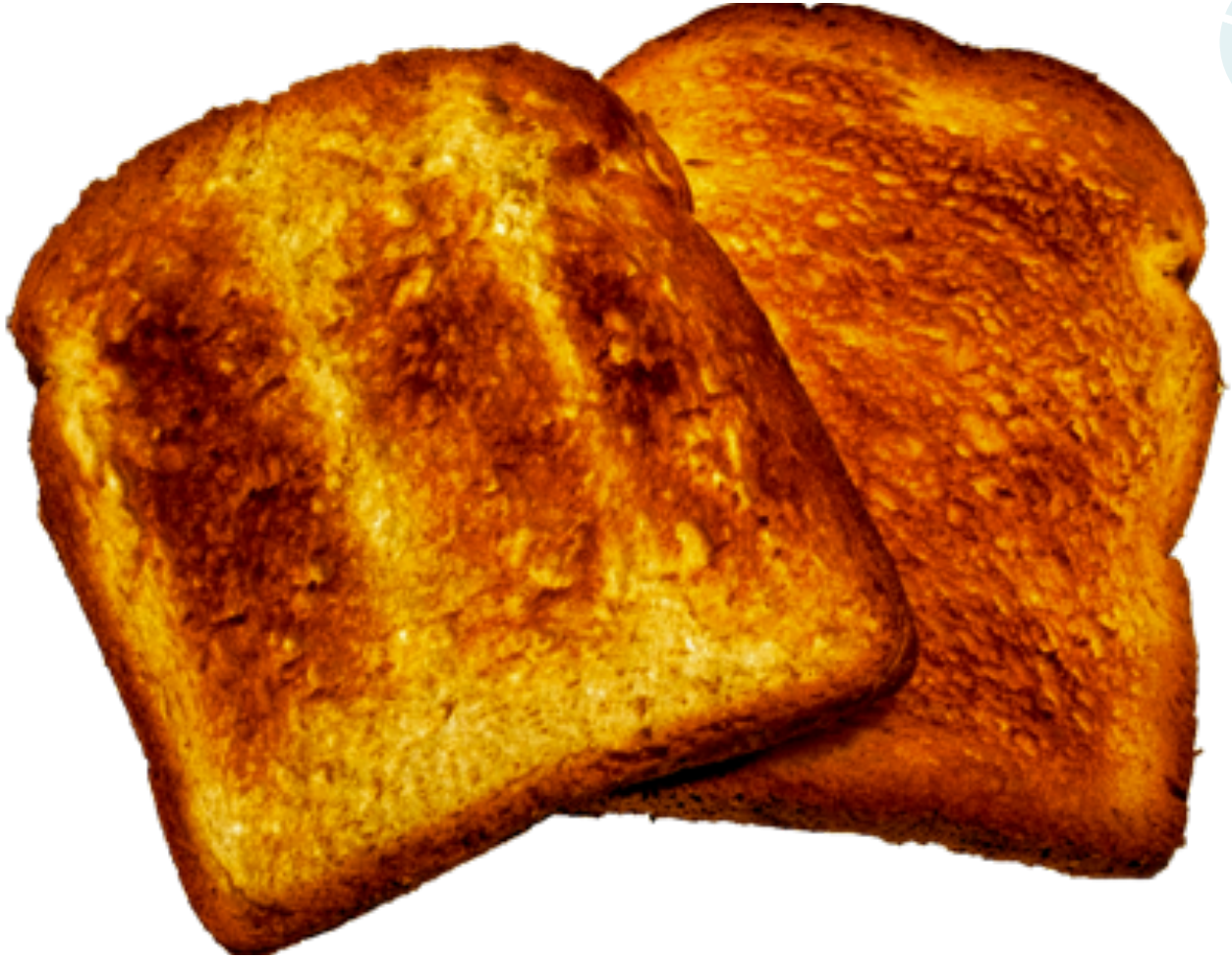
It is easier to improve processes by focussing on the 90% non-value adding activities (40% BVA + 50% NVA)



instead of focussing on the 10% value-adding activities (CVA).

Slimmer werken,
blije klanten

Toast!



Slimmer werken,
blije klanten

8 types of waste

Waste of:

Waste is a characteristic of a process, not an individual

1. Transport
2. Inventory
3. Motion (movement)
4. Waiting
5. Overproduction
6. Overprocessing (gold plating)
7. Defects
8. Skills

Remember: TIMWOODS

Slimmer werken, blije klanten

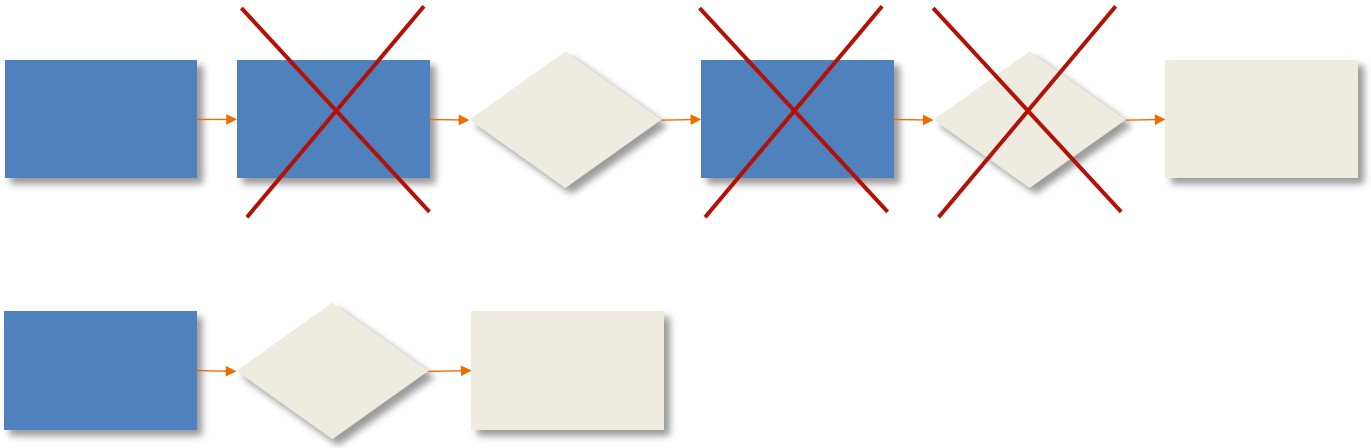
Read more

Lean & Waste

Waste in processes

Eliminate non-value adding activities:

1. Customer determines the concept of value;
2. Activities in the process that do not add value, are considered waste;
3. Reduce waste as much as possible.

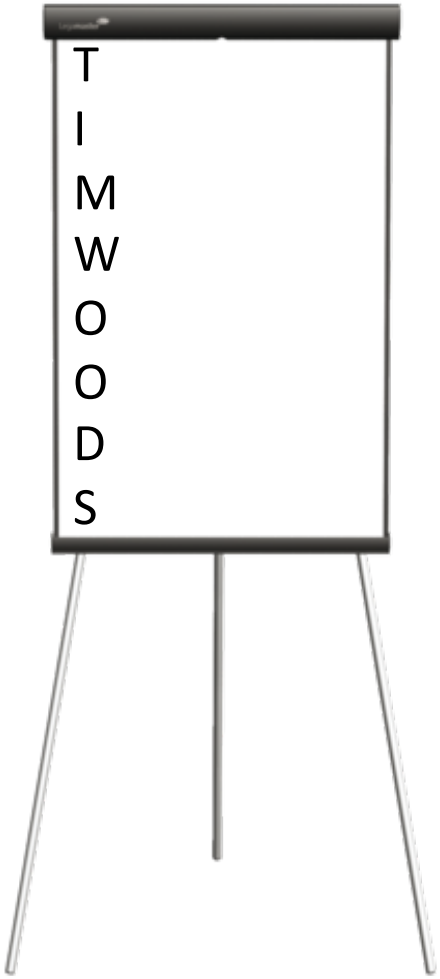


Slimmer werken,
blije klanten

Exercise: Waste

- Which types of waste do you recognize in processes at work or home?
- In pairs

Take 15 minutes!

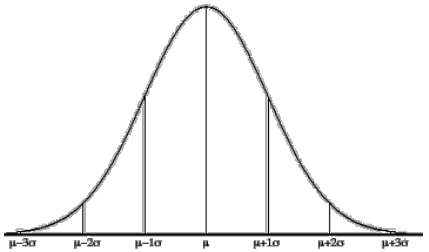


Slimmer werken, blije klanten

History of Six Sigma

bureau tromp
LEAN & SIX SIGMA

- Carl Friedrich Gauss (1777-1855)
  - Making variations in processes measurable
  - Normal distribution (Gauss-curve) and Sigma



- Bill Smith, Motorola (1986)
  - Using statistics to improve processes
  - Project-based improvement tool

- Jack Welch, General Electrics (1996)
  - Developed the methodology and introduced the [illegible]ucture

Slimmer werken,
blije klanten

Today's work

- Introduction

- **Introduction Lean and Six Sigma**
  - Lean Management
  - **Six Sigma**
  - Lean Six Sigma Methodology and Organization

- Process Simulation
  - Van Nelle Coffee Filter Factory

- Final Remarks

bureau tromp LEAN & SIX SIGMA

Slimmer werken, blije klanten

What is Six Sigma?

bureau tromp
LEAN & SIX SIGMA

Working towards constant quality ('Zero Defects')

Six Sigma involves:

- Reducing variety in processes
- Measuring = knowing
- Probability and statistics

Because

- Customers experience variation, not averages!

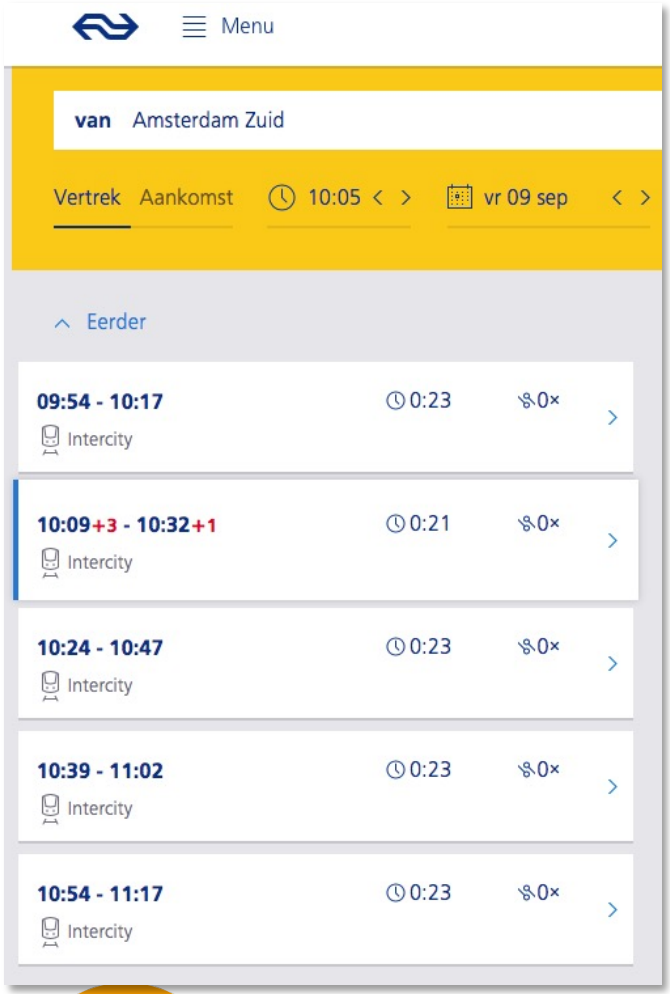
Six Sigma is a structured approach:

- DMAIC
- Belts (Yellow, Orange, Green, Black)



Slimmer werken,
blije klanten

Example: Variation





"Variation is evil in any customer-touching process."

— Jack Welch, Chairman & CEO

Customers don't judge us on averages or defect reduction alone. They feel and experience the variation of each transaction and our performance across the end-to-end customer experience.

Slimmer werken, blije klanten

Variation occurs in all processes

Count the number of times the letter ‘f’ appears in the following text:

The necessity of training farm hands for first class farms in the fatherly handling of farm livestock is foremost in the minds of farm owners. Since the forefathers of the farm owners trained the farm hands for first class farms in the fatherly handling of farm livestock, the farm owners feel they should carry on with the family tradition of training farm hands of first class farms in the fatherly handling of farm livestock because they believe it is the basis of good fundamental farm management.

Variation is part of nature

Variation is <u>always</u> found in <u>all</u> processes

- Nature: shape/size of leaves, snowflakes
- Humans: handwriting, walking speed
- Mechanical: weight, size, shape of a product

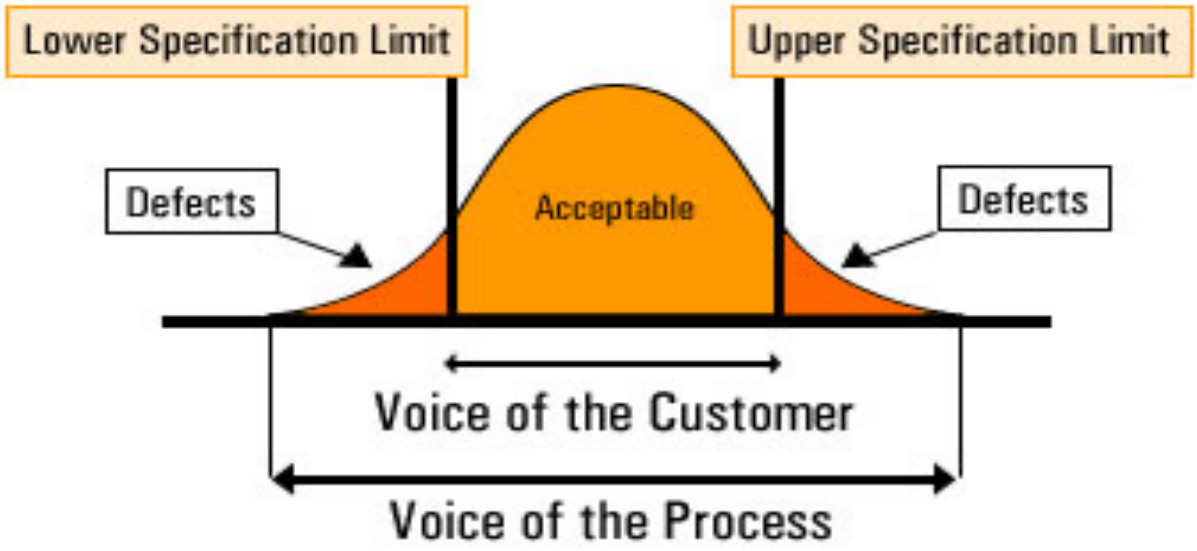
Variation is acceptable within certain limits

- Voice of the customer vs. voice of the process



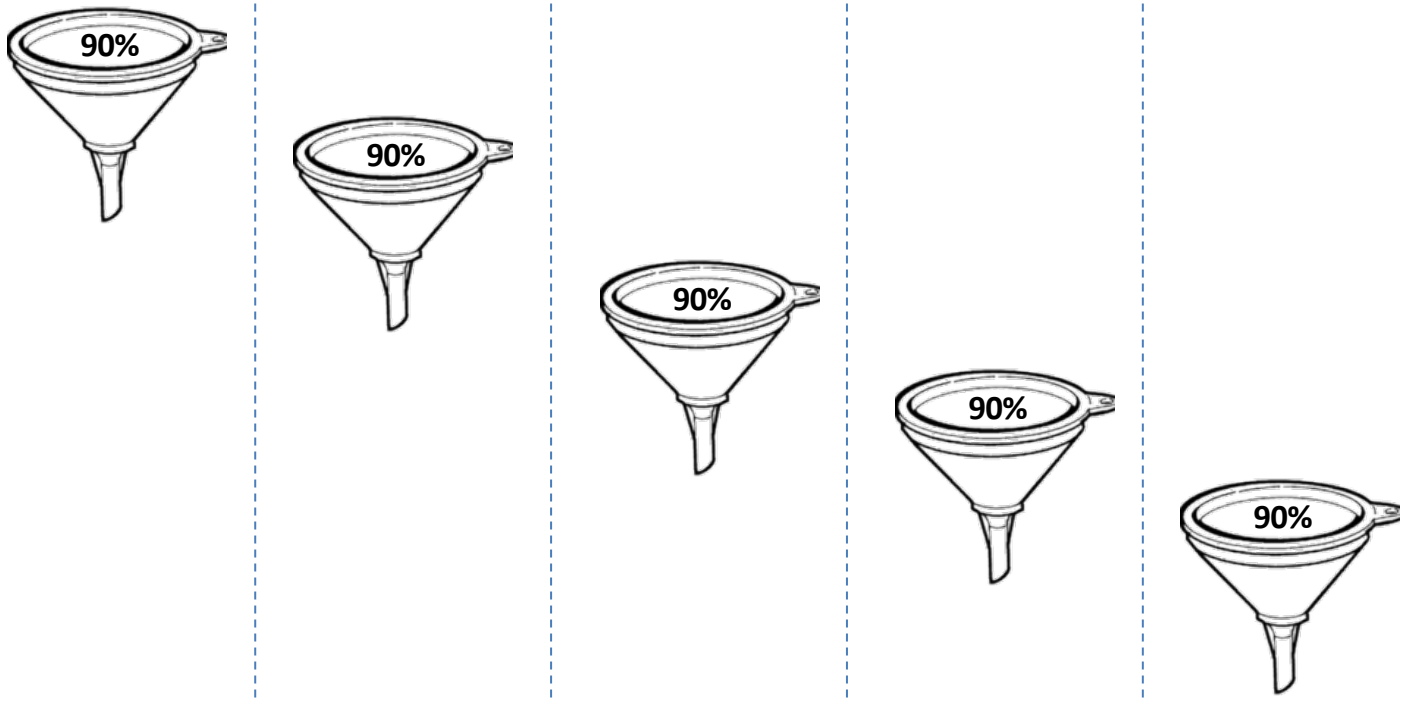
Slimmer werken,
blije klanten

Core of Six Sigma



Slimmer werken,
blije klanten

Rolled Throughput Yield



Slimmer werken,
blije klanten

Why **6** Sigma instead of 5 or 4?

bureau tromp
LEAN & SIX SIGMA

2.8 Sigma = 99% well

- 20.000 items of post misplaced per hour
- 15 minutes of unsafe drinking water per day
- 5.000 inaccurate medical interventions per week
- Two aborted landings at Schiphol per day
- 200.000 wrong medical prescriptions per year
- No electricity for 7 hours per month

VS

6 Sigma = 99.99966% = well

- 7 items of post misplaced each day
- 1 minute unsafe drinking water every 7 months
- 1.7 inaccurate medical interventions per week
- One aborted landing at Schiphol every 5 years
- 68 wrong medical prescriptions per year
- No electricity for 1 hour every 34 years

Livonia Boil Water Advisory To Last Through Weekend

February 23, 2018 at 12:00 pm

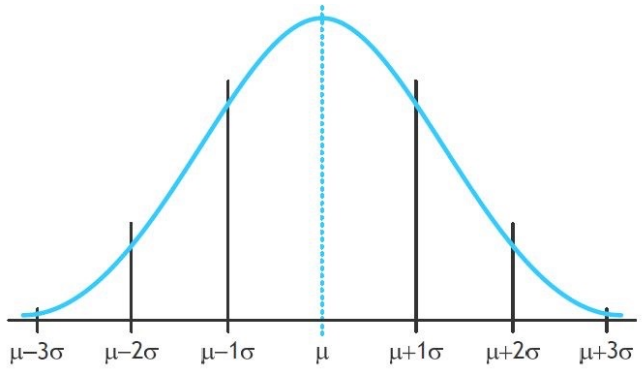
LIVONIA (WWJ) – Residents in Livonia could have a very long weekend ahead, thanks to a water main break impacting the entire city.

The city is currently under a boil water advisory and residents are being told they will have to boil their water until at least Monday as crews work to correct the problem.

Slimmer werken, blije klanten

Sigma and Process capability

Processes with higher Sigma levels are more capable in meeting the Voice of the Customer!



Sigma factor	Amount of defects per million	Yield (VOP=VOC)
1σ	690.000 dpm	68,27 %
2σ	308.000 dpm	95,73 %
3σ	66.800 dpm	99,73 %
4σ	6.210 dpm	99,9937 %
5σ	230 dpm	99,999943 %
6σ	3,4 dpm	99,9999996 %

Slimmer werken, blije klanten

Comparing Lean en Six Sigma

bureau tromp
LEAN & SIX SIGMA

Lean

- **Practical**

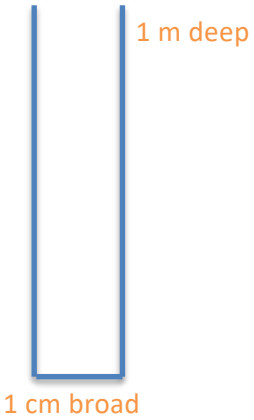
- Shortening process lead time in the entire value chain
- Eliminating non-value adding activities
- Observation of the process
- Improving **with** the organization (involvement)

Six Sigma

- **Analytic**

- Reducing variation in processes
- Improve value-adding activities
- Use of data and statistics
- Improvement **of** the organization





Slimmer werken, blije klanten

Simulation – Van Nelle Coffee Filter Factory

- Round 1

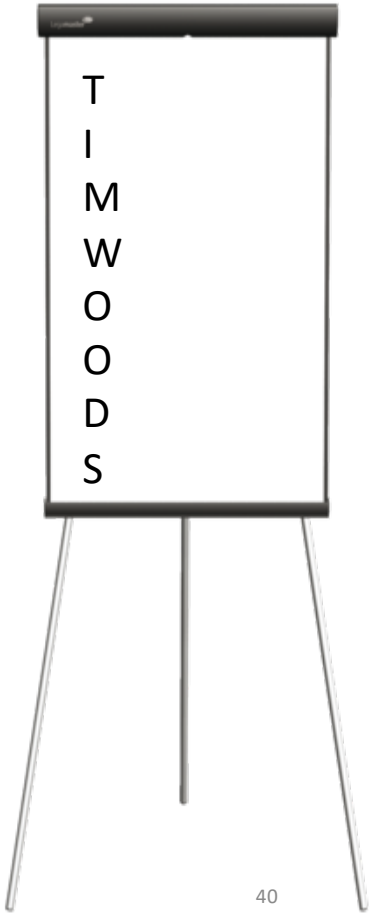


Slimmer werken,
blije klanten

Improve!

Improve your process as a group

- Implement solutions to improve your process
- You have 15 minutes
- No limits on improvement efforts, do what you can!



Slimmer werken,
blije klanten

Simulation – Van Nelle Coffee Filter Factory

- Round 2



Slimmer werken,
blije klanten

Homework

- Define what value you provide for the customer.
- Identify business added value steps in the proces.
- Identify wastes in your proces which do not provide value. Try to understand the waste better by investigating the consequence for the (internal) customer.
- Select a structural waste you would like to reduce or take away.

bureau tromp
LEAN & SIX SIGMA
Slimmer werken, blije klanten

bureau tromp

LEAN &
SIX SIGMA

Green Belt Day 2

Lean Six Sigma

Slimmer werken,
blije klanten

Schedule Day 2

- **Six Sigma**
  - **Fresh up**
  - **DMAIC project structure**
  - **Define phase**
  - **Selection of project**
  - **Elaborate project visually**
  - **Define team/kickoff**
  - **Problem statement**
  - **VOC: KANO**
  - **CtQ**
  - **SIPOC**
  - **Stakeholder analysis**
  - **Project charter**

Slimmer werken,
blije klanten

Freshing up

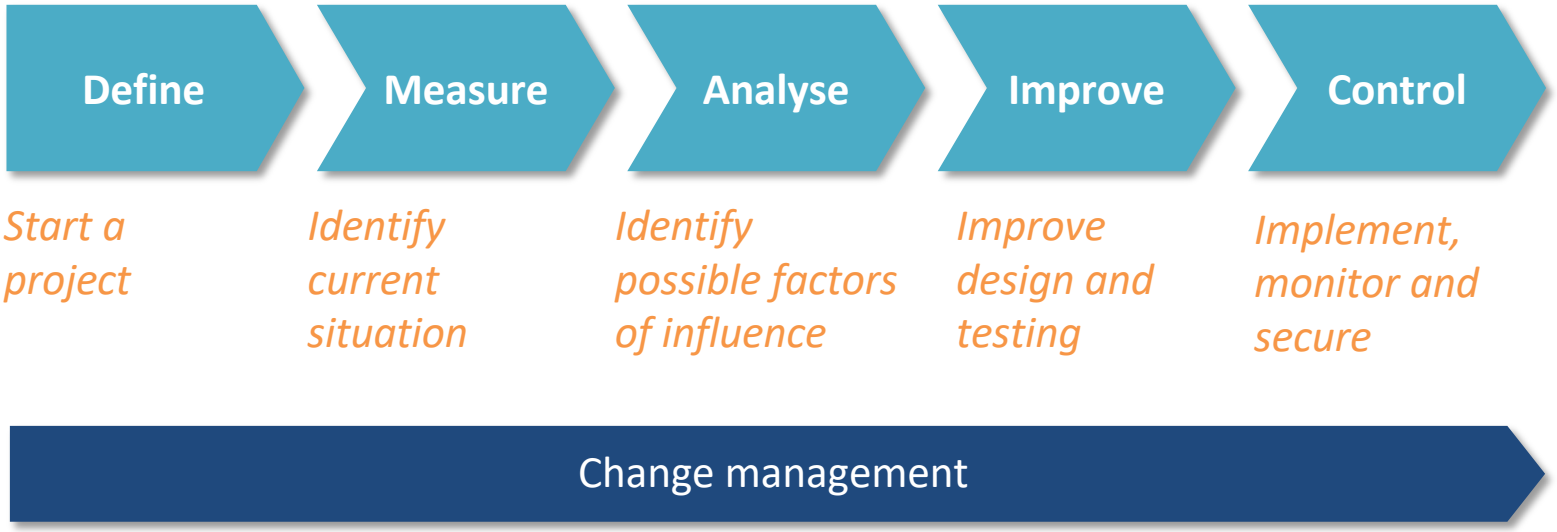
- Who is who?

- Exercise:

bureau tromp
LEAN & SIX SIGMA

Slimmer werken,
blije klanten

Six Sigma structure for improvement



Slimmer werken, blije klanten

Six Sigma structure for improvement

bureau tromp LEAN & SIX SIGMA



	Starting the project	Determining current situation	Identifying influencing factors	Identify solutions and testing	Monitoring and securing
Activities	• Defining problem (occasion) • Scoping • Who is the customer and what does the customer want? • VOC → CTQ • Goal project (Y) • Stakeholders analysis • Team composition • Inform organisation	• Map current process • Identifying waste and value • Identifying and measuring most important process variables (Y en X-en) • Visualisation process performance	• Analyse causes from VSM • Hypothesis testing (effect of X on Y) • Determine critical X	• Elaboration of solutions for the most important causes • Appreciation risks of alternative solutions Set new SLA's and KPI's • Design implementation for new process • Coping with resistance	• Testing and measuring new process • Insight in results • Continuous improvement of new process
Potential tools	• SIPOC • Kano analysis • Stakeholder analysis • Communication plan • Project charter	• VSM (current and ideal state) • Plan for measure • Minitab (e.g. control chart, process capability analysis)	• Fishbone • 5 x Why • Pareto diagram • Minitab (e.g. 1 & 2 sample-t, ANOVA)	• Brainstorming • VSM (future state) • FMEA • Poka Yoke • Implementation plan	• Control Chart • OCAP • PDCA

Change management & project support

Slimmer werken, blije klanten

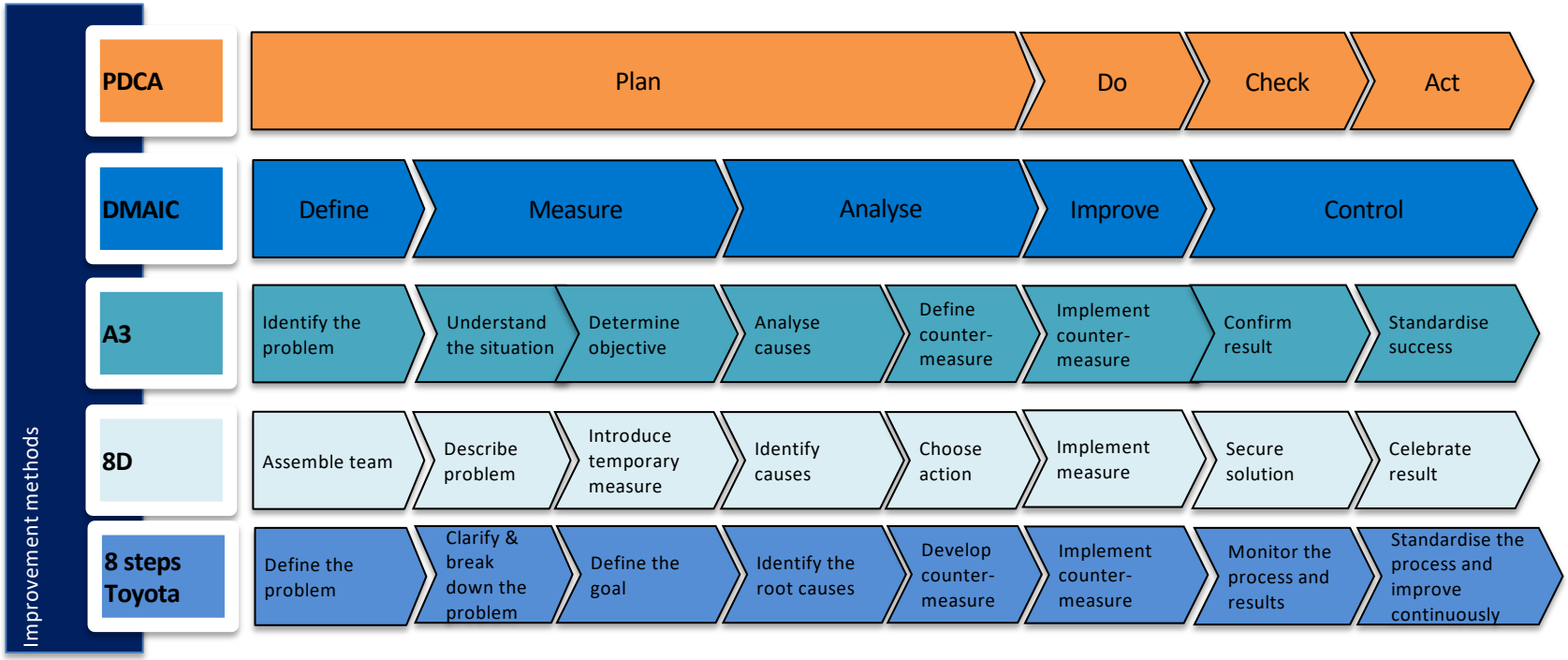
Which approach do you choose?

Exercise: the declaration process

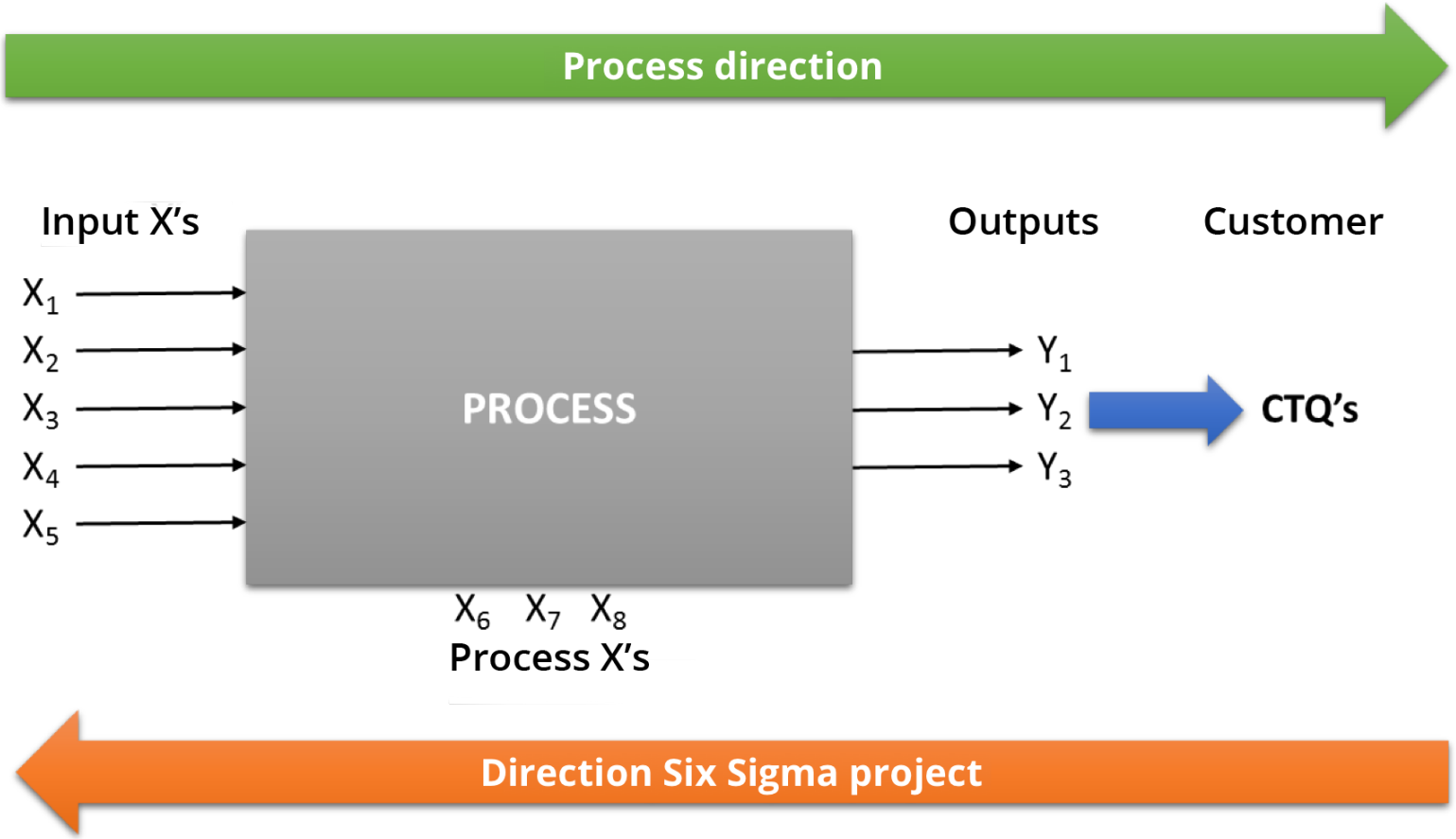
OPTION A	OPTION B	OPTION C
• Discuss what needs to be improved in the declaration process • Map the current process • Define and implement improvements • Make sure the improvements are embedded in the process.	• See which other process can be improved that resemble the declaration process • Identify bottlenecks • Come up with solutions to the bottlenecks • Implement the solutions	• Set the objective • Map the current process • Identify the bottleneck and analyse the root cause • Determine and implement the improvements

Improvement structures

Different types



Course of Six Sigma structure for improvement



Slimmer werken, blije klanten

Y is a function of X



result

$$Y = f(X_1, X_2, X_3, X_4, \ldots, X_{??})$$

Example:

Project goal Y = Time for finishing a phone call

Possible X-s':

- Number of operators
- Number of incoming calls
- Availability/Functionality of information system
- Experience of the operators
- …

In every project we determine an Y

This Y contributes to the desired goal

Slimmer werken, blije klanten

Improvement methods ▶ Overview

Which ones do you use?

Improvement methods	Lead time	Who?	Theory
Daily and weekly stand-up / 5S	Daily / weekly	Operations	Lean
Kaizen-events/A3 (PDCA)	1 to 8 weeks	Improvement team	Lean
DMAIC	12 to 24 weeks	Project team	Lean & Six Sigma

A3-owner

Date

Process

Process owner

Plan

1. Background

Define the problem

2. Current state

Describe the current situation

3. Objective of the desired situation

Determine the target situation

4. Root cause analysis

Analyse the root causes

Do, Check, Act

5. Improvement measures

Design the solutions

6. Implementation plan

How to implement the solution

7. Results

Describe, celebrate and evaluate the result

8. Assurance and follow-up actions

Make it your standard

Improvement method ► A3

Example

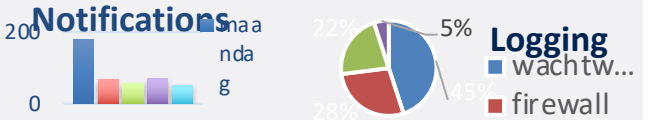
A3-owner	Anneke van Loon	Process	Issues login Blackboard
Date	24 November 2019	Process owner	J. Pieters – Head Servicedesk

Plan

1. Background

An average of 90 notifications come in every day from users who can't log in to Blackboard. The management department spends an average of 7.5 hours a day on this, resulting in waiting times when resolving other issues.

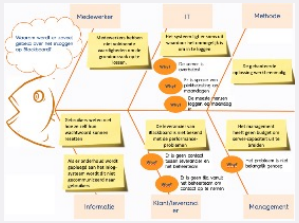
2. Current state



3. Desired state

There will be only 40 notifications incoming everyday about not being able to log in to Blackboard. Measured over a week from 16 to 20 December. This saves 50*5 minutes per day = 250 minutes.

4. Analysis



Do, Check, Act

5. Improvement measures

1. Send a clear mail to the user after activating the account
2. Talk to the vendor about issues with the firewall
3. Tackling problems with the work method to avoid new questions

6. Plan

Action	Deadline	Responsible
Schedule appointment with vendor for firewall issue	2 December	Anneke
Customize text activation mail	8 December	Gijs
Customize work statement	8 December	Gijs

7. Results

In the week of 16 to 20 December, an average of 45 reports were received.
This means that the target has not yet been met. However, we have completed the actions fully and on time and we see a decrease compared to the problem situation.
We are making a new A3 to investigate what is still not going well.

8. Assurance and follow-up actions

We will continue to monitor progress to see if there are other opportunities for improvement later on.

bureau tromp

LEAN &
SIX SIGMA

Green Belt Day 2

Slimmer werken,
blije klanten

Lean Six Sigma

Project selection

Project selection

bureau tromp
LEAN & SIX SIGMA

Not-suited

- Very complex
- Wide scope
- Known solution
- Limited or no access to data
- Capital intensive
- No strategic agreement

Suited

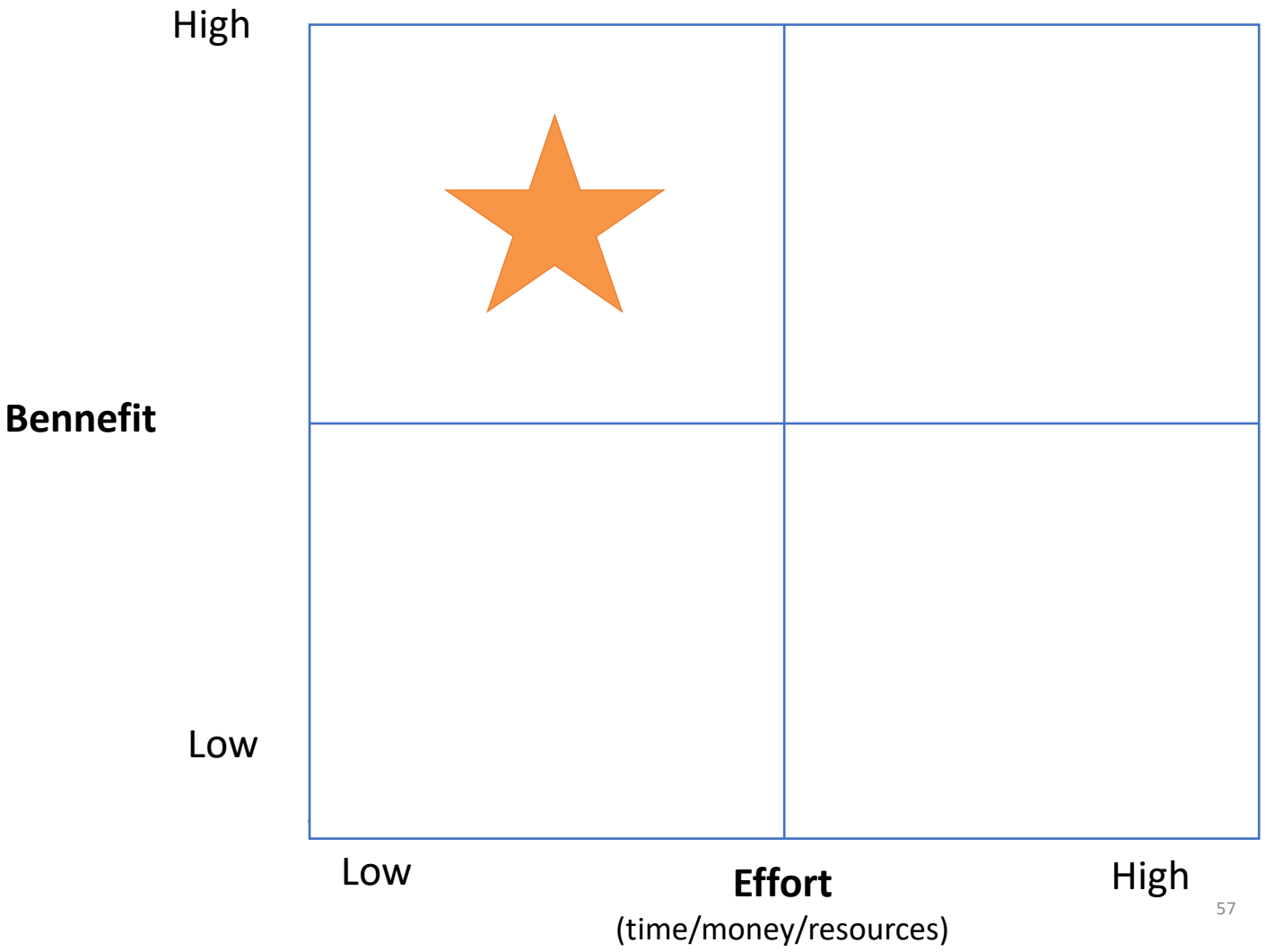
- Focus on defects and variation
- Cost saving, high revenues
- Fits into DMAIC structure and tools
- High chance of succes
- Preferably historical and current data available

Slimmer werken,
blije klanten

Project selection

bureau tromp
LEAN & SIX SIGMA

Choose the right project using the Benefit/Effort matrix



Slimmer werken,
blije klanten

Project team

- Look for team members with knowledge and experience on all different aspects of the project
- Make sure the team is a proper reflection of the organization (or process)
- Make sure there is a diversity of opinions
- Do not consistently use the same people for differing projects
- Teams should consist of 4-6 members
- Make sure members can express the right capacities
- Team members should prioritize and be able to give the project the priority it needs



Kick-off

A successful kick-off accounts for:

- Training of necessary knowledge
- Team-bonding
- Sharing/ discussing project goals
- Defining project rules
- Naming roles and responsibilities within the team
- Discussion of planning
- Developing a communication plan



Slimmer werken,
blije klanten

Factors of succes

- Management commitment
- Top-down as well as a bottom-up approach
- Availability of budget and capacity
- Strategic coordination
- Selection of the right projects
- Availability of the right people
- Correct use of DMAIC and tools



Slimmer werken,
blije klanten

Tollgate review

- At each phase transition
- Project Charter is the most important document
- The project leader presents the results and expectations for continuation to the project sponsor (Champion)
- The project sponsor/Champion decides if it is a Go or No-go



Slimmer werken,
blije klanten

Schedule Day 2

- **Six Sigma**
  - **DMAIC project structure**
  - **Define phase**
  - 2nd Principle of Lean: Value stream

Slimmer werken,
blije klanten

Six Sigma structure | DEFINE



Starting a project

Determining current situation

Identifying influencing factors

Identifying solutions and testing

Monitoring and securing

Result:

- Problem statement
- Customer
- VOC
- CTQ
- Projectgoal (Y)
- SIPOC
- Stakeholder analysis
- Project charter

Slimmer werken, blije klanten

Starting a project for improvement

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

The first phase of DMAIC is defining the problem. It allows for understanding the defined problem before investing time and money in improvements.

Before you start a project of improvement, it is essential to:

- Talk the project through with the customer;
- Determine the requirements;
- Understand the context of the problem;

In short: experience and take a look at the problem yourself!

Go to Gemba!



Slimmer werken, blije klanten

Why the workfloor?

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

What happens here?

Barn

Water

Person

Fire

Car

Wheel

Window

Car

Roof

Slimmer werken,
blije klanten

A picture is worth a thousand words

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



Slimmer werken,
blije klanten

Six Sigma structuur | DEFINE



Starting a project

Vaststellen huidige situatie

Identificeren potentiële invloedsfactoren

Verbeteringen ontwerpen en testen

Implementeren, monitoren en verankeren

Result:

- Problem statement
- Customer
- VOC
- CTQ
- Projectgoal (Y)
- SIPOC
- Stakeholder analysis
- Project charter

Slimmer werken, blije klanten

Customers

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Customers:

- ‘Pay our invoices’;
- Are always right (even if we cannot meet their requirements or if it is below cost-price);
- Help us determine which activities create value and which do not.

- Identifying changes in customer behavior are of importance for the process-design and strategy of an organization.
- Therefore it is important to identify the features in your products and service that your customers appreciate.

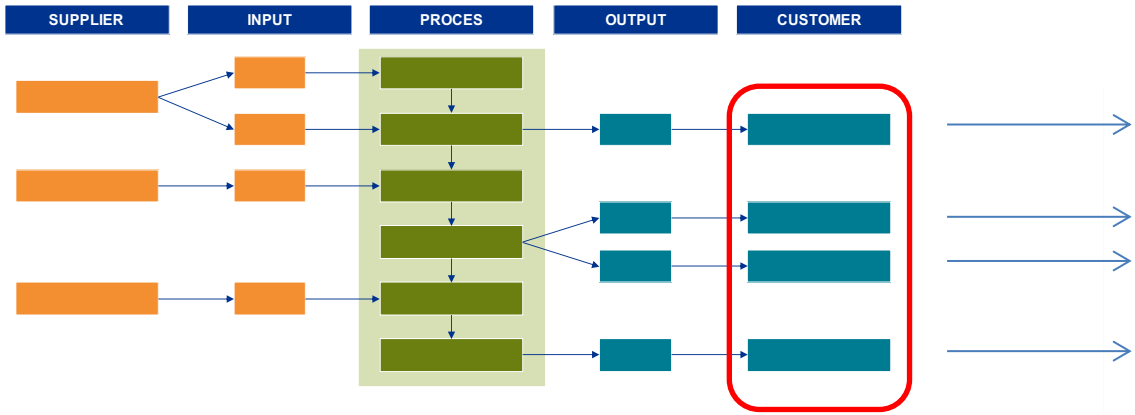
Internal customers – External customers

Slimmer werken, blije klanten

Voice of the customer (VOC)

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



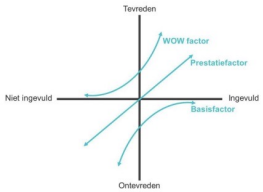
1. Identify



2. Segment



3. Get your VOC



4. Prioritise

VoC	CCA	CCR

5. Translate VOC to CTQ



6. Determine indicator for measurement

Slimmer werken, blije klanten

Voice of the customer

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Convert the voice of the customer into:

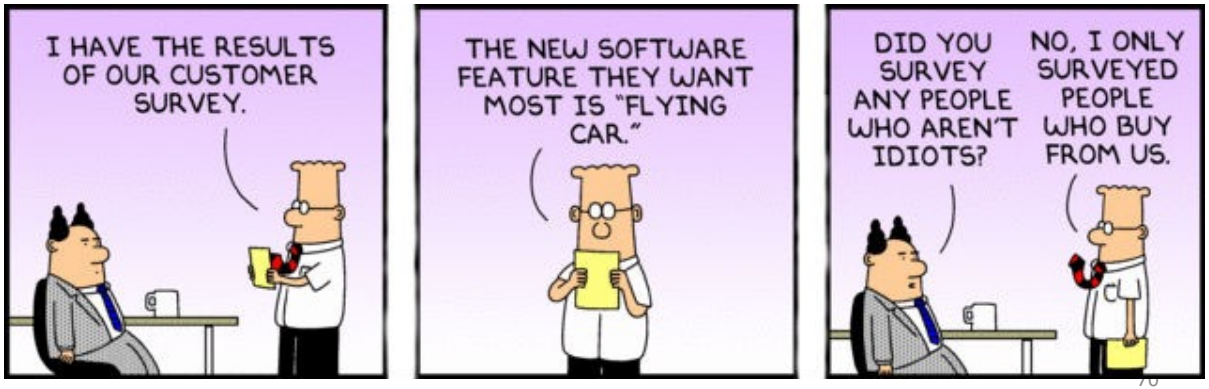
- Reactive data

  (complaints, requests for service, MTO's, KTO's)
- Proactive data

  (interviews, market research, customer panels)

Examples of voices of the customer:

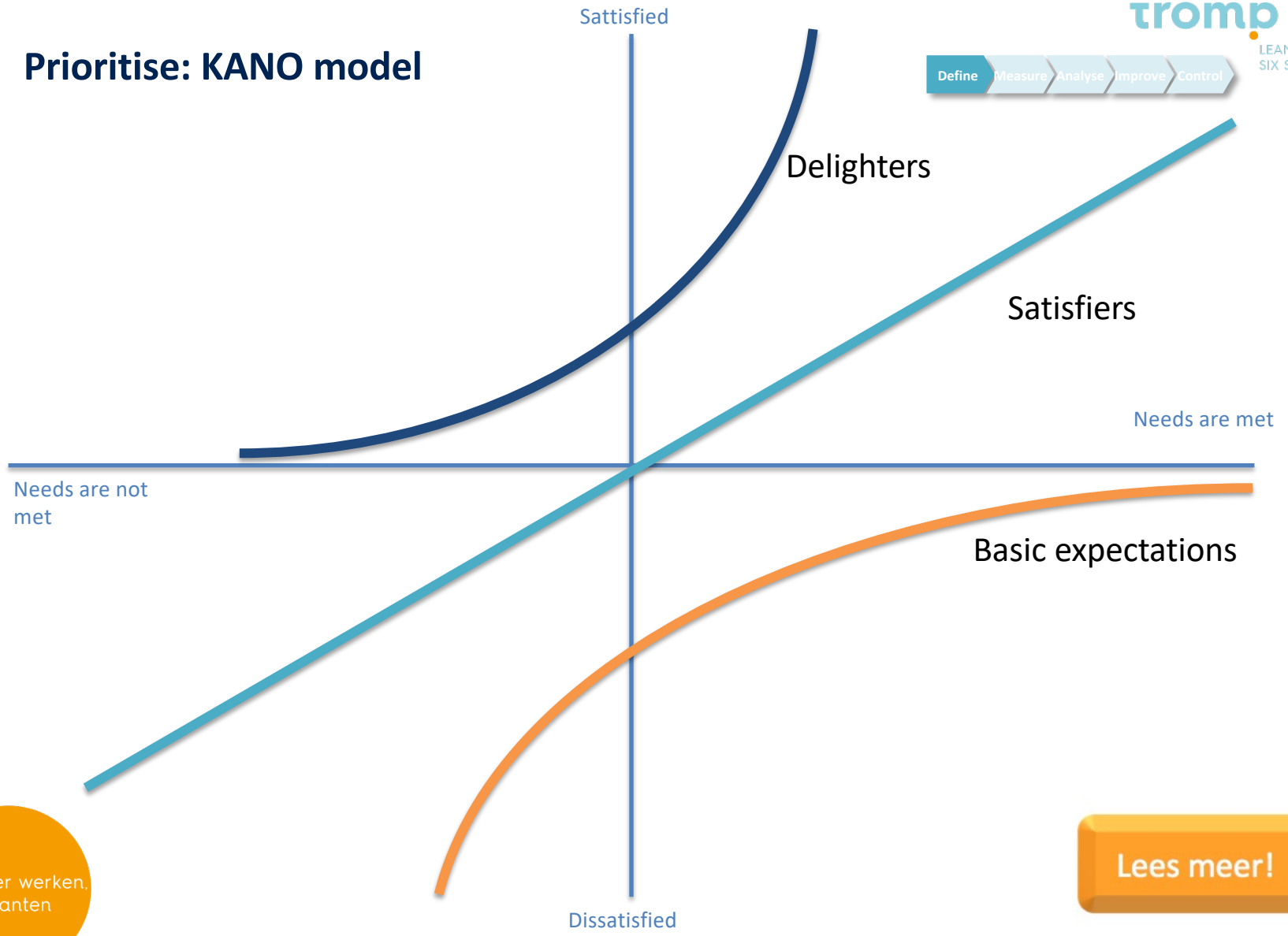
- We want certainty about delivery on the agreed date
- I want a shorter delivery time
- We want faster answers to our questions
- Customer service couldn't answer my questions
- Placing orders should be easier
- Delivery always has to meet the requirements
- I want more insights in delivery time



Slimmer werken, blije klanten

Voice of the customer

Prioritise: KANO model



bureau tromp
LEAN & SIX SIGMA

Define Measure Analyse Improve Control

Slimmer werken, blije klanten

Lees meer!

KANO model

Basic expectations:

These expectations are typically unspoken. However, if these expectations remain unfulfilled, the customer will be extremely dissatisfied.

Satisfiers:

The more, the better.

Delighters:

Unexpected features or characteristics that impress customers and earn the company 'extra credit'. These needs are also typically unspoken.

Example: Customer needs in hotel rooms

Basic expectations	Satisfiers	Delighters
Clean	Number of towels	Fruitbowl at time of arrival
Telephone	Space in the room	Balcony on the seaside
Bed	Channels on the TV	Free films

Customer expectations change over time so you have to keep evaluating them!

Voice of the customer

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Translate VOC to CTQ

Critical To Quality

Which concrete requirements does the customer have, which **measurable characteristic** is determined for the observed quality?

- Makes a direct link between the project and the desired goals.
- The first step in the DMAIC
- The project focuses on 1 or 2 CTQ's

CTQ's mostly evolve from one of the following domains:

- **Quality** (meets the requirements)
- **Speed** (processing time, waiting time and run time)
- **Safety** (number of accidents)
- **Reliability** (number of mistakes per 1,000,000 procedures)
- **Flexibility** (changeover time)
- **Costs and hours** (money- and time-consuming)

Slimmer werken, blije klanten

CTQ-flowdown

Checklist



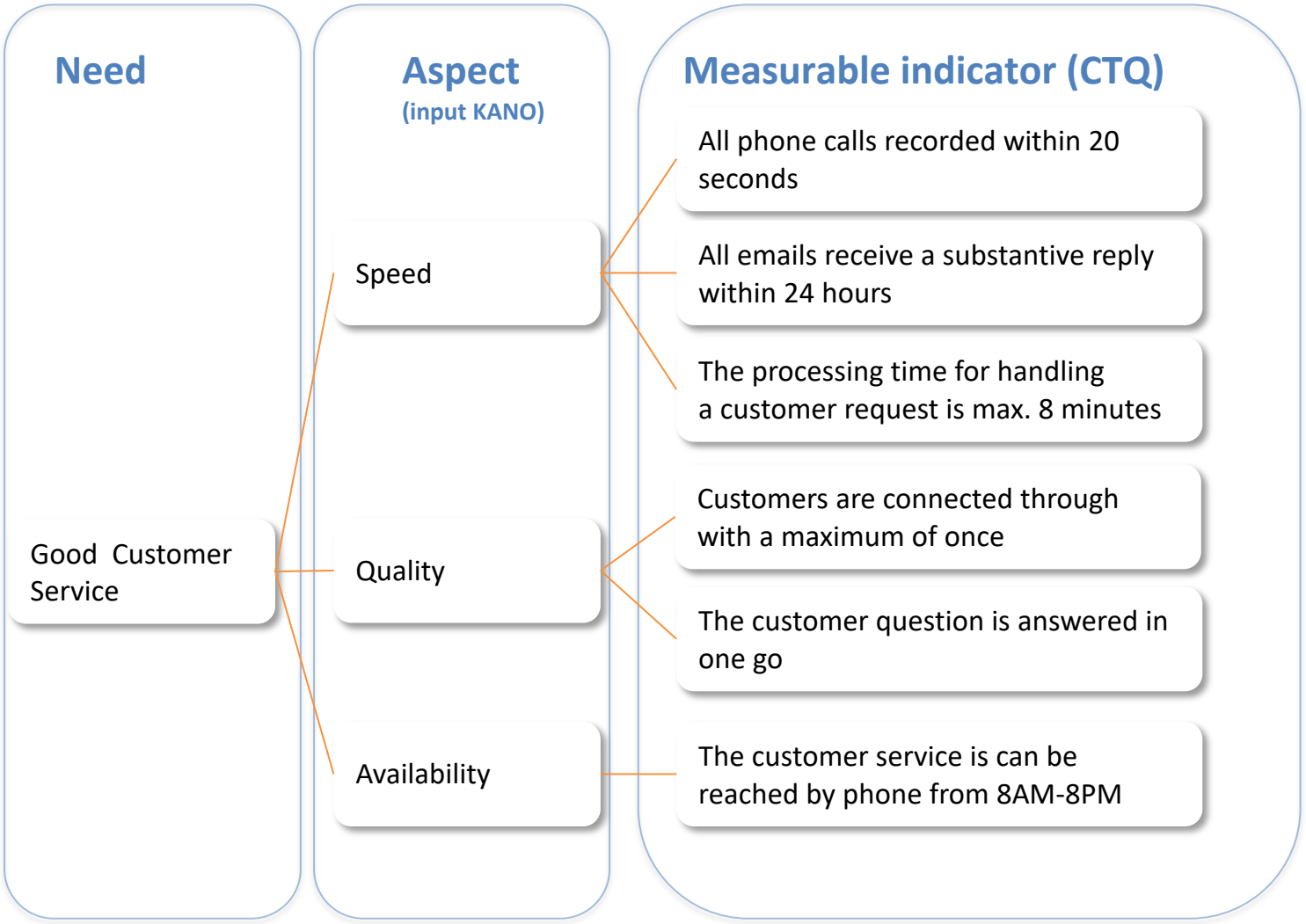
When making a CTQ-flowdown, think of the following steps:

- Describe the product or service clearly;
- Determine for what type customers (groups) the tree is set up;
- Determine which customer needs are met;
- Establish which aspects of the product or service contribute to fulfilling that need. By constantly asking: 'what exactly do you mean by ...?'
- Determine what the measurable properties are that are of importance for the fulfillment of the customer's needs;
- Connect the three levels in a tree structure.

Example: CTQ-tree or flowdown

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



Slimmer werken, blije klanten

Project CTQ

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

After mapping the possible CTQ's:

- Prioritize the CTQ's based on customers' wishes and organisational needs
- Verify with customers and the organization if the chosen CTQ-project is in line with customer expectation

Slimmer werken, blije klanten

From problemsolving to goals

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Translate VoC to CTQ to projectgoal Y



Wat does the costumer say:

"When I ask for a tender, I have to wait longer than expected"

What does the customer want according to the GB:

The customer wants the tender to be delivered in the promised timeframe

What is the CTQ acccording to the GB:

The project for improvement has to focus on 'delivery time' and thats what the CTQ is.

Voice of the Customer	CTQ's
Bad quality (Q)	Number of rejected products per delivery
Product is too expensive (C)	Costs per product unit
Unreliable deleveries (D)	% products that are delivered in 2 days

Slimmer werken, blije klanten

Make sure your customers stay satisfied!

Youtube: United breaks guitars

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



Slimmer werken, blije klanten

Six Sigma structure | DEFINE



Starting a project

Determining current situation

Identifying influencing factors

Identifying solutions and testing

Monitoring and securing

Result:

- Problem statement
- Customer
- VOC
- CTQ
- Projectgoal (Y)
- SIPOC
- Stakeholder analysis
- Project charter

Slimmer werken, blije klanten

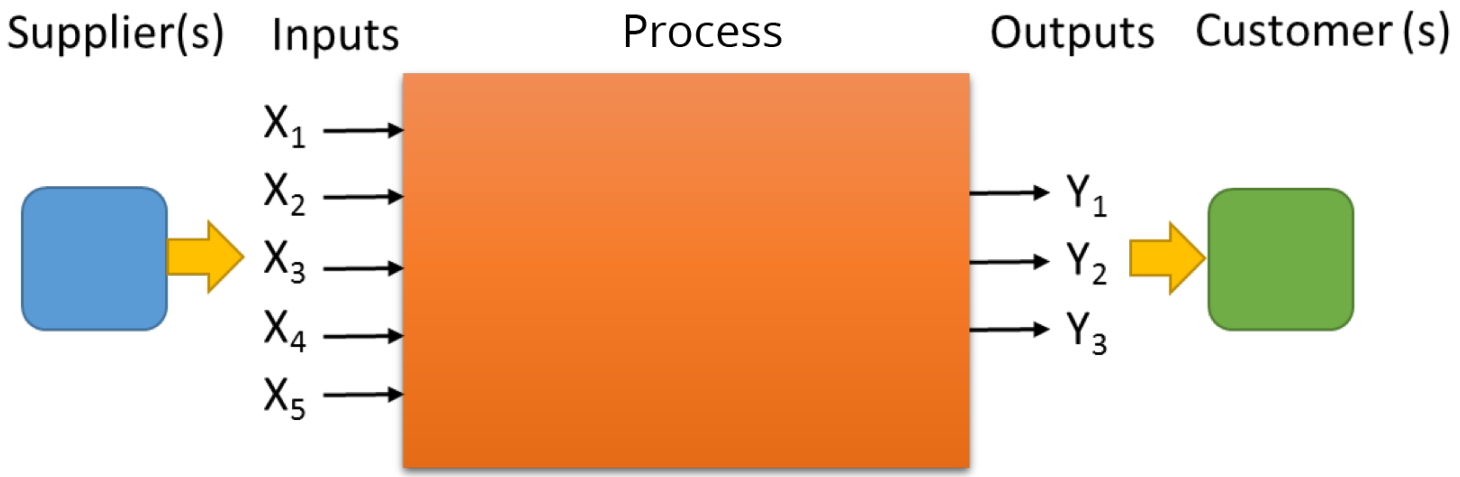
SIPOC

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

A **process** is...

A series of steps or activities with one or more kinds of INPUT that end in one or more kinds of OUTPUT of value to the CUSTOMERS.



Supplier — Determines the — **Process Input(s)** — Defines the — **Process structure** — Determines the — **Process Output(s)** — Lead to — **Customer demands**

Slimmer werken, blije klanten

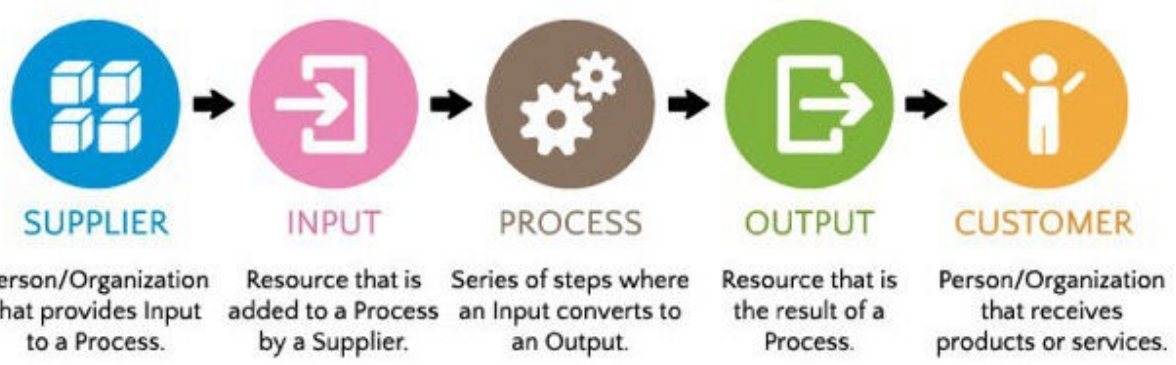
SIPOC

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

- Helps the team understand the process
- Makes sure everyone has a clear vision of the process
- Validates the scope of the process
- Gives the project-team focus
- Sets means of communication
- Is the link between the project charter and upcoming phases
- Gives insight into stakeholders involved in the process

A SIPOC is a high-level view of a process.
It stands for Suppliers, Inputs, Process, Outputs, and Customers:



Slimmer werken, blije klanten

SIPOC

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

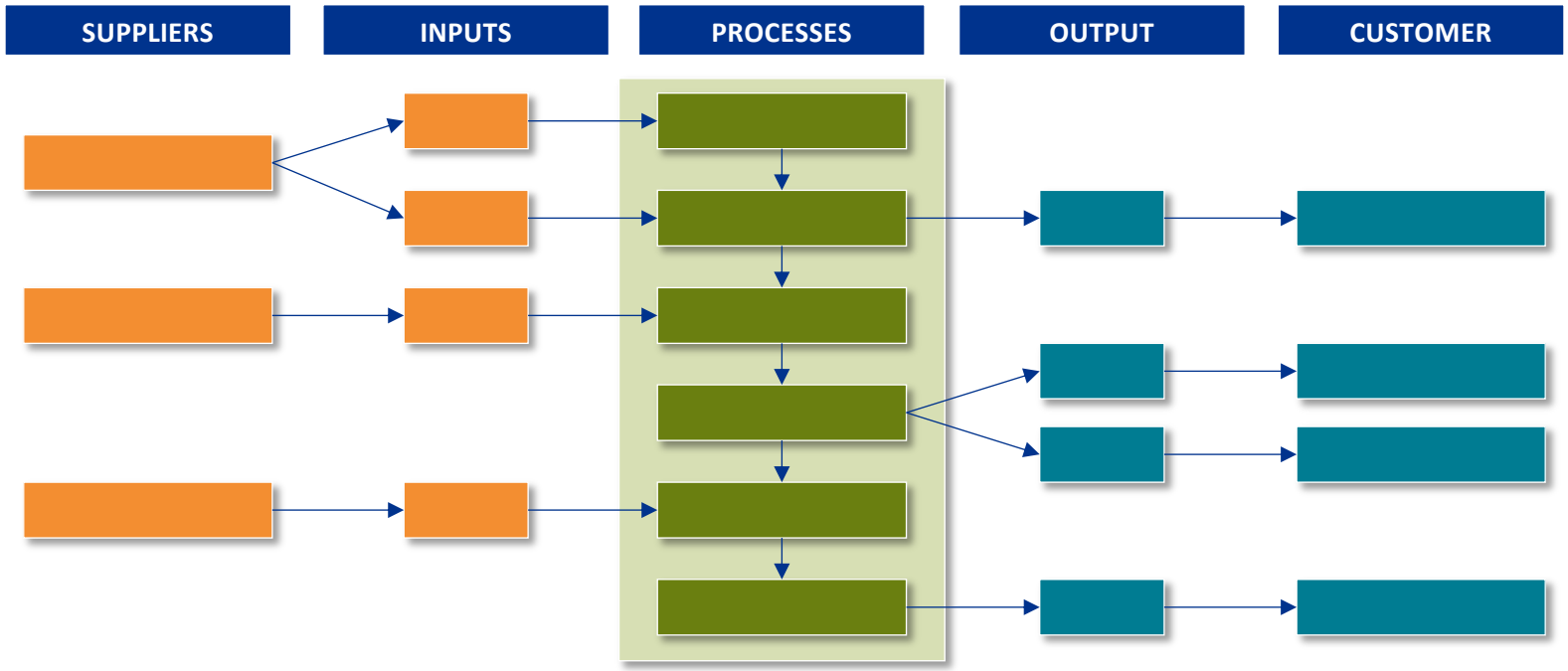
A SIPOC is a valuable medium that helps determine the scope of the process.

Road map:

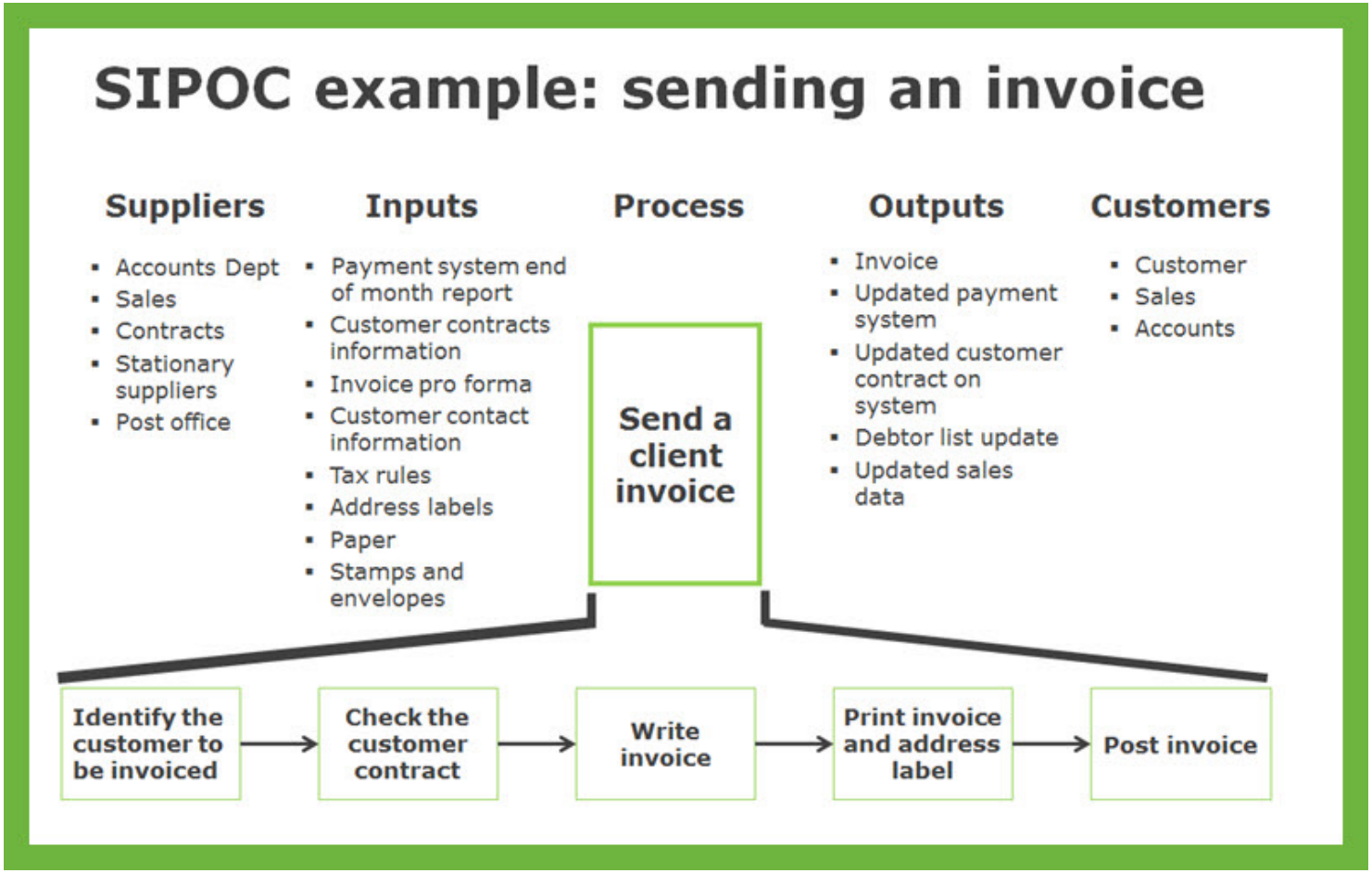
1. Start with defining the start and the end of the process
2. Describe the main process between the start and the end in 4-7 steps
3. Identify the output(s) (products, services, information)
4. Describe the customer for every output
5. Identify the input(s) of the process.
6. Describe the supplier for every input (who, what do they deliver, what is the effect on the process)
7. Validate the process description (is the description indeed a reproduction of the actual situation?)

Slimmer werken, blije klanten

SIPOC



Example: SIPOC



Slimmer werken, blije klanten

Six Sigma structure | DEFINE



Starting the project

Determining current situation

Identifying influencing factors

Identifying solutions and testing

Monitoring and securing

Result:

- Problem statement
- Customer
- VOC
- CTQ
- Projectgoal (Y)
- SIPOC
- Stakeholder analysis
- Project charter

Slimmer werken, blije klanten

Stakeholder analysis

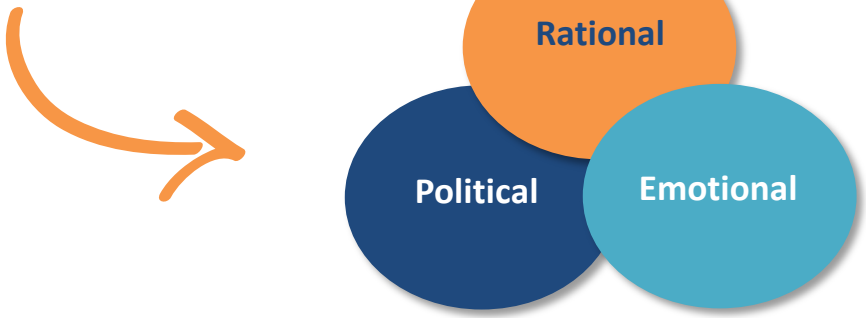
bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

- Stakeholders:
  - Can be customers, suppliers, shareholders or other parties
  - Are involved in the project/process
  - Can influence the result of the project
- Without clear vision of the stakeholders, the chances of resistance grow.

Rational
- Loss of job
- Change of role
- Moving because of job
- Unknown future

Political
- Lack of personal development
- Relationship with bosses under pressure
- Own kingdom under pressure



Emotional:
- Loss of reputation and trust
- Interpersonal rejection
- Loss of selfconfidence
- Fear for the unknown
- Demotion
- Threat of known contacts

Slimmer werken, blije klanten

Stakeholder management

bureau tromp
LEAN & SIX SIGMA



Step 1: Analysis and mapping

- Identify stakeholders and register worries and issues

Step 2: Communication, strategy, and planning

- Communicate through different channels, depending on the audience

Step 3: Involvement strategy and activities

- Involve stakeholders in the design and implementation

Step 4: Continuous judging and succession

- Stakeholder management is dynamic!

Slimmer werken,
blije klanten

Stakeholder analysis

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Step 1: analyze and mapping



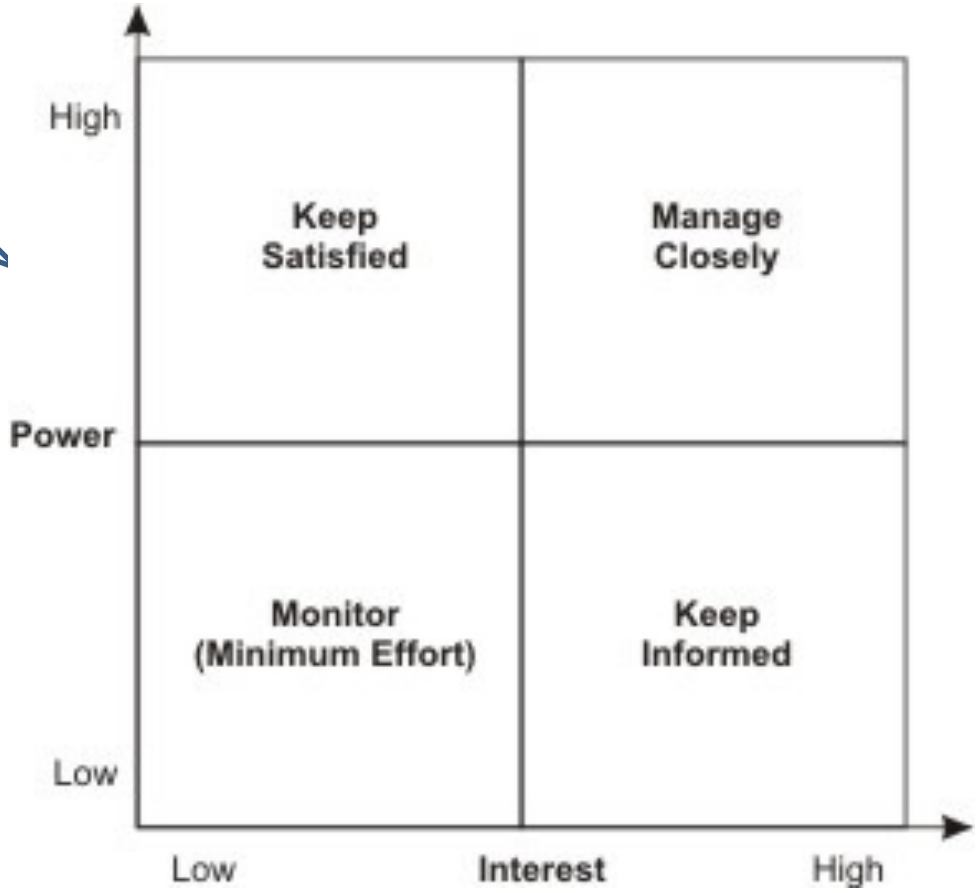
Slimmer werken, blije klanten

Stakeholder analysis

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Put the identified stakeholders in the correct quarter of the diagram to determine appropriate communication



Slimmer werken, blije klanten

Example: Stakeholder analysis

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Stakeholder Analysis

Version 1.0 Date: 29/01/2013

#	Stakeholders	Key involved	Project involvement	Impact of project on stakeholder	Influence of stakeholder on project	Expected resistance	Means of communication	Comments
Total population								
1	All employees		Communication	Low	Low	Low	Weekly contact via EO	
Sectional population/ gremia								
2	Management		Client/ member core team	High	High	Low	Via advisory committee and core team	
3	All employees RH & SC		Selection in project team	High	Moderate	Moderate	TL meeting SC & RH	
4	Insured	Marketing	Customer	High	Moderate	Low	Monthly through project team	
5	Intermediate and authoritative	Sales	Customer	High	Moderate	Low	Monthly through project team/ in advisory committee Arjen	
6	Employee council (OR)		Communication	Low	Low	Low	Involve when necessary	
7	IT		Part of project team	Moderate	High	Moderate	Project team	Capacity problems
8	Project team	Jan Pieterse	Supplier input/implementation/acceptance future state	High	High	Moderate	Project team meetings/ update every two weeks	
9	Legal services		Customer	Moderate	Moderate	Low	Partaking project team/ coordination VoC	
10	Financial services		Customer	Moderate	Moderate	Low	Involve when necessary/ coordination VoC	
11	SA (+ team assistance)	Simone Kroes	Supplier	High	High	Moderate	TI metting/ MT C/ Bila	
12	Secretariat		Customer	Moderate	Moderate	Low	Partaking project team/ coordination VoC	
13	Special affairs		Customer	Moderate	Moderate	Low	Partaking project team/ coordination VoC	

Slimmer werken, blije klanten

Communication plan

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

A stakeholder analysis results in a communication plan:

To who do we want to communicate? at what moment and about what subjects to make the project a success?

Target group	What	How	When	Who
Client + indirect MT	Report of progress, temporary results and next steps	Final result for each phase (tollgate)	Every 2 weeks	Project manager through the client
Involved co-workers and team members	Project documents	Available on intranet	Continuous	Project manager
	Work documents available on network	Folder 'LSS project' on N-disk	Continuous	Project team-members
	Conversations and questions about project and methods	Personal	Regularly	Project team-members
All co-workers	Reporting progress as news announcement	Via intranet	Every 2 weeks	Project manager
	Communicating 'Quickwins'	Via intranet and personally with the directly involved	When fixed	
	Discussing methodology at the water cooler	Personally	Regularly	Project team-members

Slimmer werken, blije klanten

Stakeholder analysis

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Continuous assesment and follow-up's



Slimmer werken,
blije klanten

Project Charter

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

- A project charter accounts for **clearance** about conditions and approach of a project for improvement.
- The project charter is the ‘spot on the horizon’.
- A project charter consists of:
  - Background of the problem or need
  - Measurable goal of the project
  - Scope of the project
  - Approach and planning in broad sense
  - What the business case is (costs versus profit)
  - Composition of the project team
  - An agreement with the customer.
- The Project Charter has to be updated after every DMAIC phase with the obtained results



Slimmer werken, blije klanten

Example: Project Charter

bureau tromp LEAN & SIX SIGMA

Background and/ or opportunity statement

When an entrepreneur wishes to exploit the sale of beverages and or edibles, or wishes to make changes to a current arrangement, he will need a exploitation permit. The current term for processing this permit is 12 weeks, with a possible elongation of another 12 weeks. This term for granting permits is regularly not met.

The permit applicators (mostly entrepreneurs) deem a term of 12 weeks (and often 24 weeks) unacceptable.
We as municipal council consider it imperative to shorten the total time between the application and granting of an exploitation permit. We will reflect on the current situation and future organisation of the exploitation process.

Target

Shortening the time between application and assignment of exploitation permits to a term of 4 weeks by June 2016.

- Shortening the process of exploitation permits (from application to being granted) to a maximum of 4 weeks

Indicators

Primary indicator (Ceteris Paribus):
Processing term:

- Lowering lead time
- Lowering operational time

Under the condition of relocating extra capacity (FTE) as a possible solution.

Scope

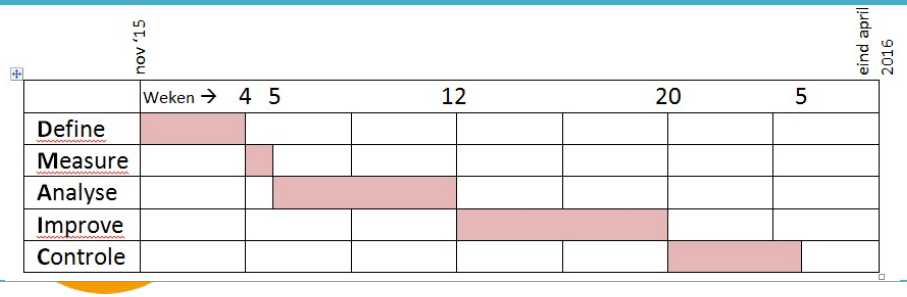
Within Scope:
Process:

- Onward from application (municipality) until possible assignment of permit
- Including, examinations at REO, Enforcement, Police & Fire department and Bibob.

Outside of Scope:

- Composition and contents of application form. Examine at National Bureau Bibob.

Approach and planning



Team (people involved for optimalisation)

Role	Contributor
Champion/process proprietor	Larisa
Permits	Sanne & Sudesh
Permits (bsm-plan)	Sylvia
REO	Frank
Municipality department	Aad
Enforcement	Anja
Project management	Marc
	Erna
	Warsha

Business case

Benefits

- Shorter completion period (8 weeks)
- Ceasing of rent expenses
- Less duplicate work and therefore improved internal capacity

Investment

- Project managers' time
- External projectguidance Bureau Tromp

Sign off

Date: .. - .. - ....

Signature Larisa

A3 report

- A problem solving and planning document on one sheet (A3 format).
- Contains all the information about the situation that you really need.

Background	**Future State & Countermeasures**
- Why do we need to work on this? - Context - Importance	- Actions being taken to address the issue (what, who, when) - Quick fixes (Containment actions) - To Be process map
Current State	**Impact**
- Problem statement/definition - As Is process map - Scale of the problem (data)	- Results achieved - Trend graph (before/after)
Objective	**Follow-up**
- Target level of performance - Desired outcome	- Actions still required (what, who, when) - Learning points to share
Root Cause Analysis	
- Fishbone diagram - 5 Whys - Data (Pareto, Scatter diagram)	

bureau tromp

LEAN &
SIX SIGMA

Green Belt training

Lean Six Sigma

Slimmer werken,
blije klanten

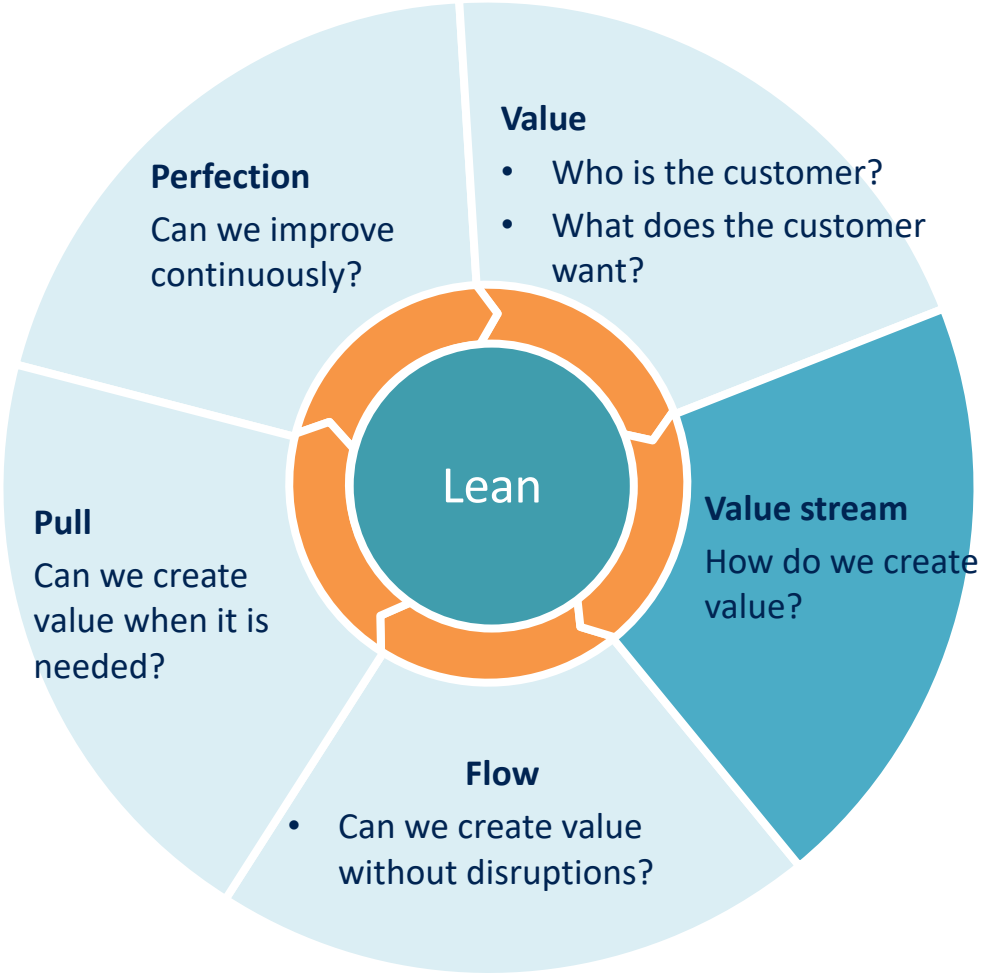
Day 3

Training schedule

Day	Morning	Afternoon
1	Kick-off Introduction to Lean Management Lean management principle 1: Value	Introduction to Six Sigma Business game
2	Lean Six Sigma DMAIC structure Six Sigma: Define phase	Define, stakeholder analysis, projectcharter
3	A3, Lean management : principle 2; Vlaue stream mapping; Six Sigma basic statistics	Six Sigma: Measure phase
4	Six Sigma: Analysis phase	Lean Management principle 3 and 4: Flow and Pull
5	Six Sigma Analysis: Minitab	Six Sigma: Improve phase
6	Six Sigma: Control phase Change Management	Theoretical Exam Wrap-up

Slimmer werken,
blije klanten

Principle 2: Value Stream



Slimmer werken, blije klanten

Proces mapping

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

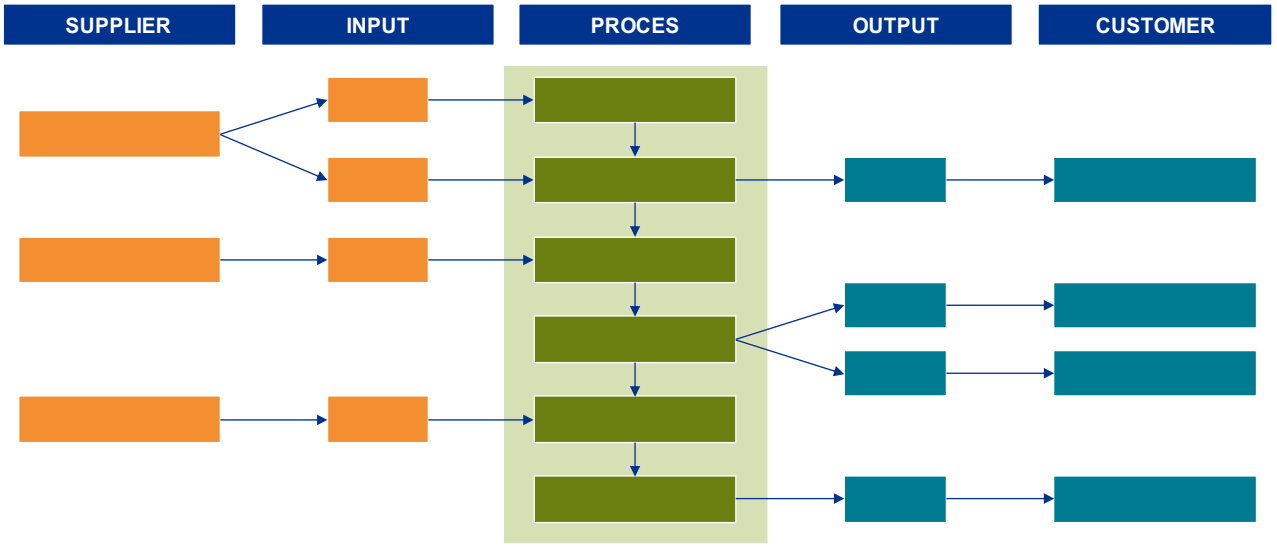
- A process can be mapped in various ways, depending on its intended purpose:

Methode	Doel
SIPOC	Low detail level, chain approach, useful for scoping
Flow chart	Focused on activities within the process, higher detail level
Swimming lanes	Focused on activities (more detailed), divided by department or function (swimming lanes).
Spaghetti diagram	Focused on mapping movement and transport
Value Stream Map	Focused on the product, mapping out forms of waste
Makigami	Focused on processes where the product is not immediately visible, physical or transparent (service or administrative process).
Customer Journey Mapping	Focused on the experience of the process through the eyes of the customer
Process Mining	Maps your processes based on available data in the systems

Slimmer werken, blije klanten

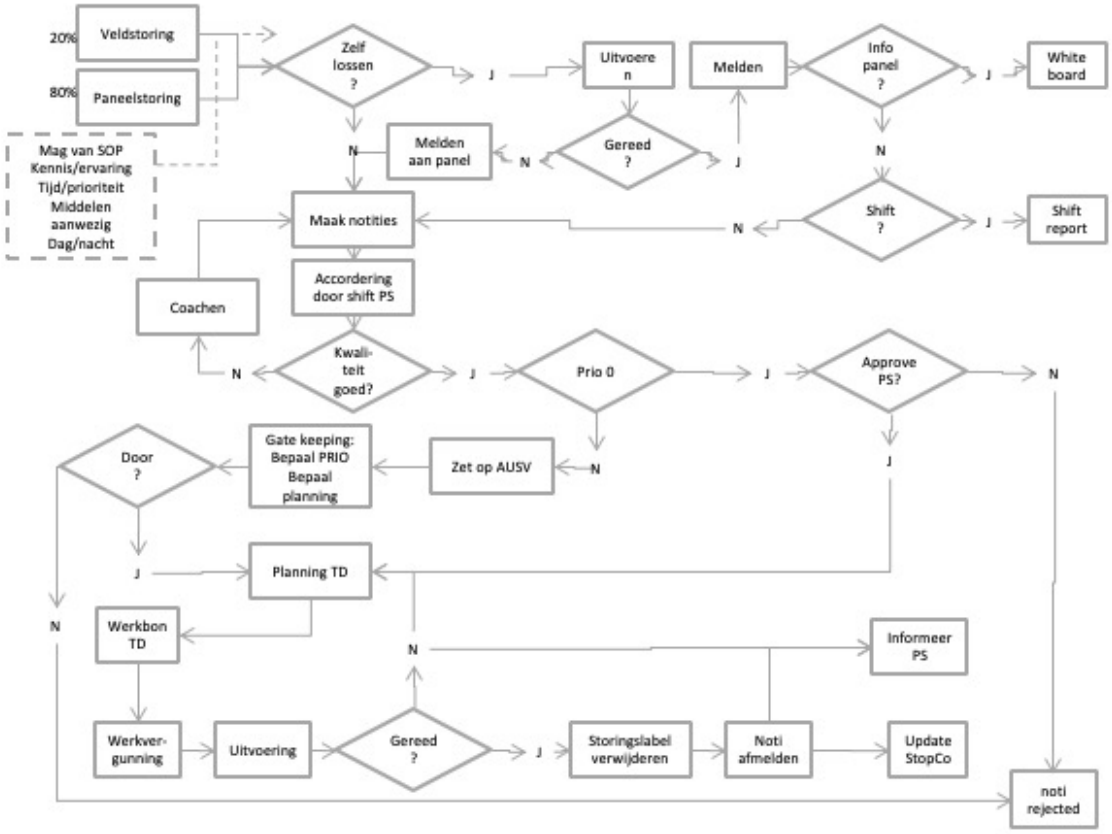
Measure ▶ Process Mapping

SIPOC



Measure ► Process Mapping

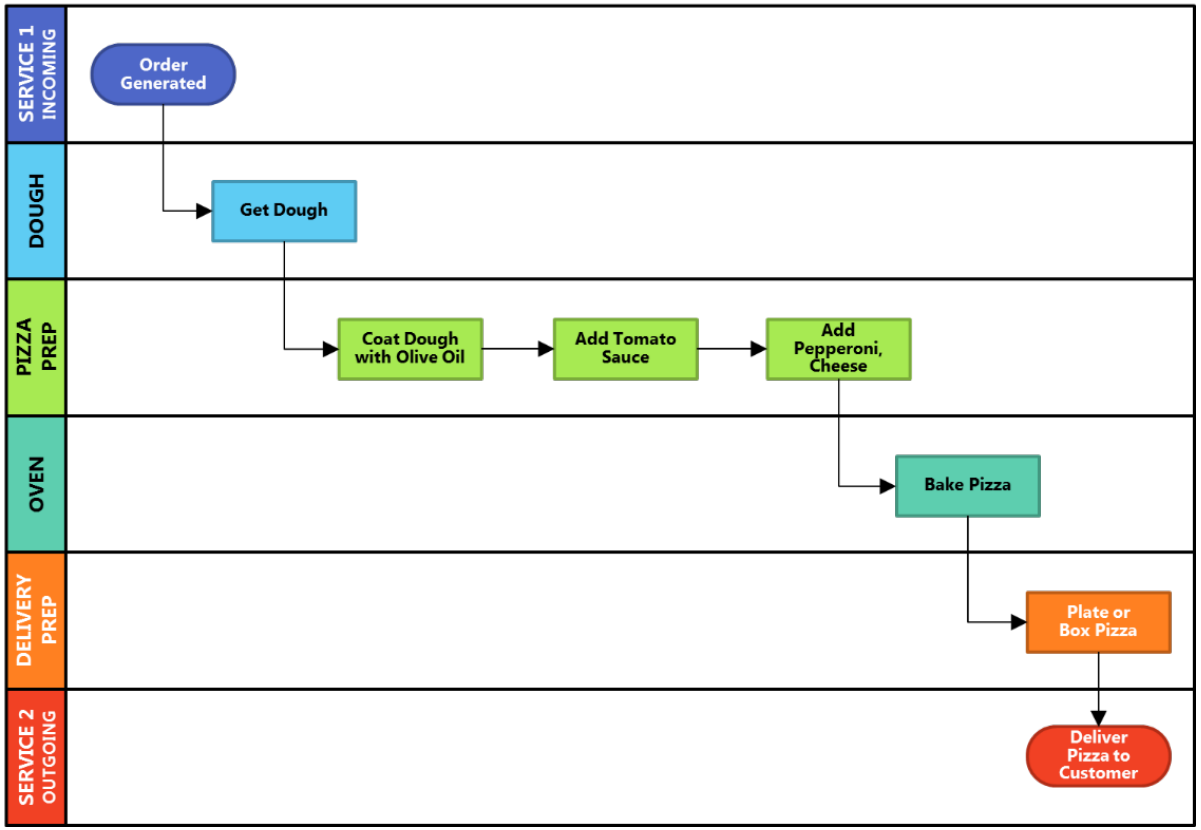
Flow Chart



Swimming Lanes

Future State: The Pizza Place

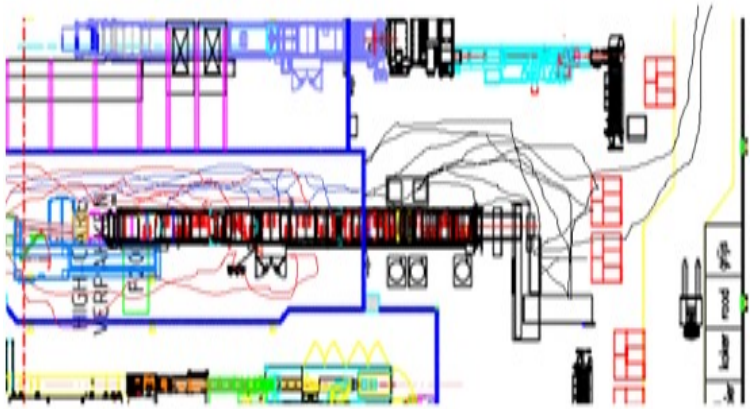
Source: North Carolina Center for Public Health Quality

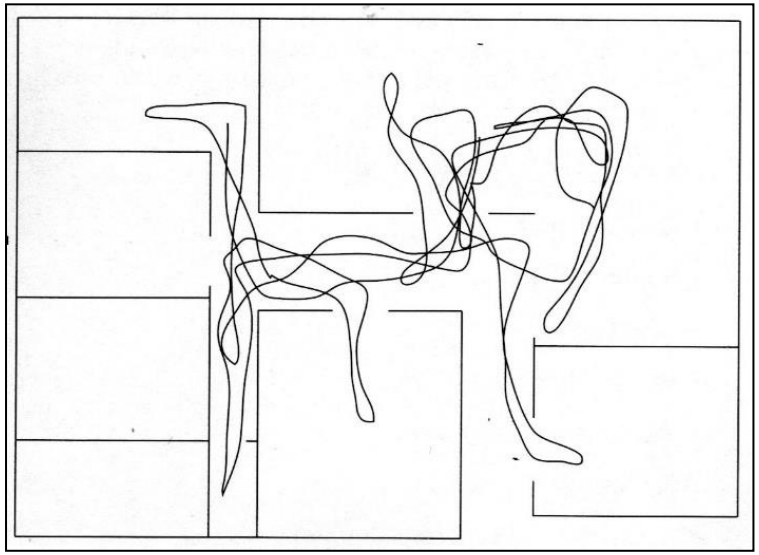


Measure ► Process Mapping

Spaghetti-diagram

Goal: to map unnecessary movements of people and transport of products (files, photos, purchases)



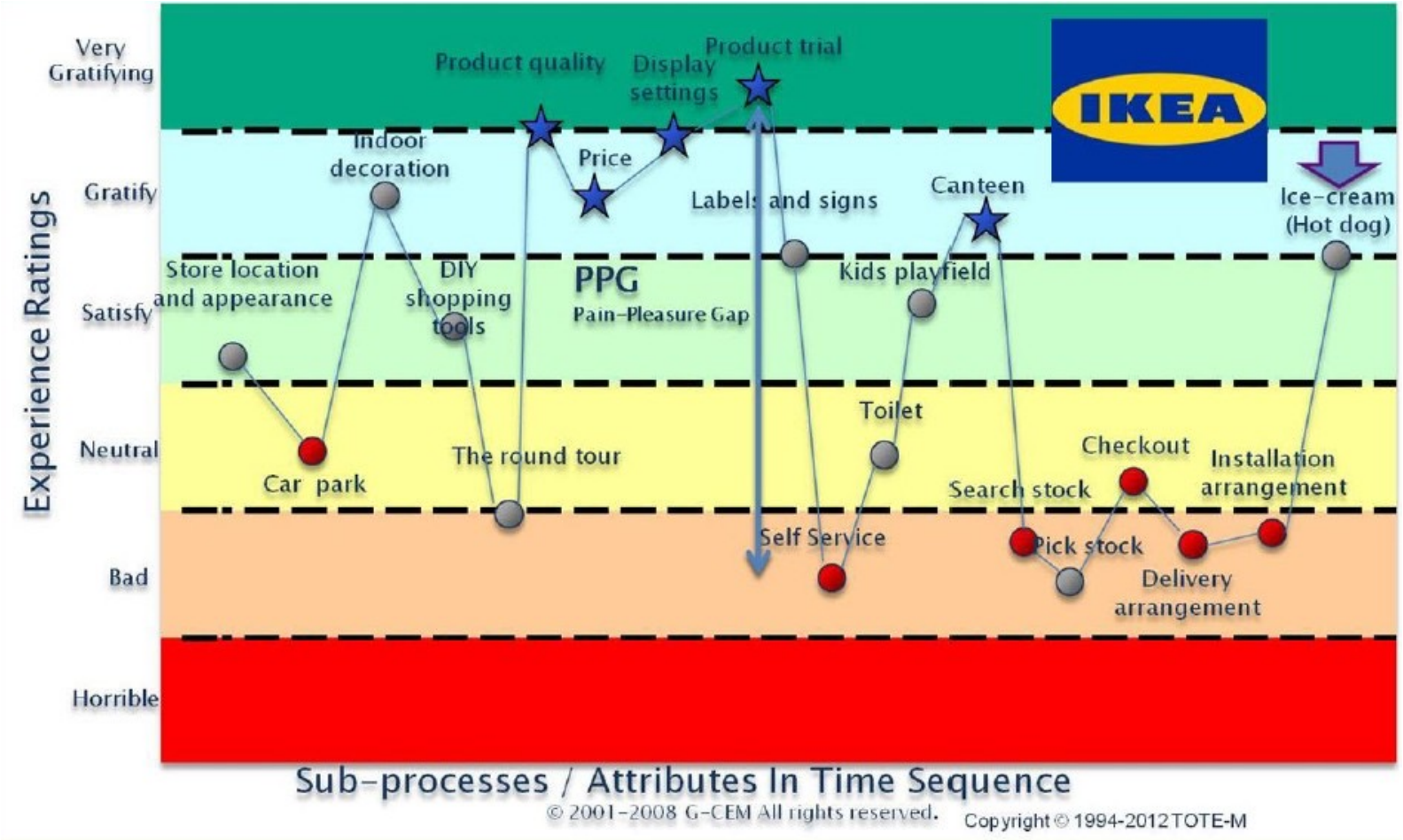


How to make a spaghetti diagram?

1. Make a map of the work area
2. Choose the subject you want to follow (material, people, information)
3. Record every movement of the target until it is finished

Customer Journey Mapping

bureau tromp
LEAN & SIX SIGMA



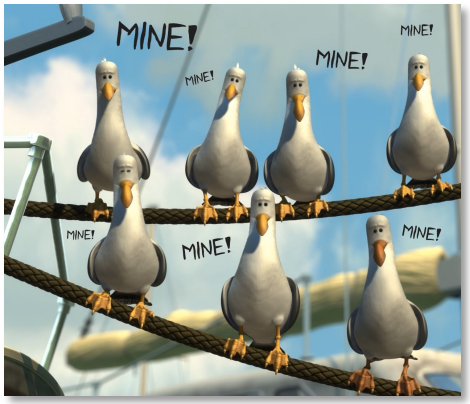
Slimmer werken,
blije klanten

Process Mapping vs. Process Mining

- Wat moet ik in mijn achterhoofd houden bij procestekeningen?
  - Alleen het meest gangbare procesverloop wordt zichtbaar, waardoor uitzonderingen (bv. doorlooptijd, volgorde) of fouten verborgen blijven
  - ‘Olifantenpaadjes’ kunnen (bewust of onbewust) achtergehouden worden: het optimale proces vs. de procesrealiteit
  - Het uittekenen van een proces is een tijdrovende klus

- Process Mining is een tool (met bijbehorende software) om op basis van logdata uit systemen bedrijfsprocessen in kaart te brengen en te analyseren. Voordelen:
  - Objectief: het daadwerkelijke proces gedetailleerd in kaart
  - Visueel: toegankelijk voor presentaties en analyse

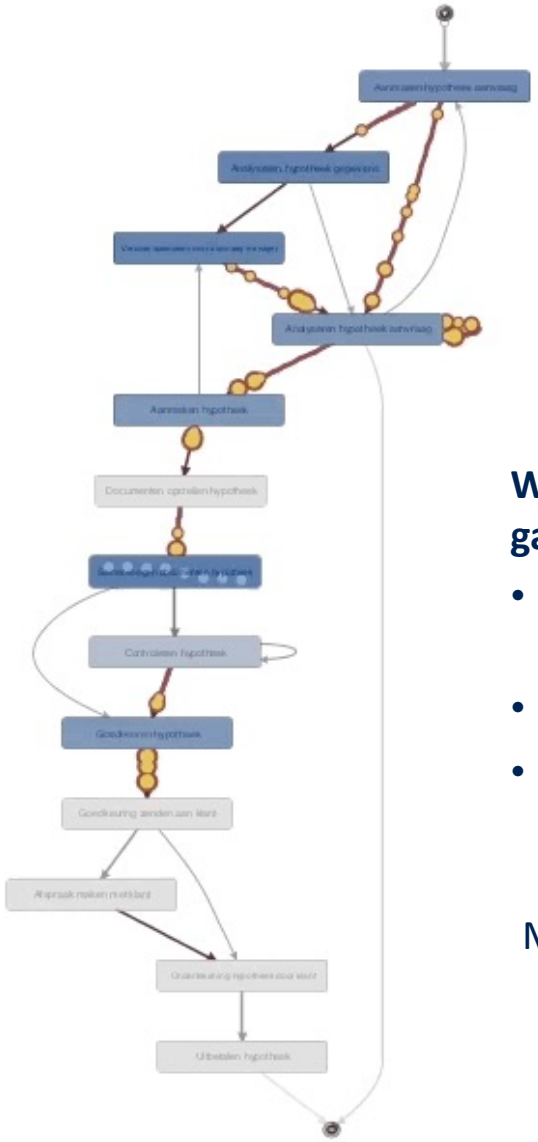
- Toepassingen van Process Mining:
  - Processen inzichtelijk maken
  - Controleren of afspraken worden nagekomen (compliance)
  - Bottlenecks, herstelwerkzaamheden en andere verspillingen opsporen



Slimmer werken,
blije klanten

Voorbeeld Process Mining

- Zie jij de:
- Complian
- Bottlenec
- Herstelwe



Wat heb ik nodig om aan de slag te gaan?

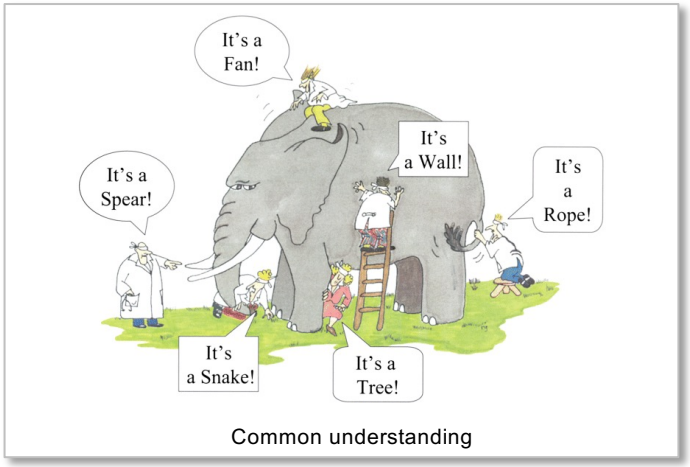
- Data: casusnummer, activiteit en tijdstempel
- Software: gratis en betaalde opties
- Training: met onze Foundation-training in 1 dag aan de slag!

Meer info: **ProcessMiningTraining.nl**

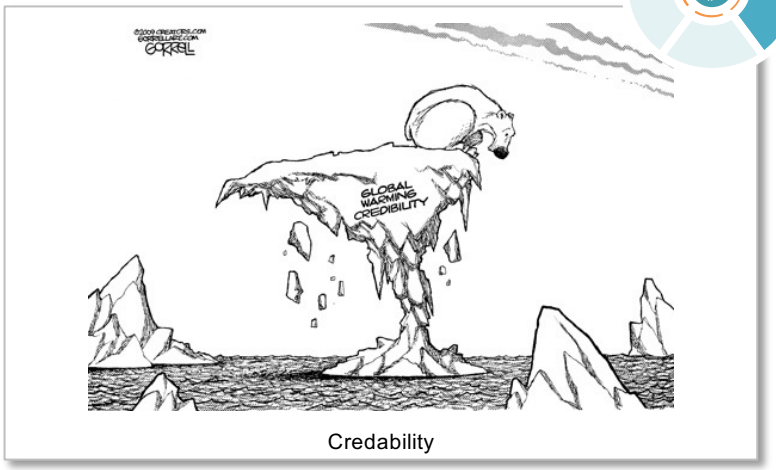
Slimmer werken,
blije klanten

Value Stream Mapping

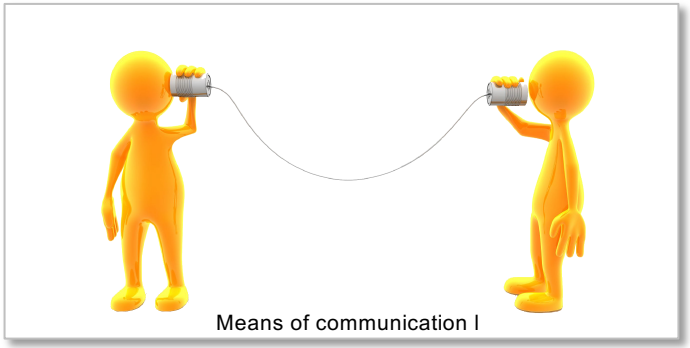
Why value stream mapping?



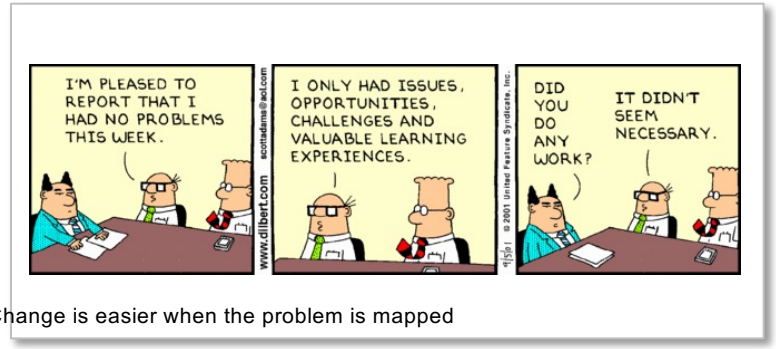
Common understanding



Credability



Means of communication I



Change is easier when the problem is mapped

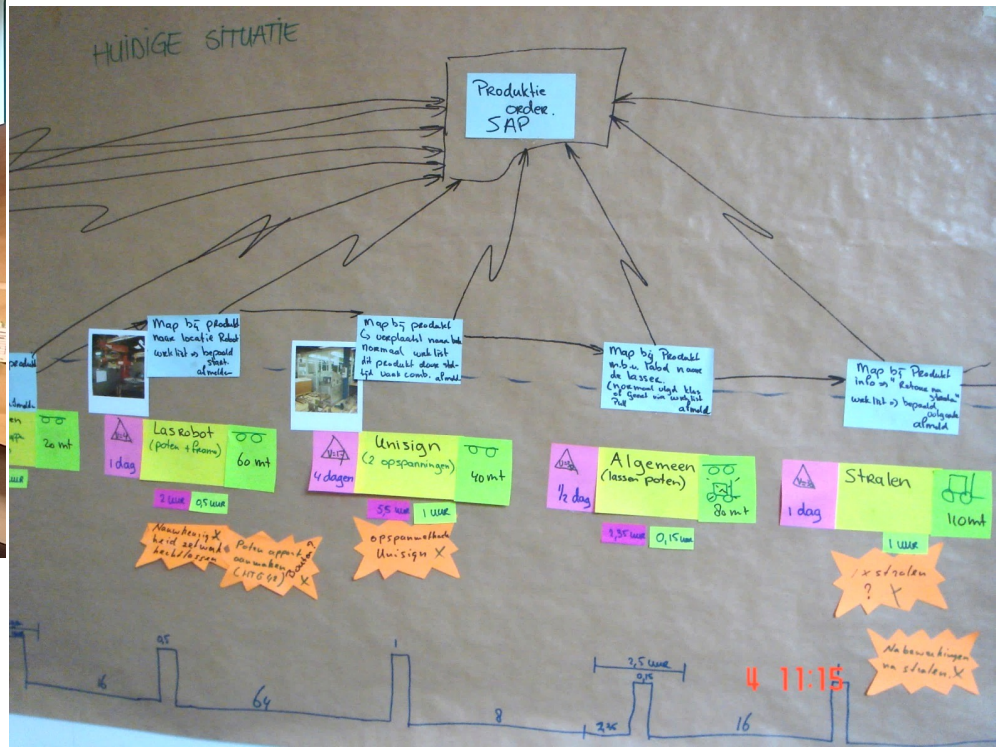
Slimmer werken, blije klanten

Value Stream Mapping, example

bureau tromp
LEAN & SIX SIGMA

A Value Stream Map is a process description that includes detailed information on the process.

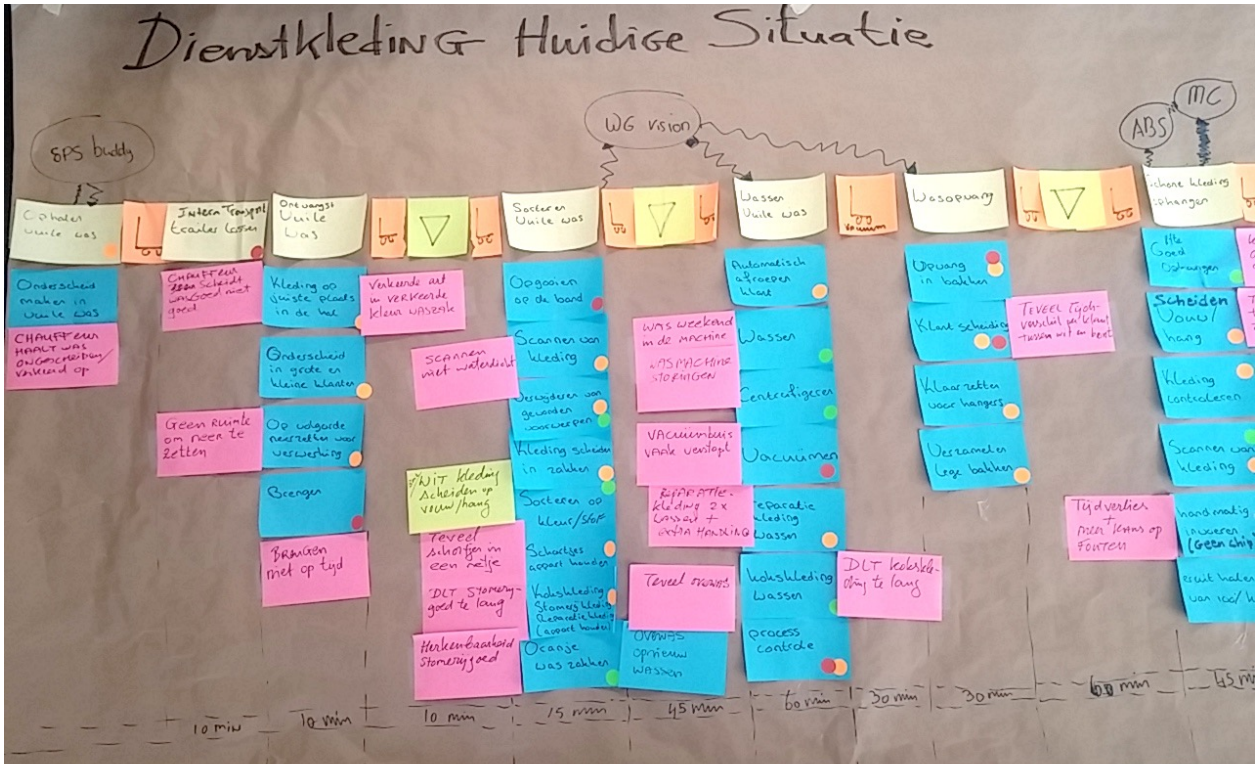




Slimmer werken, blije klanten

Value stream mapping present situation (example)

VSM 2nd lean principle



Value stream mapping present situation (example)

VSM 2nd lean principle

bureau tromp
LEAN & SIX SIGMA



Value Stream Mapping

bureau tromp
LEAN & SIX SIGMA

Characteristics of Value Stream Mapping:

- Use of Post-Its
- It is a group process
- Discussion about the actual process, not on what is written on paper (the hidden factory).
- Visit the workplace to delve into the process
- Have a Muda walk
- Use of stopwatch and counting

The people on the work floor are best able to tell what goes well and what doesn't.

Slimmer werken,
blije klanten

Value Stream Mapping

Making a Value Stream Map

1. Draw the current process
2. Add process data (numbers & stock)
3. Add lead time

The VSM is often the central instrument in a lean project

- Eliminate waste and the ‘ hidden factory’
- Increase quality: Look at waste, and analyse it with the help of Pareto analysis
- Tip: always do a ‘muda walk’ and take photo’s!



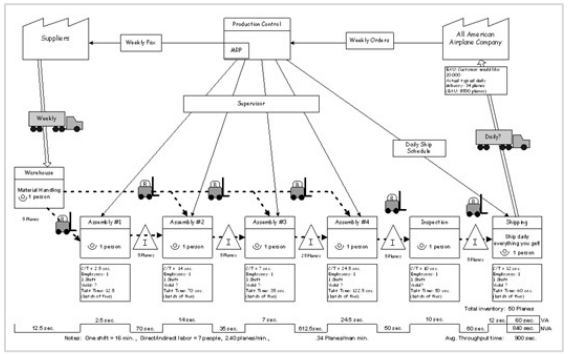
Slimmer werken,
blije klanten

Value Stream Mapping

bureau tromp
LEAN & SIX SIGMA

Checklist value stream mapping:

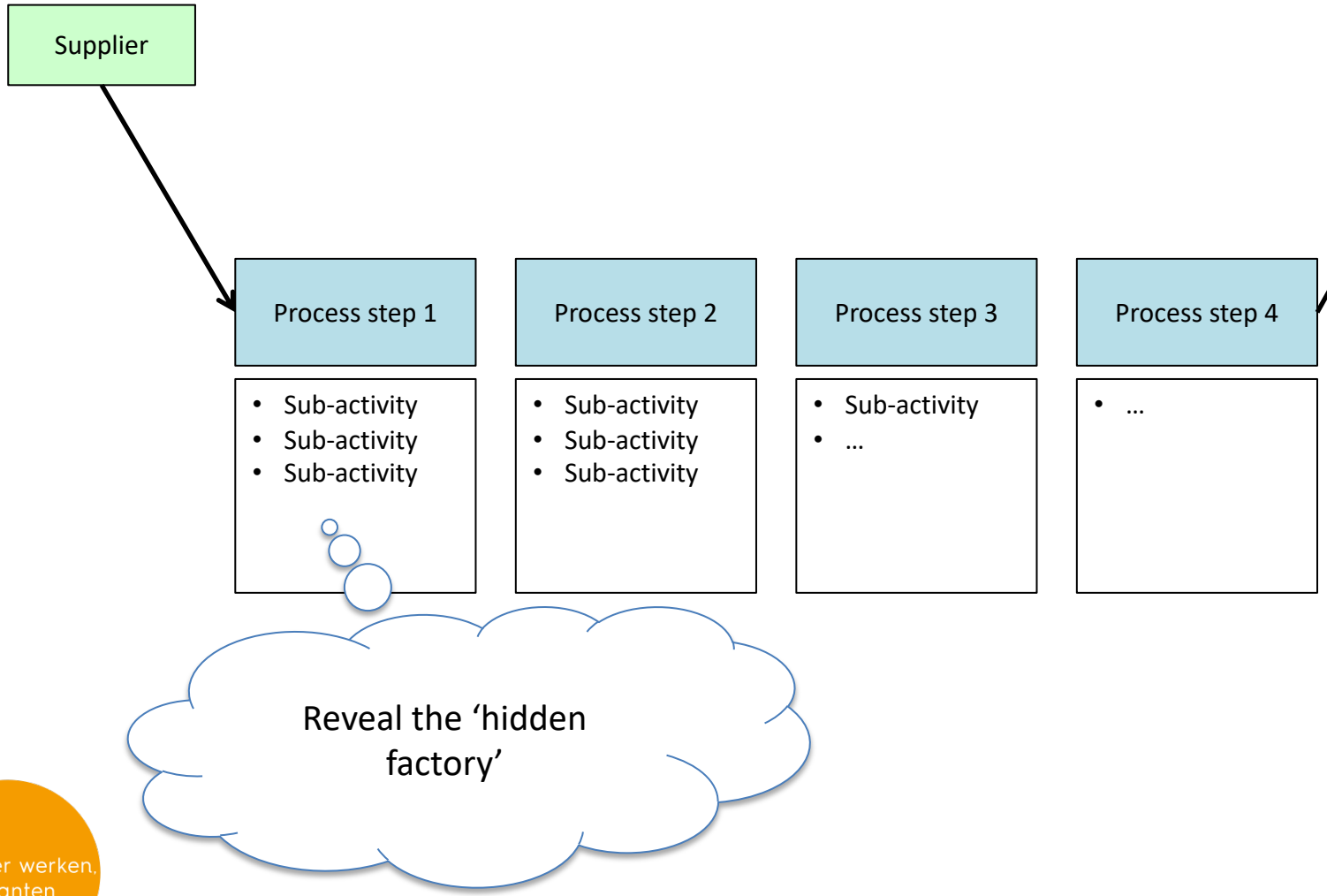
- Step 1: Determine the procesflow to be mapped
- Step 2: Determine the start and end of the process (SIPOC)
- Step 3: Map the main process steps in de middle part of the brown paper and then the activities under each main step
- Step 4: Determine transportation and inventory between the main steps
- Step 5: Determine information flow at the upper side of the brown paper
- Step 6: Add process data (cycle time, # defects, percentages, etc.) below each main processtep
- Step 7: Identify value and waste (CVA, BVA, NVA)
- Step 8: Put leadtime for each step at the bottom side
- Step 9: Name possible bottlenecks and improvements



Go to the gemba to check!

Slimmer werken, blije klanten

1. Map the current process

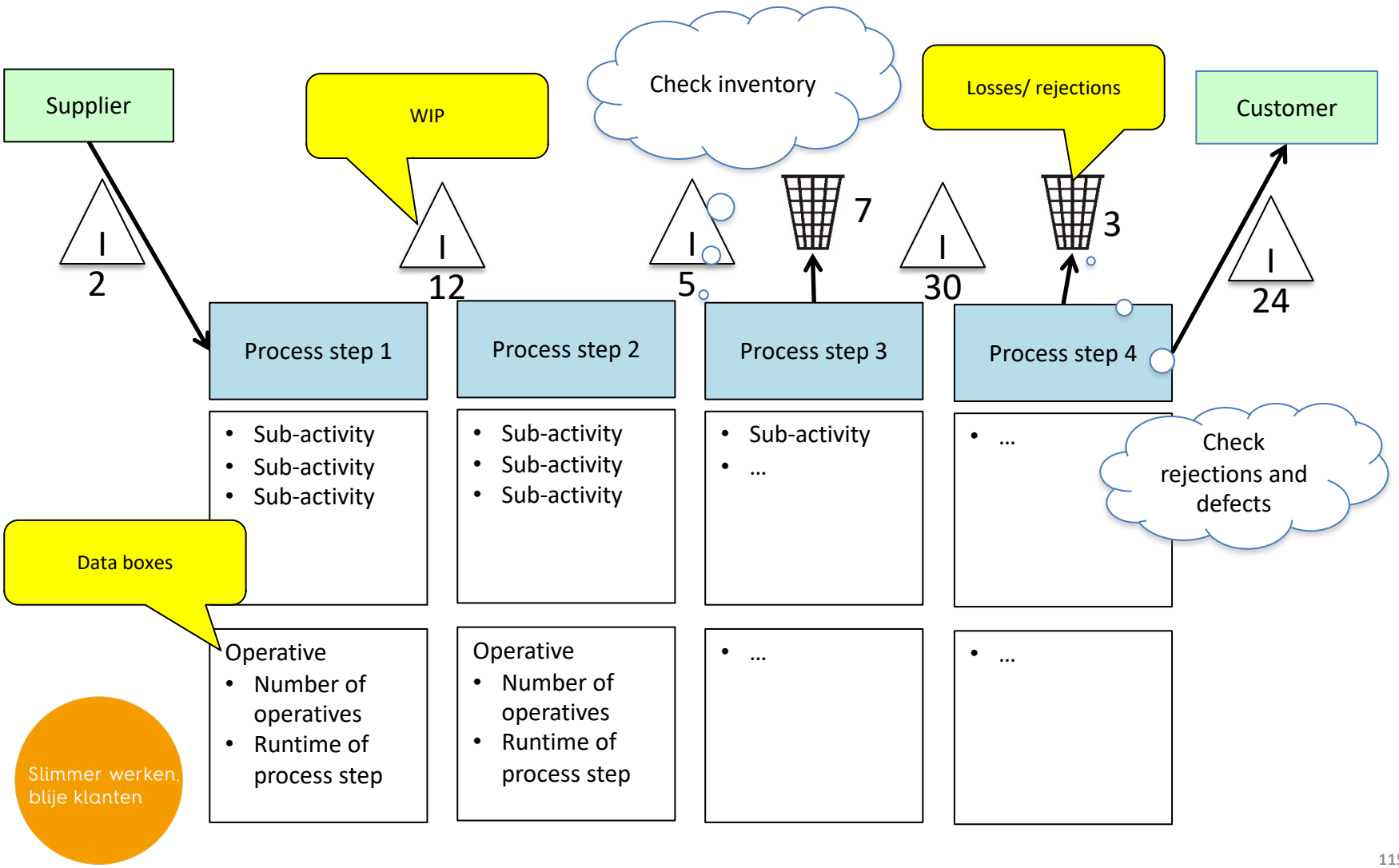


Slimmer werken, blije klanten

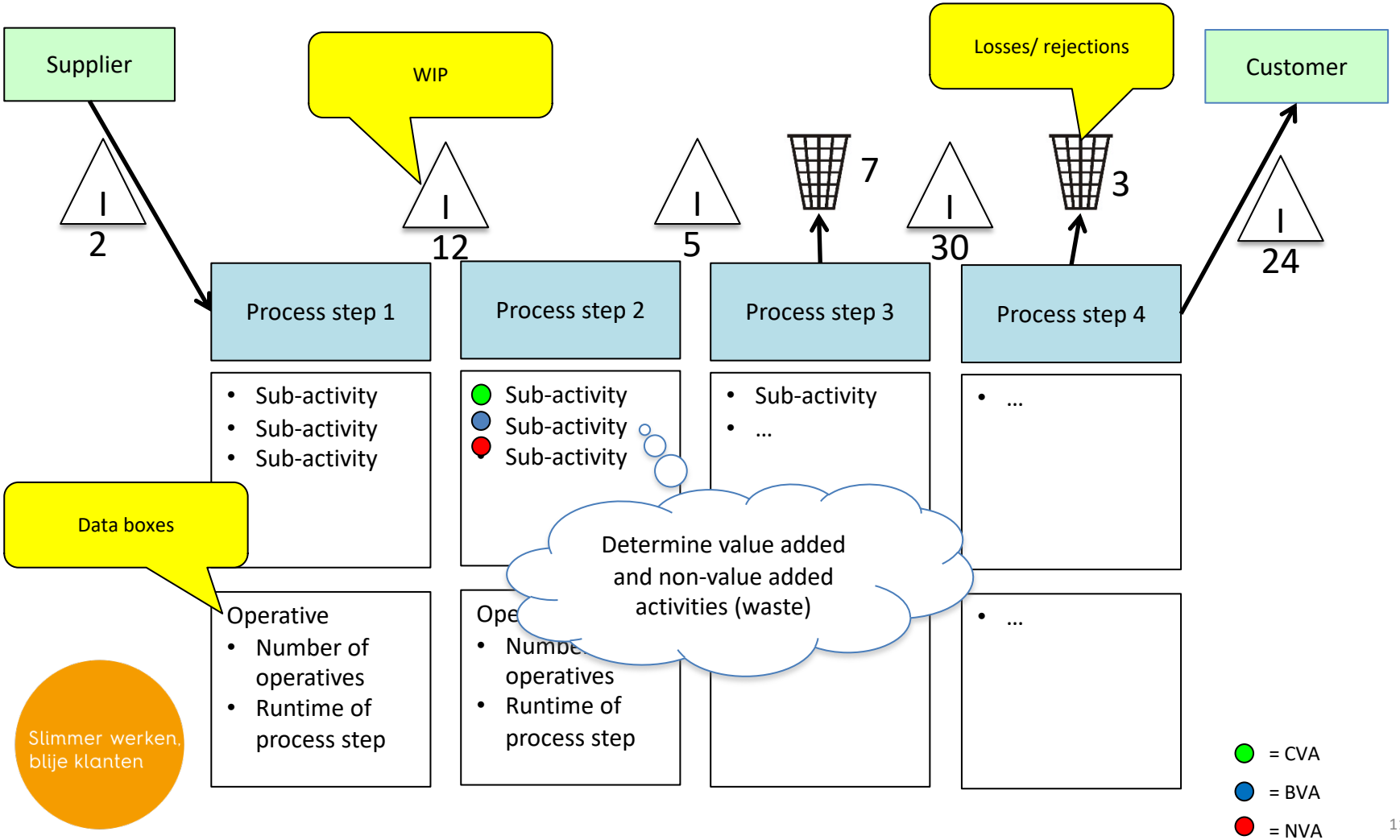
2. Add process data – numbers and defects

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



3. Identify waste



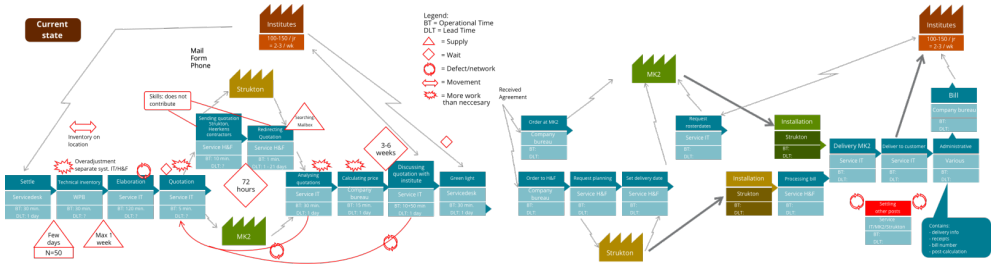
Value Stream Mapping

bureau tromp
LEAN & SIX SIGMA

1

Current situation

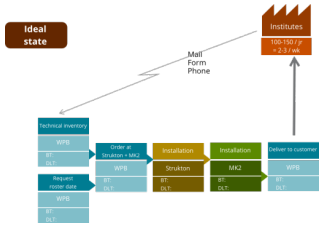
- Current State VSM
- As Is-situation
- IST-situation



2

Ideal situation

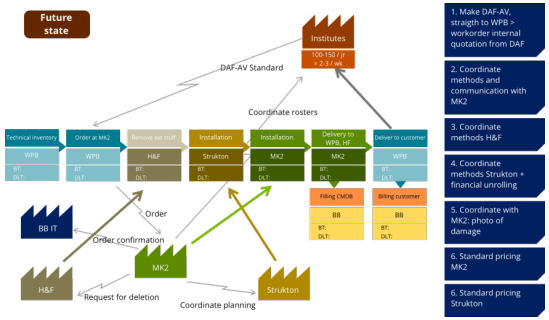
- Ideal State VSM
- Can be filled creatively (Not necessarily a process)



3

Future situation

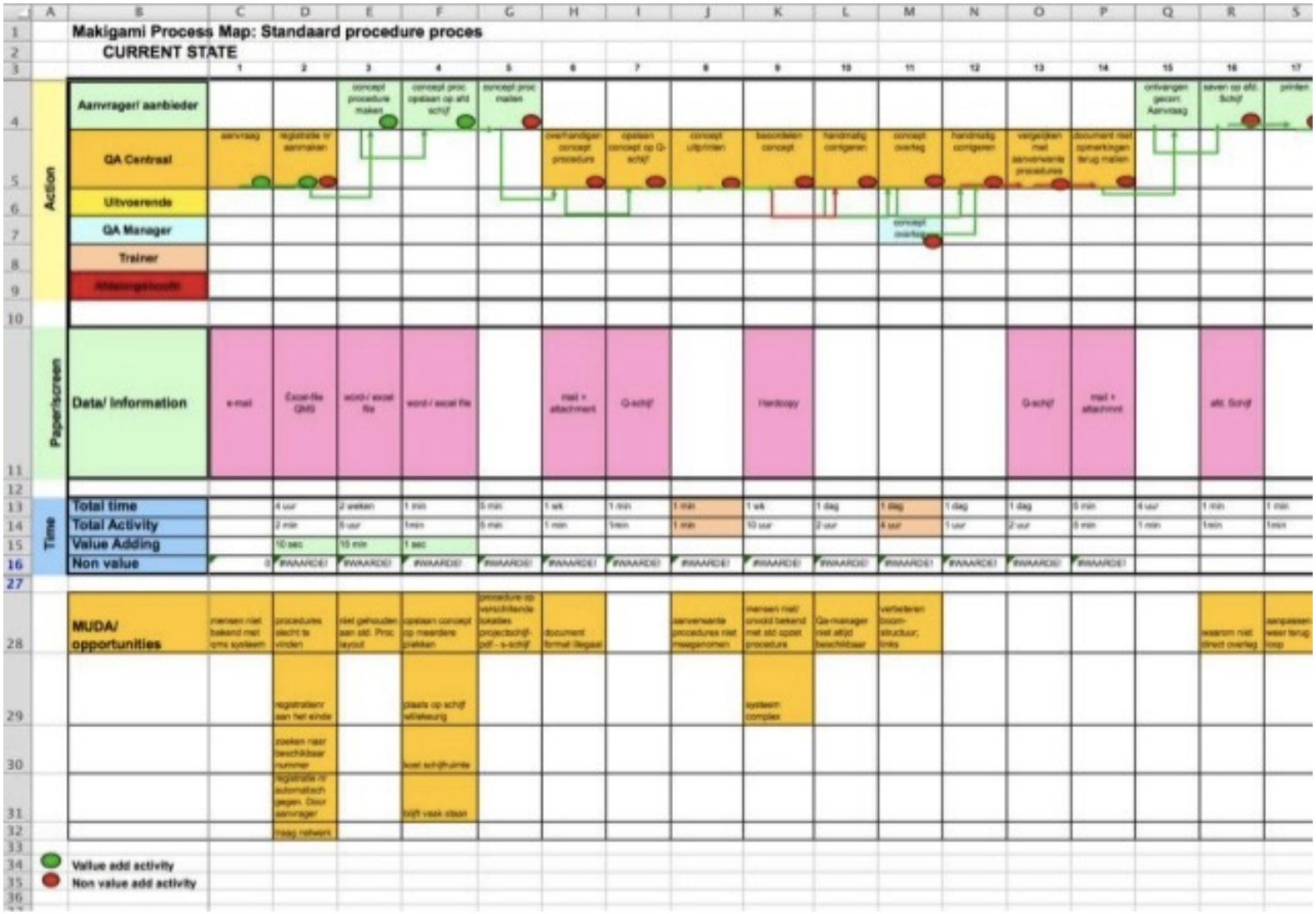
- Future State VSM
- To Be-situation
- SOLL-situation



Slimmer werken, blije klanten

Measure ► Process Mapping

Makigami



Assignment

Work as a group to:

1. Make a VSM of a process
2. Think of a plan for measurement
3. Think of and write down improvements and choose the three best ones

Present to the board. The board takes a decision.
Implement the 3 improvements in the process.



You have 60 – 90 minutes for this assignment

Slimmer werken, blije klanten

Simulation game

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



Slimmer werken,
blije klanten

Assignment

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Get started as a group to:

1. Determine the VOC and the CTQ
2. Make a project charter

- Brainstorm and write improvements on paper. Select the best three.
- Present them to the board. The board will make a decision.
- Adjust max. 3 elements of the process



You have 60 to 90 minutes for this assignment

Slimmer werken, blije klanten

Closing

Next time:

- Six Sigma
  - Basic statistics
  - Measure Fase

- Questions?

Slimmer werken,
blije klanten

bureau tromp

LEAN &
SIX SIGMA

Green Belt training

Lean Six Sigma

Slimmer werken,
blije klanten

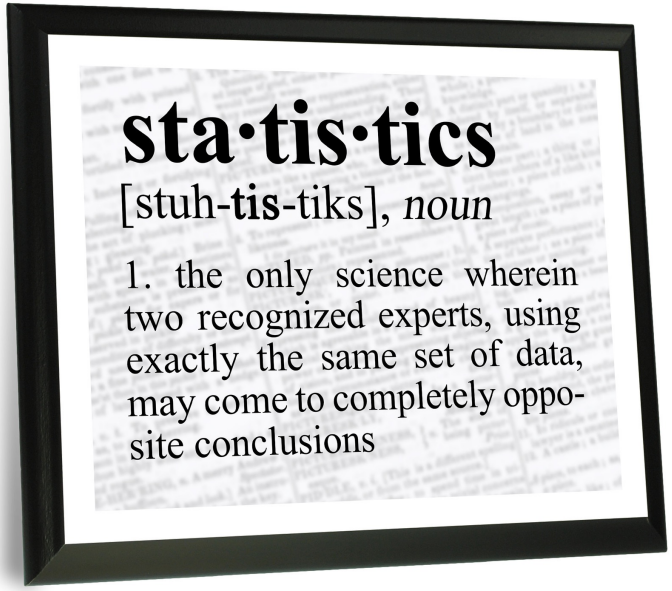
Day 3

Schedule Day 3

- Six Sigma
  - Basic statistics
  - Measure Phase

Slimmer werken,
blije klanten

Basic statistics



Statistics is a tool for **collecting** and **analyzing** data and drawing conclusions based on this.

Slimmer werken, blije klanten

Basic statistics

Statistics are:

- The science that examines the state forces of all kinds of things and maps the results in numbers
- A science, the methodology and the technique of collecting, fabricating, interpreting and presenting data
- A quantitative method for collecting, classifying, presenting and analysing numerical data, and drawing conclusions based on this data
- A current of mathematics that deals with a large number of numerical data to conclude the processes that are behind this data

Why statistics?

- Objective decision making
- More faith in decisions
- Effective communication about decisions



Slimmer werken, blije klanten

Characteristics of a data set

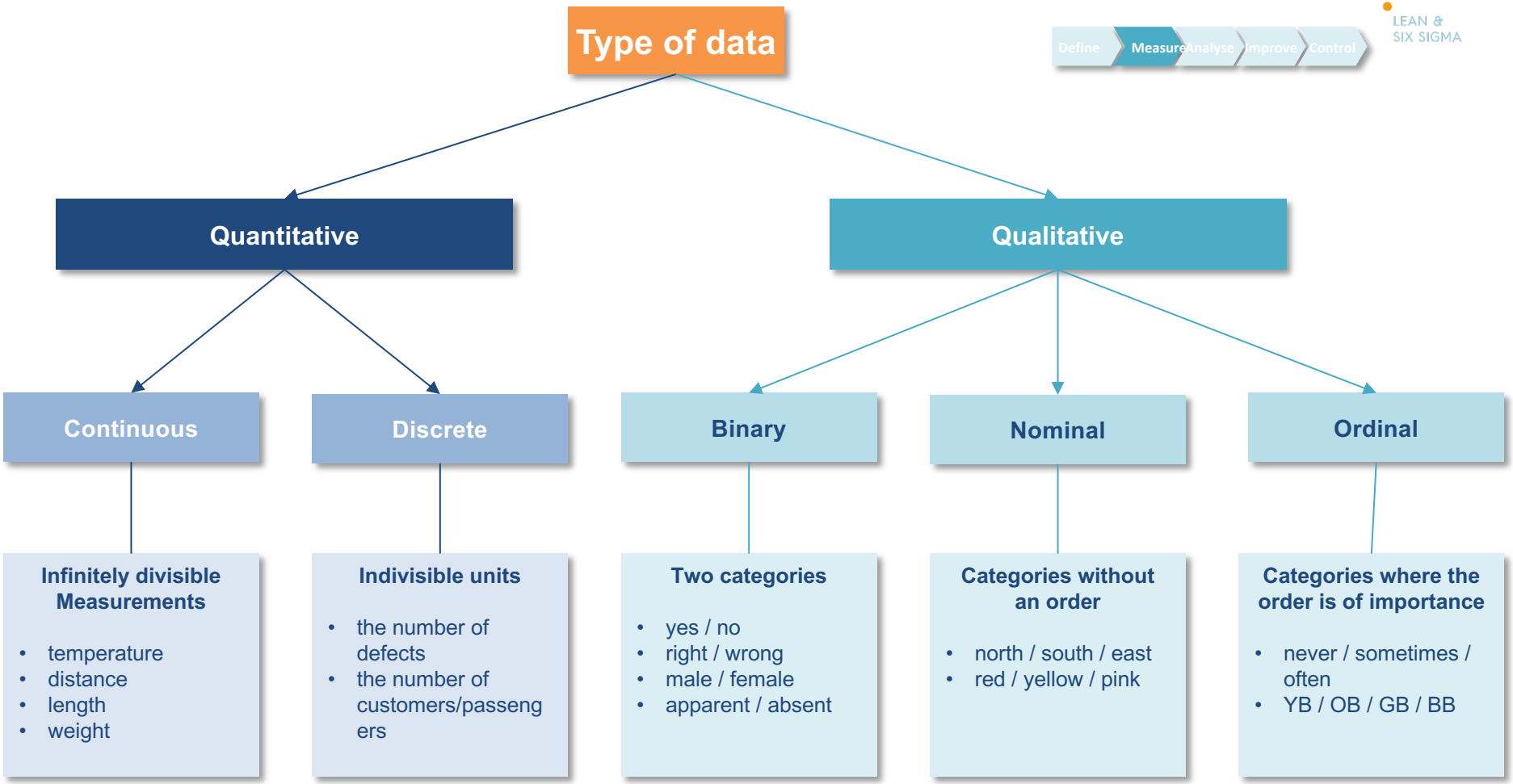
The human brain is unable to interpret large data sets, so we work in a structured way to understand the data.

1. Determine the **type of data**
2. Make a **graphical representation**
3. Determine the **characteristics**

Different types of data

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



Slimmer werken, blije klanten

Type of data

Preferably continuous data!

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Quantitative data:

Continuous data
- Infinitely divisible
- Measures
- Examples: temperature, distance, length, weight

Discrete data
- Indivisible units (not <1)
- Numbers
- Example: the number of defects

Qualitative (attribute) data

Ordinal data
- Has a particular sequence
- Example: always, mostly, sometimes, rarely, never

Nominal data
- Random categories
- Example: north/east/south

Binary data
- Two categories
- Example: yes/no, good/wrong



The type of data determines which analysis you will be doing later

Slimmer werken, blije klanten

Characteristics of a data set

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

The human brain is unable to interpret large data sets, so we work in a structured way to understand the data.

1. Determine the **type of data**
2. Make a **graphical representation**
3. Determine the **characteristics**

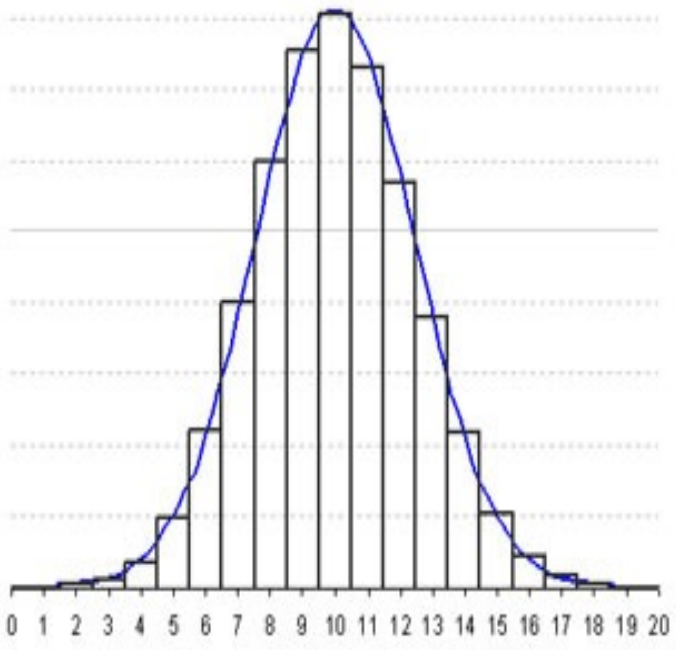
Slimmer werken, blije klanten

Distribution of data

Central tendency and variation tell something about the distribution of the data:

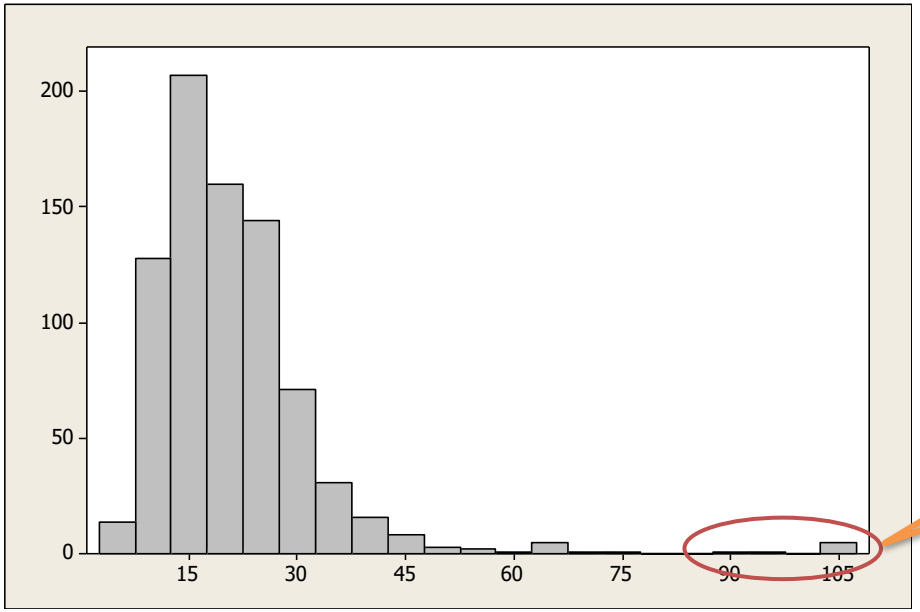
- What is the central point of the data?
- What is the range of distribution?

The distribution displays the distribution of value counts in the data set. The peak is the central tendency, the width indicates the range of the variation.



Histogram

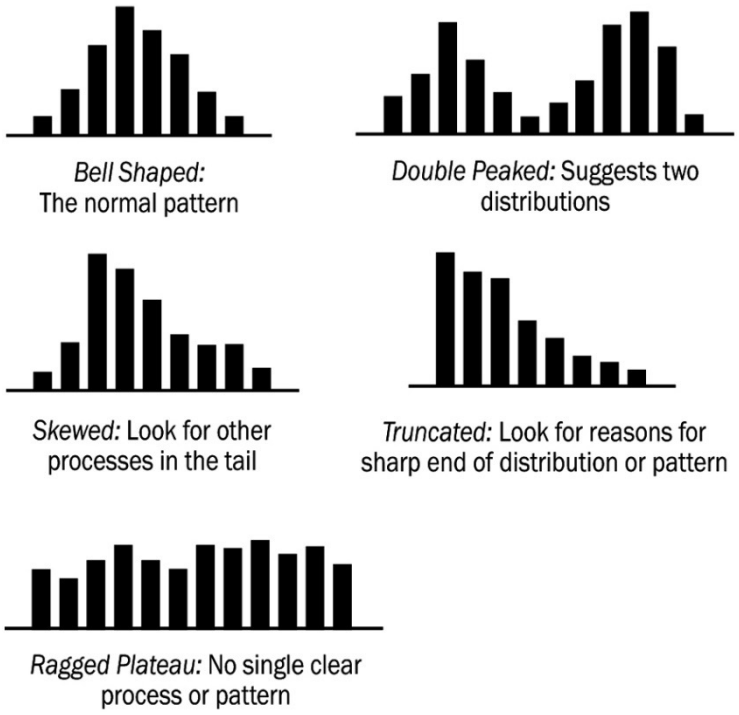
- Most used way to graphically display the frequency distribution and distribution of continuous data.
- Data are grouped into classes (usually of equal intervals).
- The height of a vertical bar represents the frequency per interval.

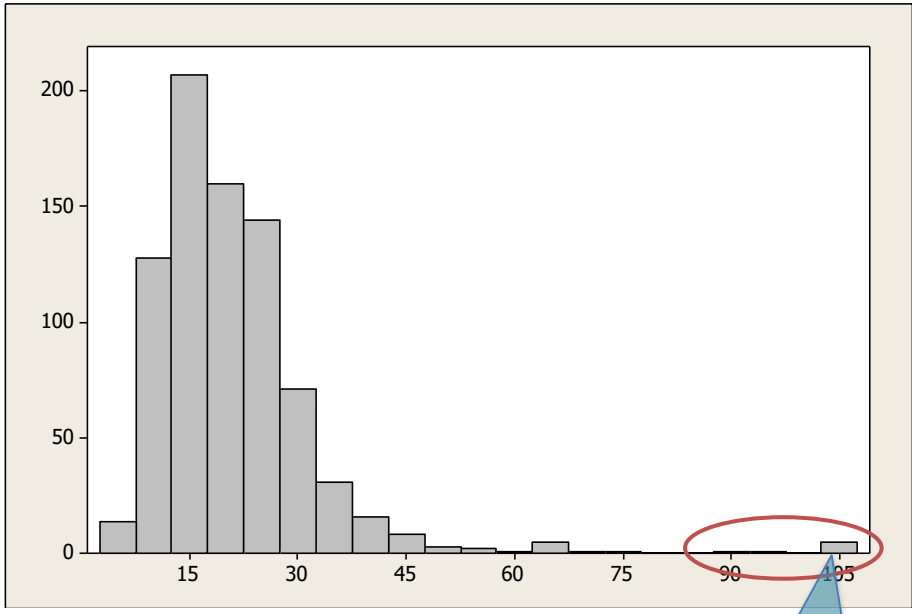


Outliers: Values that stand out in the data set and who don't seem to fit in the graph

Slimmer werken, blije klanten

Interpret a Histogram





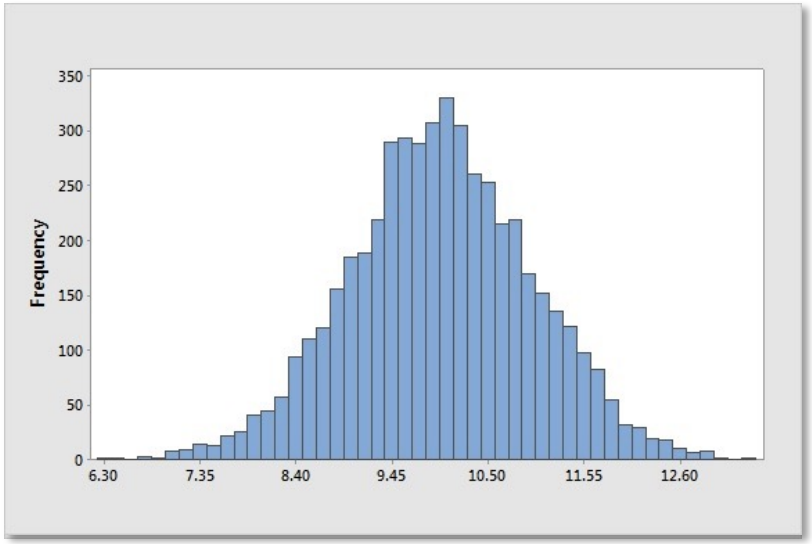
Outliers: values that stand out, they don't seem to be in line with the rest

Slimmer werken, blije klanten

Interpret a histogram

Bell shaped histogram

- Symmetrical pattern
- Data clustered around the center
- Does not mean that it is a normal distribution!
- Example: IQ Dutch population

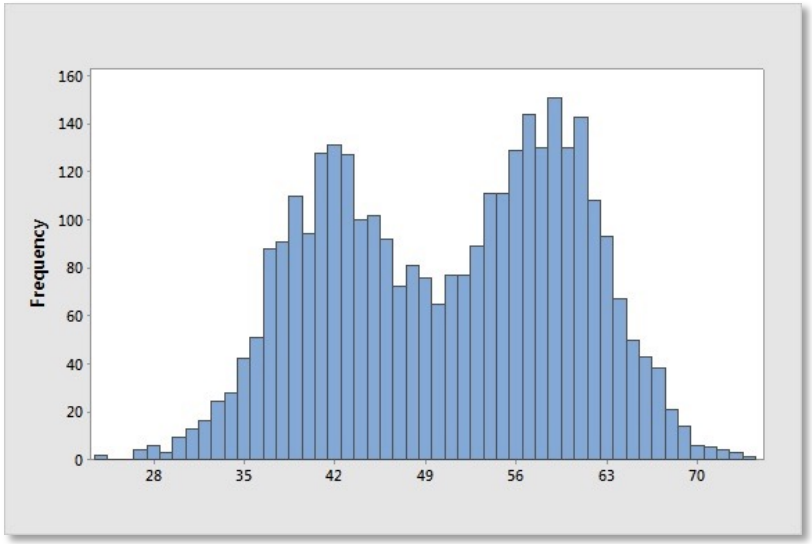


Slimmer werken,
blije klanten

Histogram interpreteren

Bimodal (double peaked) histogram

- Data is centered around two peaks.
- Suggests two distributions: analyze whether you are looking at two groups.
- Examples:
  - Callers per hour at a callcenter (collapses during lunch)
  - Length of adults in the Netherlands
    (peak among women is lower than peak of men).



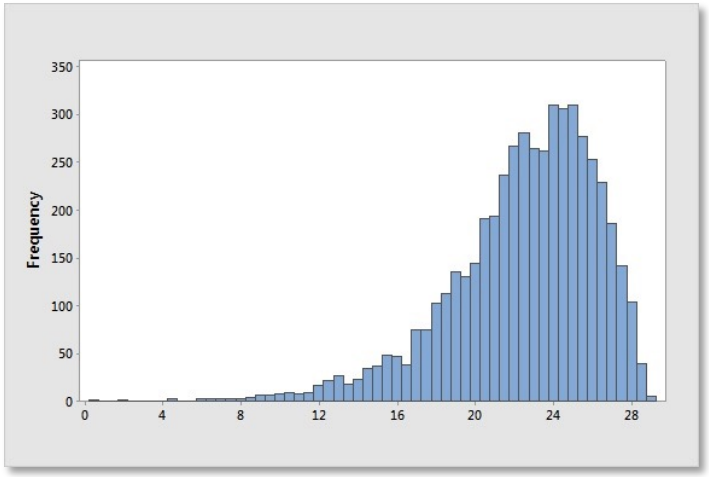
Histogram interpreteren

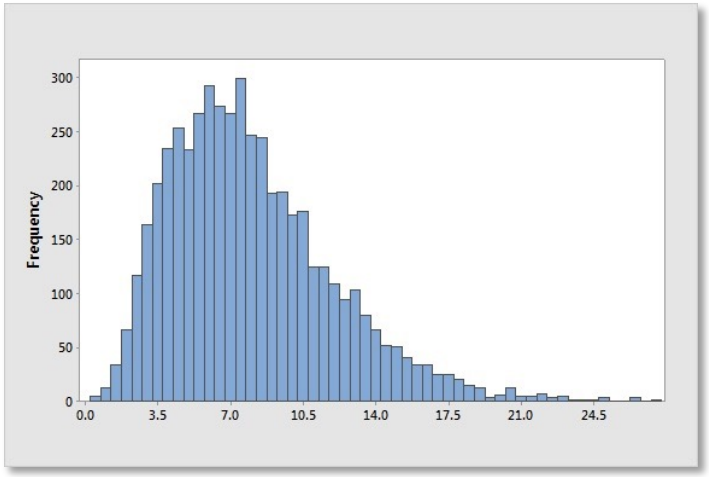
Skewed (left or right) histogram

- Data clustered around a high (Left Skewed) or low (Right Skewed) value. The frequency decreases as the value becomes smaller (LS) or larger (RS). The "tail" determines the name!
- Natural limits prevent higher (LS) or lower (RS) value

- Example:

  - Left Skewed: Results LSS Green Belt exam (max. 100%)
  - Right Skewed: Size of holes during the filter game (min. 1 mm)



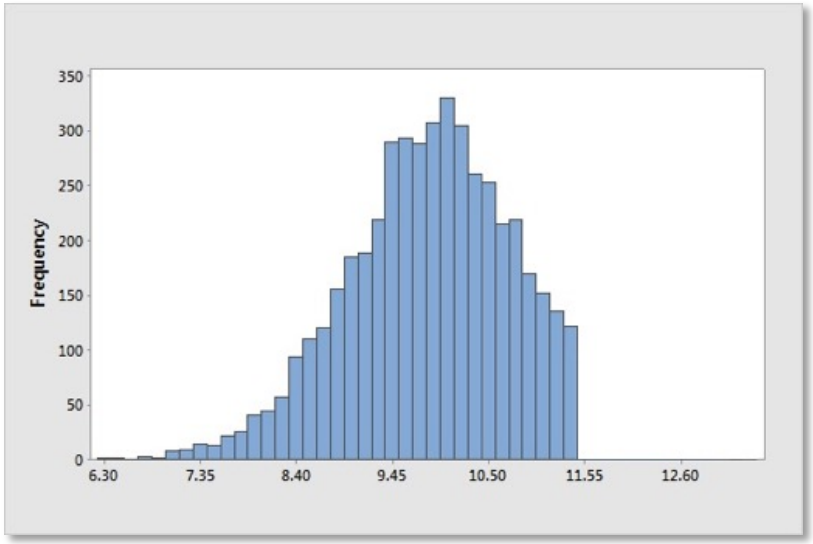


Slimmer werken,
blije klanten

Histogram interpreteren

Truncated histogram

- Distribution whose tail is "clipped"
- Check if there are reasons for the abrupt ending
- Example: filters with a hole larger than the USL are removed from the process by the quality controller



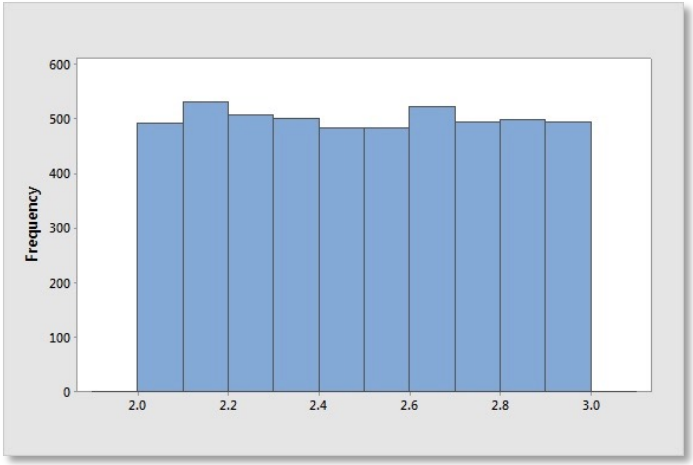
Slimmer werken,
blije klanten

Histogram interpreteren

Ragged plateau (uniform) histogram

- Ragged plateau (uniform) histogram
- No pattern, about the same frequency per interval
- Possible causes:
- Combination of multiple factors for variation that can influence each other (interaction): analyze them separately (Two-way ANOVA)
- Number of classes is too small: try different grouping

- Example:
- Interaction: exam grades compared to IQ (check for the number of study hours)
- No interaction: number of winning tickets per final number, throwing results 150 times with a die



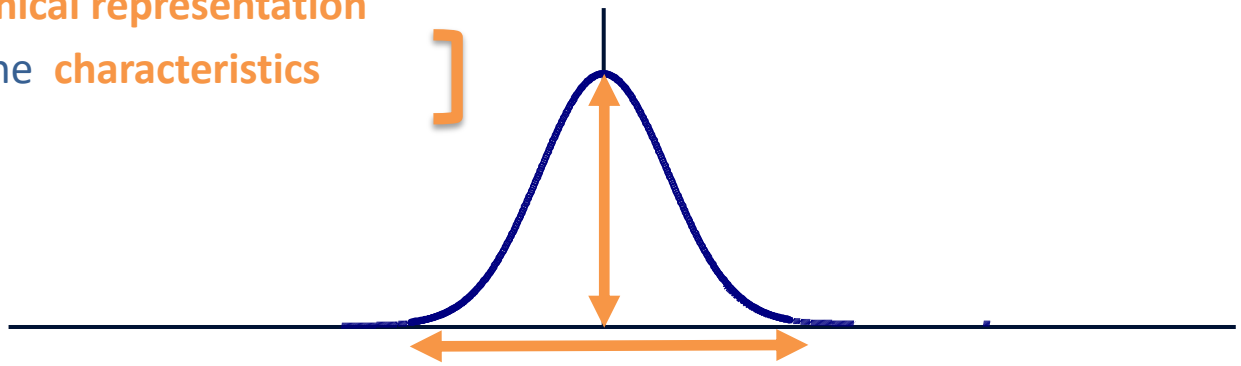
Characteristics of a data set

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

The human brain is unable to interpret large data sets, so we work in a structured way to understand the data.

1. Determine the **type of data**
2. Make a **graphical representation**
3. Determine the **characteristics**



Components that characterize the nature of the dataset:

1.	Average	**Centrale trend**
2.	Spread	**Variation**

Slimmer werken, blije klanten

Basis statistiek

bureau tromp
LEAN & SIX SIGMA

1. Central tendency

The middle of the process: where do we expect the most measurement points?

2. Variation

The spread of the process: the less spread, the more consistent and therefore more predictable the process

1. Mean
2. Median
3. Mode

Central tendency

measurements for the location

4. Range
5. Variance
6. Standard deviation

Variation

measurements for the changeability

Slimmer werken,
blije klanten

Mean

Mean: the result of adding up all the numbers and dividing this by the number of measures.

31 29 39 44 39 35 40 52 43 44

Total = 396 n = 10

Mean = total / n = 39,6

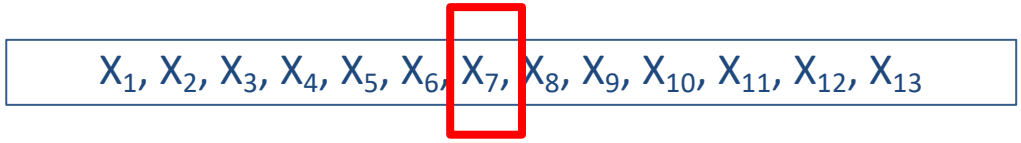
$\bar{x}$ = mean of the sample
μ = mean of the population

- Extreme values (outliers) influence the mean. Therefore, the use of the mean is only suitable when there are no outliers in the data set.

Slimmer werken, blije klanten

Median

Central value of a data-set



- Less sensitive to "outliers" than average
- Often used for non-normal data
- With an even number of observations often the average of the middle two.
- Place the observations in ascending or descending order.

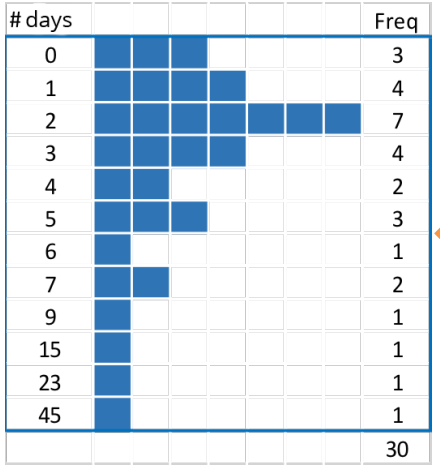
Mode

The mode is the most common value

29 31 35 39 38 40 43 44 44 52

Mode is 44

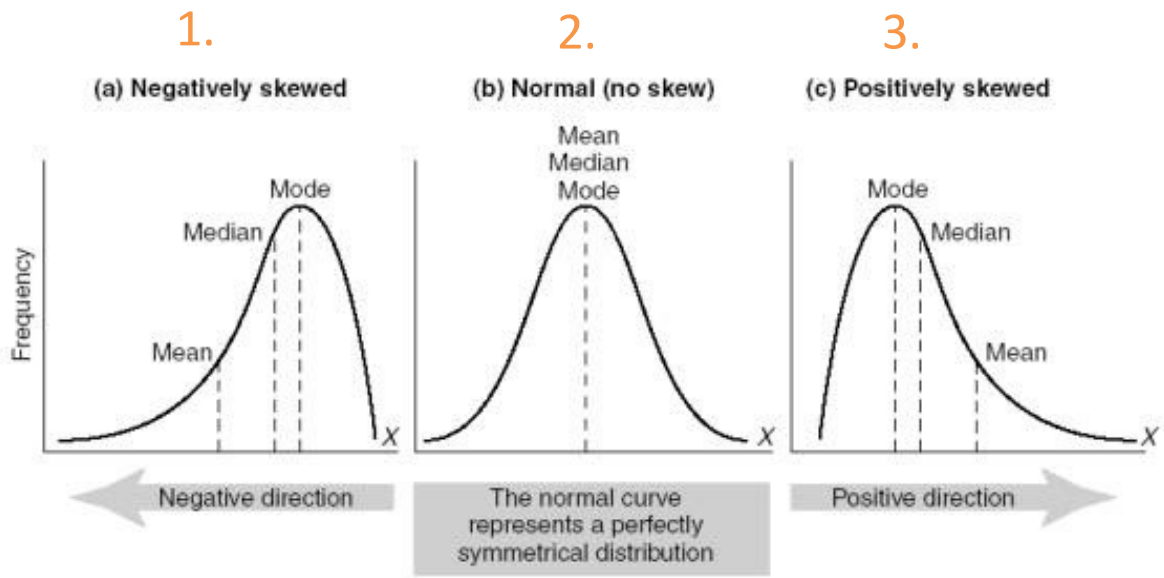
- Mode is only suitable as a measure for central value when observations lie ‘perfectly around’ the central observation.



Most common value is 2

Slimmer werken, blije klanten

Distribution of data



1. Negative skew distribution: **Mean < Median < Mode**
2. Normal frequency distribution: **Mean = Median = Mode**
3. Positive skew distribution: **Mean > Median > Mode**

Slimmer werken, blije klanten

Range

The range is the distance between the highest and the lowest measure of a data set



- Highest level – lowest level = (72 – 15) = 57
- Easy to calculate, but sensitive to extreme values (‘outliers’)

Slimmer werken, blije klanten

Mean absolute deviation

# Calls	Mean	Absolute deviation
15	39,9286	24,9286
15	39,9286	24,9286
24	39,9286	15,9286
30	39,9286	9,9286
35	39,9286	4,9286
40	39,9286	0,0714
40	39,9286	0,0714
40	39,9286	0,0714
40	39,9286	0,0714
48	39,9286	8,0714
50	39,9286	10,0714
54	39,9286	14,0714
56	39,9286	16,0714
72	39,9286	32,0714
Mean deviation:		11,5204

1. Determine the mean of the dataset

2. Calculate the absolute deviation by determining the difference of each measure from the mean

3. Calculate the mean deviation from all deviations

"The service desk receives between 15 and 72 phone calls every day"

Slimmer werken, blije klanten

Variance

The symbol of variance is displayed as σ^2

# Calls	mean	Absolute deviation		Variance
15	39,9286	24,9286		621,4337
15	39,9286	24,9286		621,4337
24	39,9286	15,9286		253,7194
30	39,9286	9,9286		98,5765
35	39,9286	4,9286		24,2908
40	39,9286	0,0714		0,0051
40	39,9286	0,0714		0,0051
40	39,9286	0,0714		0,0051
40	39,9286	0,0714		0,0051
48	39,9286	8,0714		65,1480
50	39,9286	10,0714		101,4337
54	39,9286	14,0714		198,0051
56	39,9286	16,0714		258,2908
72	39,9286	32,0714		1028,5765
Mean deviation :		11,5204		233,6378

1. Four-square every deviation

2. Add all four-squares

3. Calculate the mean of all values

$$\sigma^2 = \frac{\sum (x_r - \overline{x})^2}{n}$$

"Variance shows the degree of range, but is squared: (phone calls per day)^2"

Slimmer werken, blije klanten

Standard deviation

Mostly used to indicate variation

# Calls	Gemiddelde	Absolute afwijking	Variantie
15	39,9286	24,9286	621,4337
15	39,9286	24,9286	621,4337
24	39,9286	15,9286	253,7194
30	39,9286	9,9286	98,5765
35	39,9286	4,9286	24,2908
40	39,9286	0,0714	0,0051
40	39,9286	0,0714	0,0051
40	39,9286	0,0714	0,0051
40	39,9286	0,0714	0,0051
48	39,9286	8,0714	65,1480
50	39,9286	10,0714	101,4337
54	39,9286	14,0714	198,0051
56	39,9286	16,0714	258,2908
72	39,9286	32,0714	1028,5765
Gemiddelde afwijking:		11,5204	233,6378

$$\sigma = \sqrt{\frac{\sum(x - \overline{x})^2}{N}}$$

if: $\sigma^2 = 233.6378$
than: $\sigma = 15,2852$

"The servicedesk receives, on average, 40 phone calls a day with a standard deviation of 15 phone calls"

Slimmer werken, blije klanten

Standard deviation

The broader the distribution…

the higher the standard deviation and the range values.

The smaller the distribution…

the smaller the standard deviation and the range values.

If all values are equal to zero…

the standard deviation and range also equal zero.

Standard deviation and range are always **bigger** or **equal** to zero.

Slimmer werken,
blije klanten

Different normal distributions

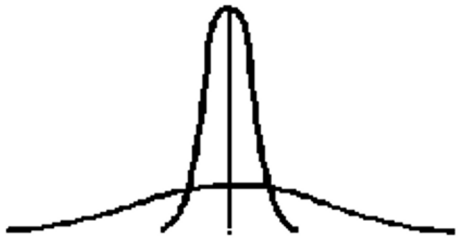
Different mean

Same standard deviation



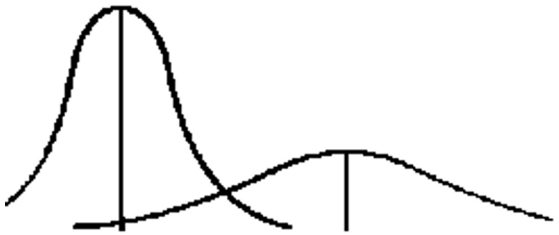
Same mean

Different standard deviation



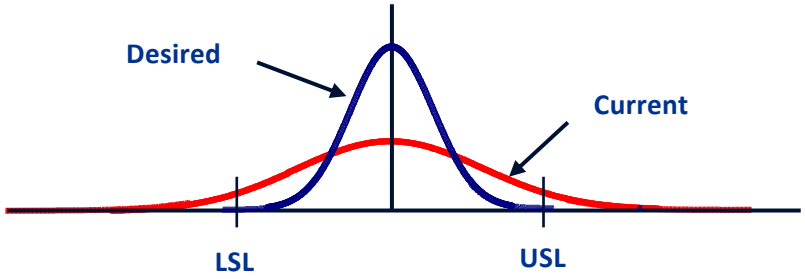
Different mean

Different standard deviation



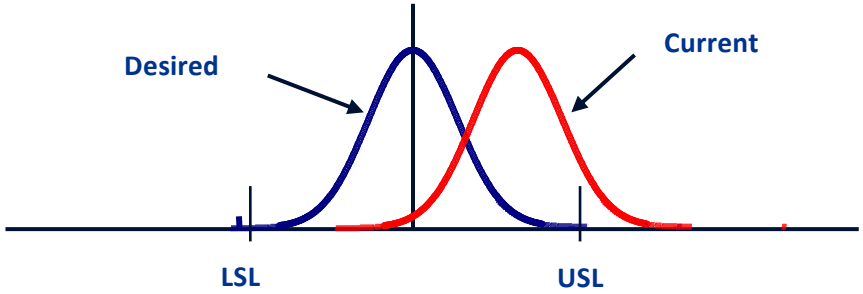
Slimmer werken,
blije klanten

No quality without consistency



Accuracy

- The ability to stay on target, represented by the mean
- This proces is accurate, but not precise.
- The problem is **range.**

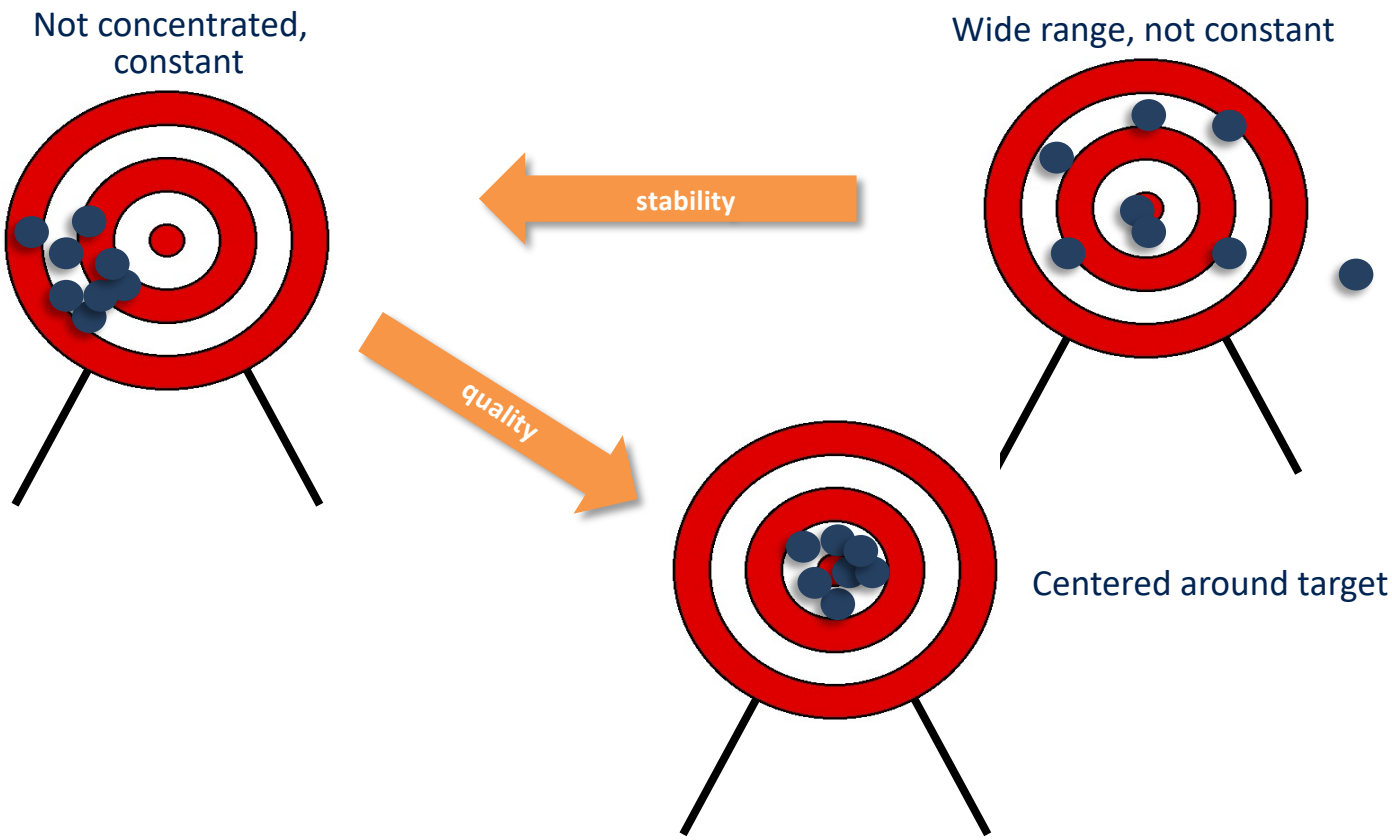


Quality

- Consistency of a process, represented by standard deviation.
- This process is precise, but not accurate.
- The problem is **location.**

Slimmer werken,
blije klanten

No quality without consistency



Slimmer werken, blije klanten

Six Sigma structure | MEASURE

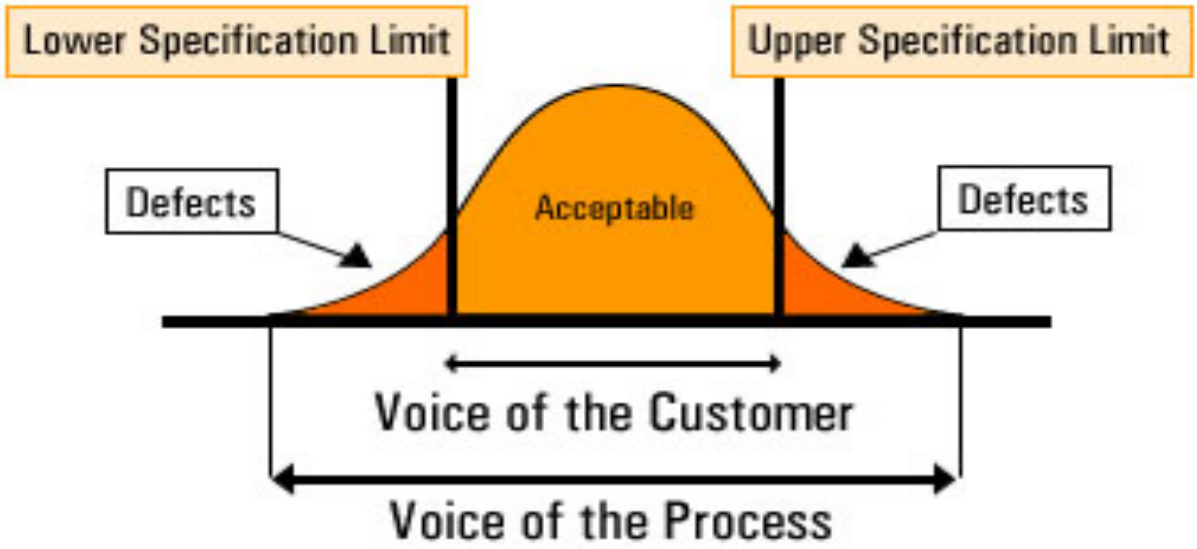


Result:

- Process performance (yield)
- Measurement plan

Slimmer werken, blije klanten

Repetition day 1: Measuring Quality

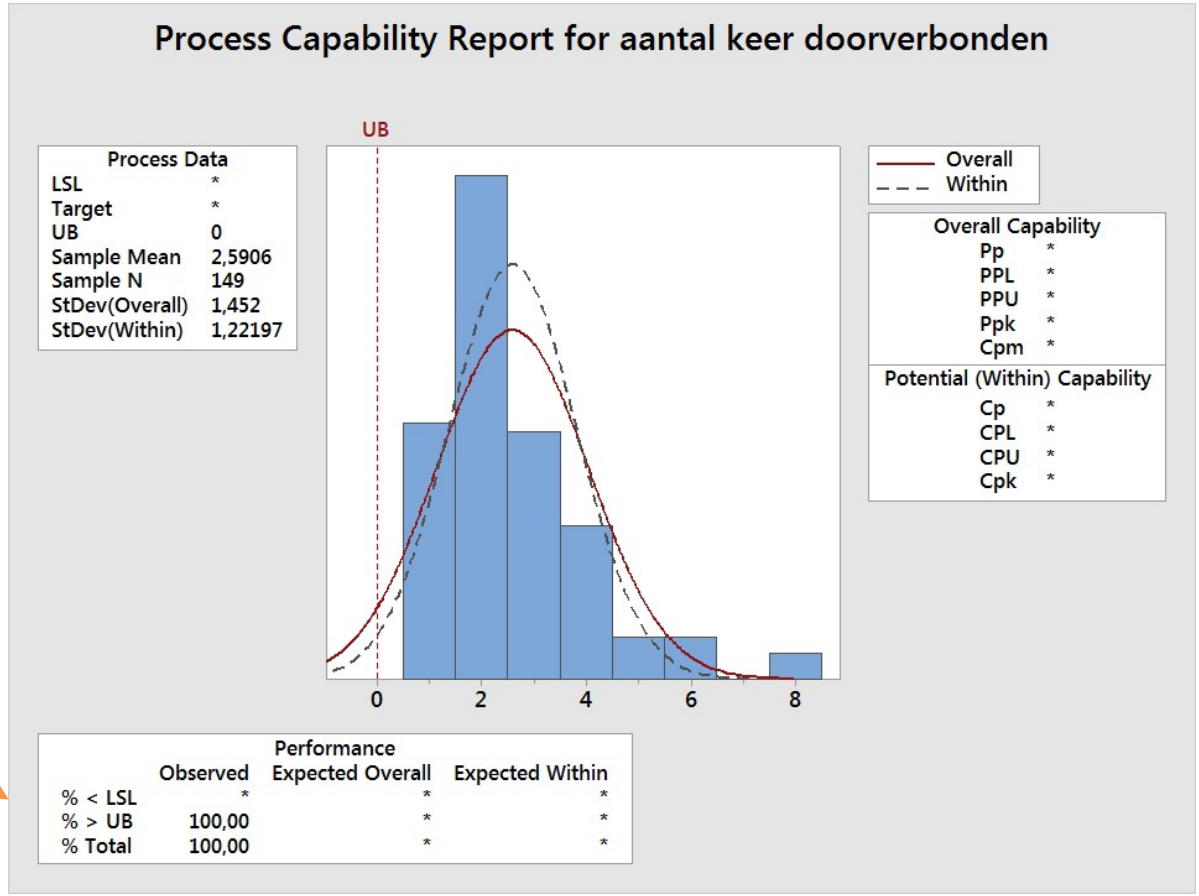


Slimmer werken,
blije klanten

Process performance

What is the process performance according to the customer's wishes? We can determine this in Minitab.

How big is my 'problem'?



Slimmer werken, blije klanten

Quality indicators

- There are three important quality indicators within Lean Six Sigma:
  - DPMO - Defects Per Milion Opportunities
  - PPM - Parts Per Million
  - DPU - Defects Per Units

- Altogether, these three quality indicators give an idea of how well the process is performing. Therefore, it is recommended to calculate and use all three numbers.

bureau tromp
LEAN & SIX SIGMA
Slimmer werken, blije klanten

DPMO

Stands for Defects Per Million Opportunities

Used in the Measure, Analyze, Improve and Control phase.

Purpose: To draw attention to reducing the number of errors

1. Define the produced product
2. Determine what error options are
3. Determine what is right/wrong
4. Record the number of inspected parts and count the errors
5. Calculate DPMO:

DPMO = Number of defects / (Number of units produced * Number of error options) * 1,000,000

Example:

Number of parts produced	N	80
Number of errors (including corrected)	D	108
Number of error options	O	4

DPMO = 108/(80*4) * 1.000.000 = 337.500

Slimmer werken, blije klanten

PPM

Stands for Parts Per Milion

Used in the Measure, Analyze, Improve and Control phase

Purpose: Draw attention to the customer perspective. A product with one or more errors is just as worthless to the customer, so a defect

1. Determine the errors that, if they occur, make the product worthless to customers
2. Record the number of products inspected
3. Count the defective products
4. Calculate the PPM value

PPM = number of defect units/ total number of units* 1.000.000

Example:

Number of defect units	63
Total number of units	80

PPM = 63/80* 1.000.000 = 787.500

You can also see the PPM in Minitab at the Process Capability

Slimmer werken, blije klanten

DPU

Stands for Defects per unit

Used in the Measure, Analyze, Improve and Control phase

Purpose: To determine the average number of defects per unit

1. Define the defect (any chance of a defect that appears in a unit is a defect)
2. Determine the number of units checked
3. Count the defects
4. Calculate the DPU

DPU = total number of defects / total number of units

Example

Total number of defects:	108
Total number of actions / units:	80

DPU = 108/80 = 1,35

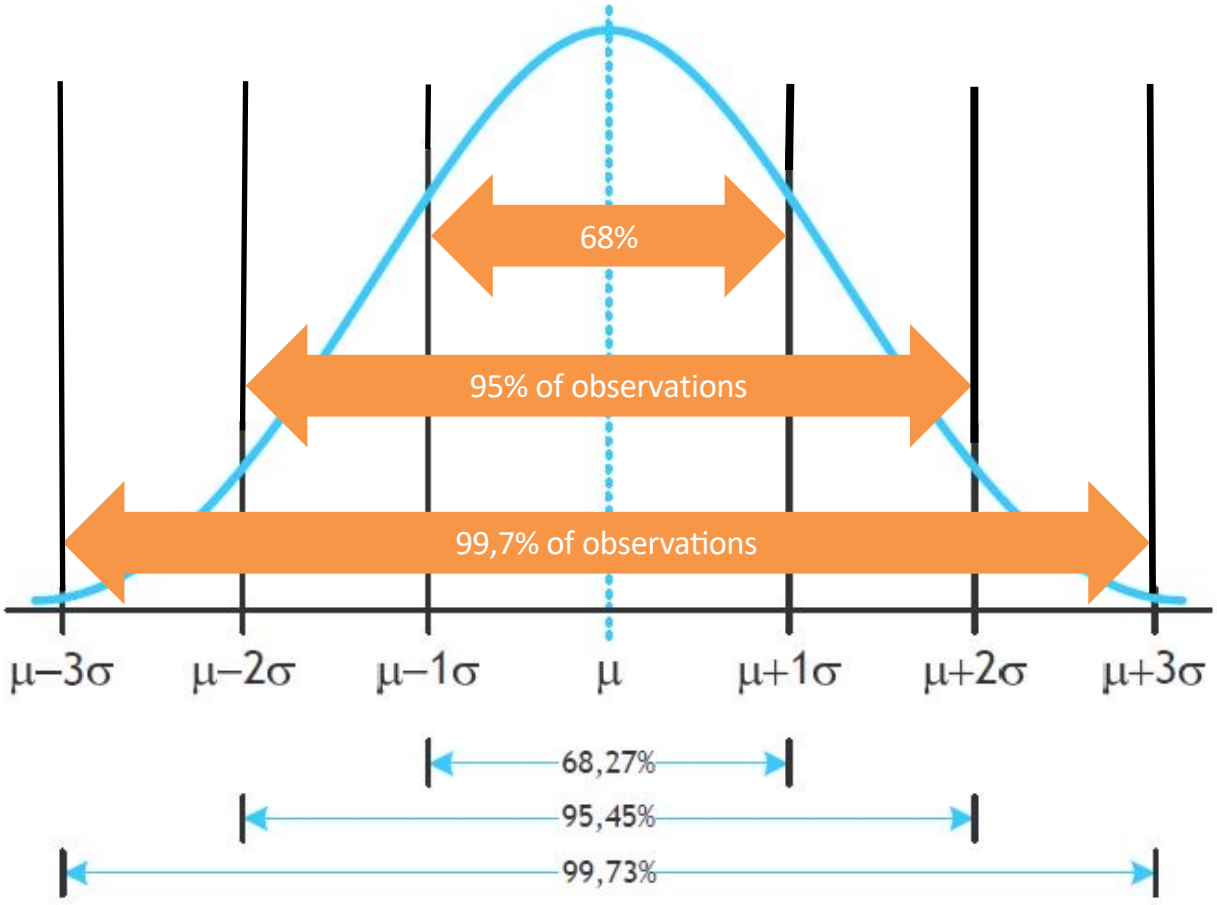
This means: on average a produced part contains 1.35 defects

Slimmer werken,
blije klanten

Quality = Yield

bureau tromp
LEAN & SIX SIGMA

% Observations

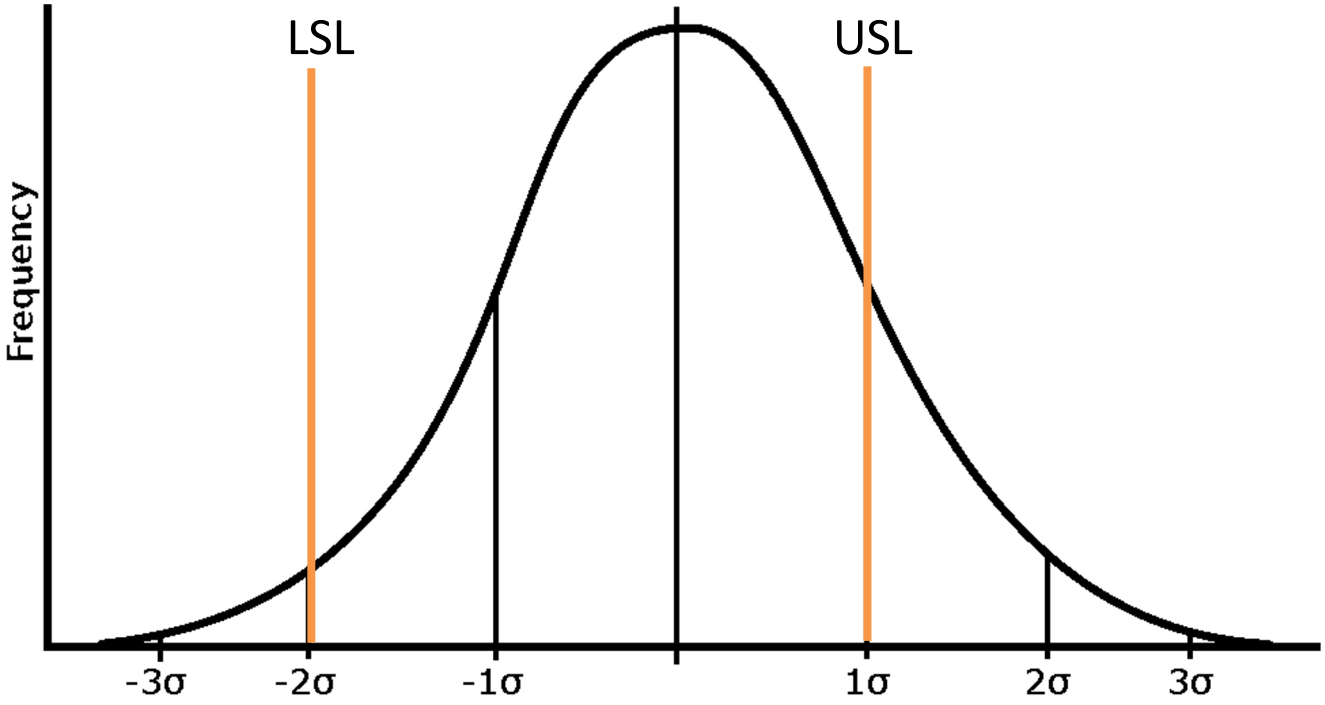


Slimmer werken,
blije klanten

Exercise: Yield

Question:

What percentage of the observations in the graphic below fall within the specification limitations?

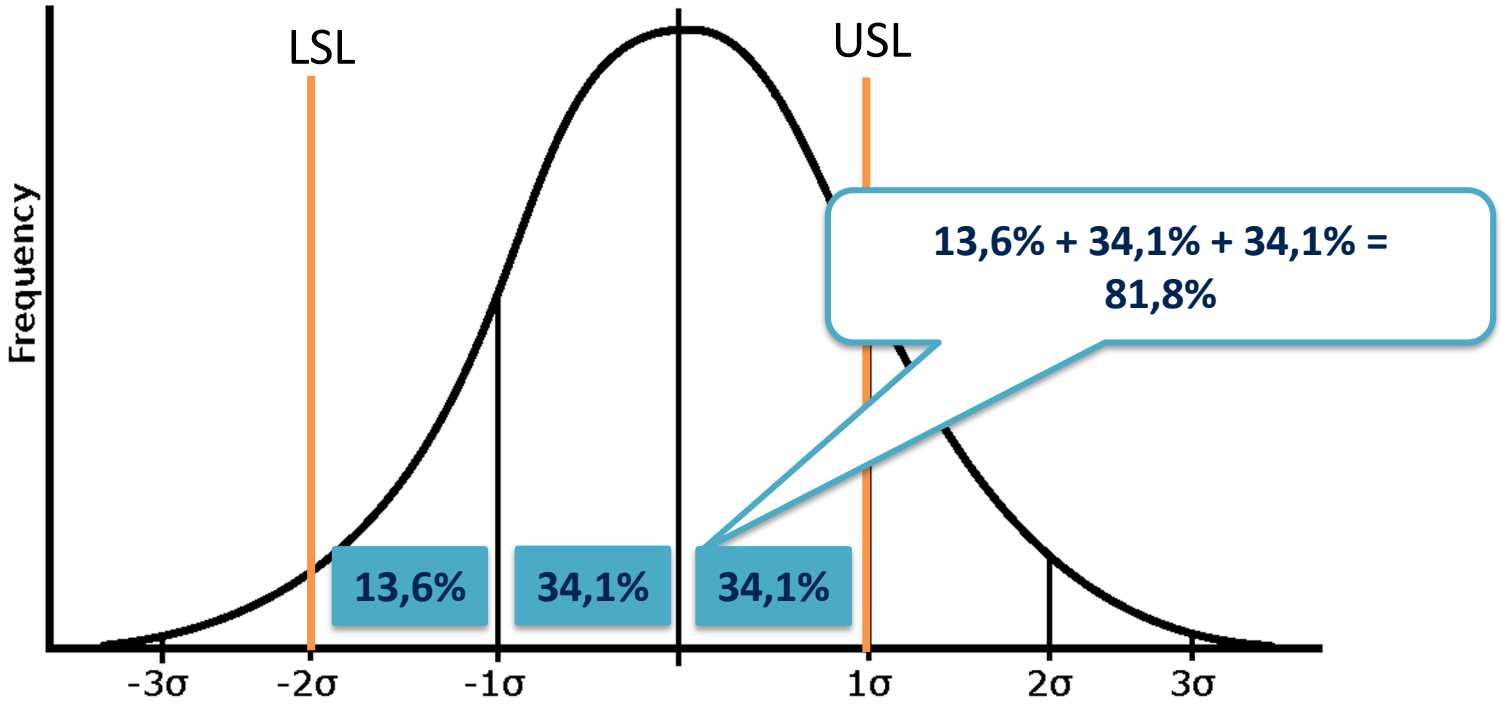


Slimmer werken,
blije klanten

Solution: Yield

Question:

What percentage of the observations in the graphic below fall within the specification limitations?

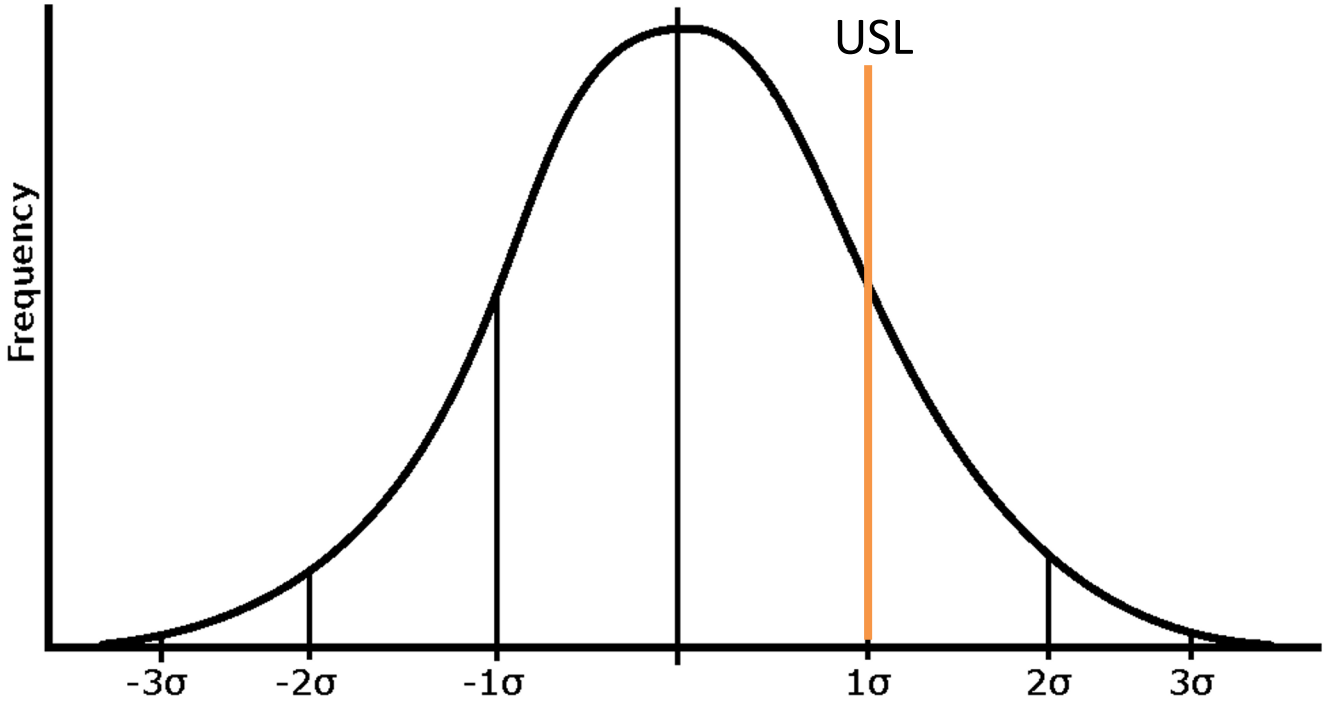


Slimmer werken, blije klanten

Exercise: Yield

Question:

What percentage of the observations in the graphic below fall within the specification limitations?

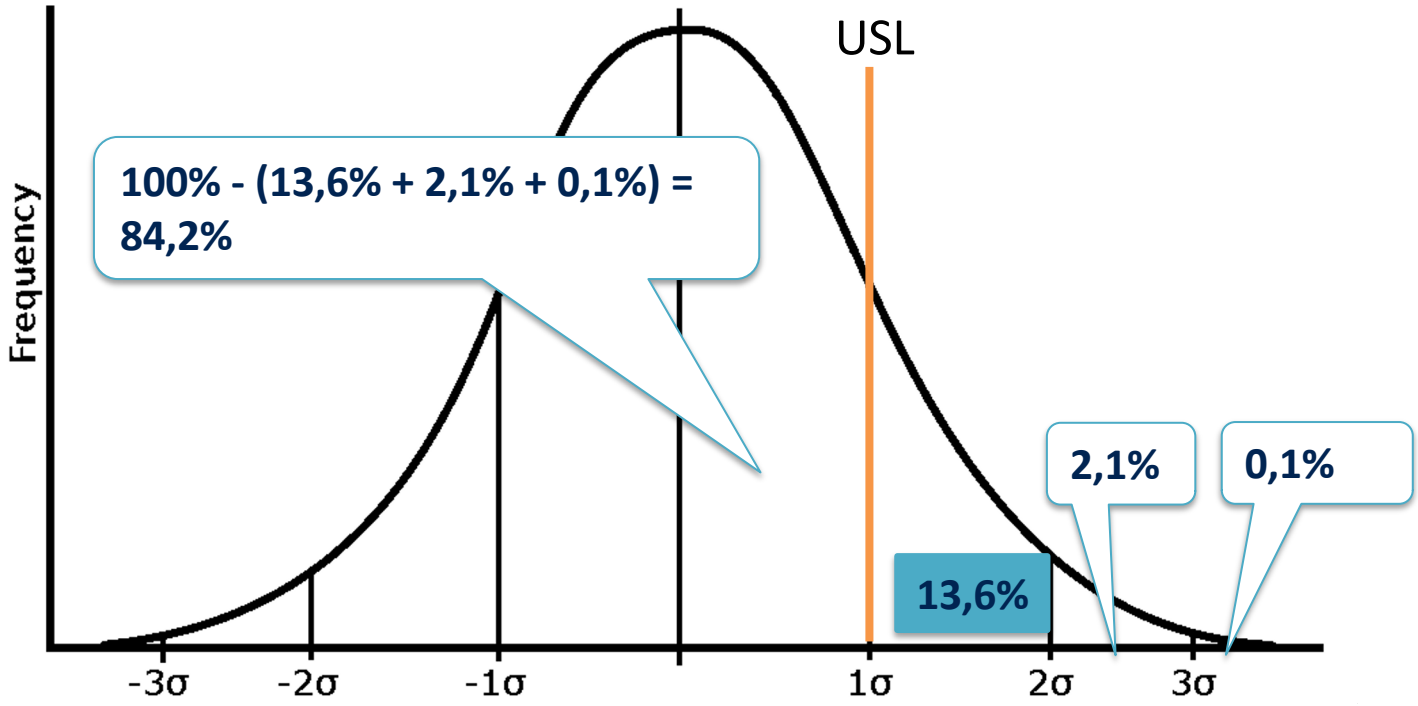


Slimmer werken, blije klanten

Solution: Yield

Question:

What percentage of the observations in the graphic below fall within the specification limitations?



Slimmer werken, blije klanten

Six Sigma structure | MEASURE



Result:

- Process performance (yield)
- Measuring plan

Slimmer werken, blije klanten

Measuring is knowing, right?

Youtube: Pushing the limits: Red card trick



What are you going to measure?

bureau tromp LEAN & SIX SIGMA

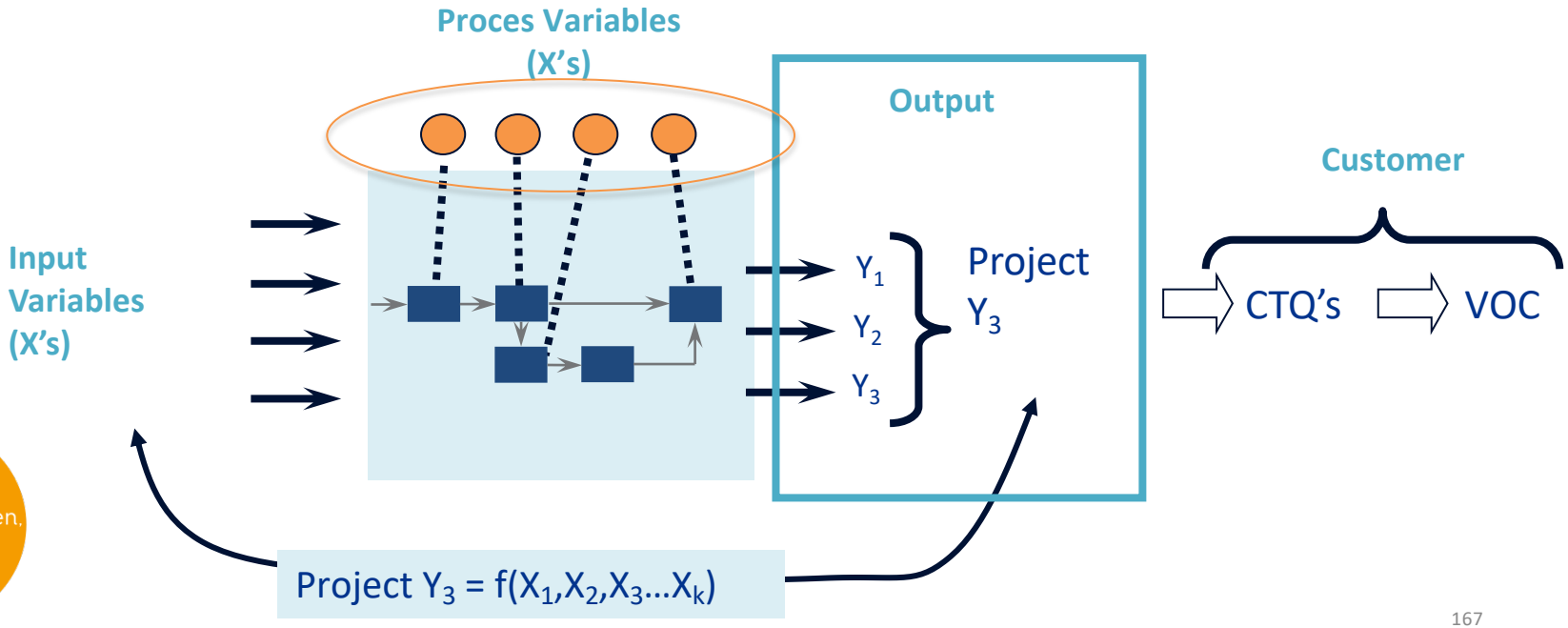
Define | Measure | Analyse | Improve | Control

Voice of the Process:

- Project Y
- Do-not-harm Y's

Stratification X's:

- Which factors (X's) influence the output of the process (Y)?
- Distinction of ' sub groups' in data



Slimmer werken, blije klanten

Stratification factors

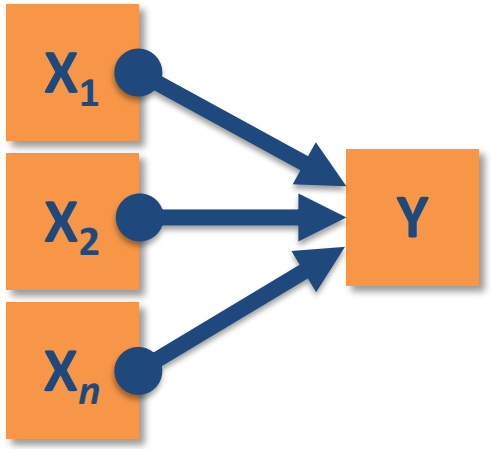
Stratify is to divide data into categories. These categories are called stratification factors.

Purpose:

Divide the measured data into stratification factors (X_1, X_2,…, X_n) that potentially influence Y.

Make sure that:

- Differences between groups are as large as possible
- Differences within groups are as small as possible



Example: Stratification X's ANWB

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

1 **Who is the customer?**

- Companies that have their own roadside assistance placed within the ANWB (lease companies, importers)

2 **What is the VOC?**

- Sufficiently fast services for a reasonable price
- No incidents that contribute to a negative image
- In some cases: personal brand rental car (importers)

3 **What is the CTQ?**

- 'The price must be lower than 30 euros per day including insurance'

Project Y's (quantitative)

4

- **Project Y: Costs of rental cars**
- Do-not-harm Y: Service around set up price (registered in SLA's)

Slimmer werken, blije klanten

Example: Stratification X's ANWB

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

What are possible X's (trivial many)?

- X1 Country where rental car is placed
- X2 The contractor where the passenger is insured
- X3 The period (high- and low season)
- X4 The servant that is called
- X5 The caregiver who handles the case

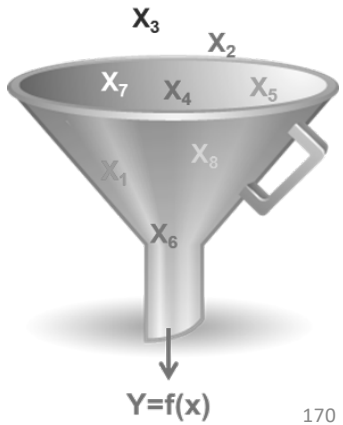
And later investigated:

- X6 Does the driver needs a tow bar or not
- X7 Is the driver on the way to or from a destination

Trivial Many

Analyse

Vital Few



Slimmer werken, blije klanten

Example: Stratification X's ANWB

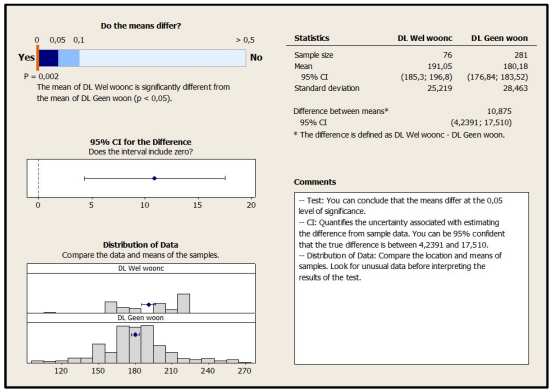
bureau tromp
LEAN & SIX SIGMA

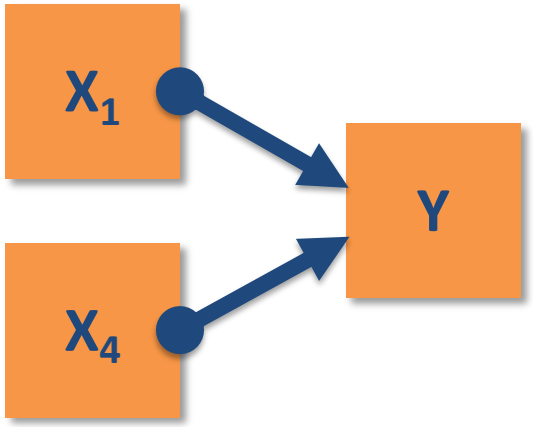
Define | Measure | Analyse | Improve | Control

Project X's (vital few)

The (statistical) analyses of the measured data concludes that of the trivial many only two x's are significant for the costs of the retal car (the project Y):

- X1 Country where rental car is placed
- X4 The servant that is called





Slimmer werken, blije klanten

Measuring plan

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

What is it?

- Summary of all measures that have to be carried out
- 'List of action' of the measure phase

What is included?

- Y and X's to measure
- Definition
- Methodology of measure
- Who, what, when, how many?

DATA COLLECTION PLAN								
WHAT					WHO	HOW	WHEN	WHERE
Measurement	Measurement type (output / input / process)	Data Type (cont / discrete)	Operational Definition (instrument /condition, method)	Result G R&R	Who is responsible (for data collection)	Decision Criteria	Date / time / freq of measurement	Source / location
Coloration of paint	Output	Discrete	Visual inspection, conducted with full lighting. The completed car is examined after undercoat, paint and varnish were applied and dried.		Operator	No differences or patches between the old and the new paint are to be recognizable. Refer color card.	Every second job between 2/6/2011 and 2/26/2011	Spray-painting department
Paint thickness	Output	Continuous	Measure with DFT-Ferrous (PosiTest DFT). The completed car is examined after undercoat, paint and varnish were applied and dried. The device is put on the middle on the painted surface.		Painter	In the spec	Every second job between 2/6/2011 and 2/26/2012	Spray-painting department

Slimmer werken, blije klanten

Measureplan

bureau tromp
LEAN & SIX SIGMA



Why do we measure?

- To get a better understanding of the current situation:
  - Relevant process information is not registered
  - The poor quality of process information
  - Information is missing: incomplete picture of the “hidden factory”.
  - To understand these "blind spots" we will have to measure and complete the missing information

Measure plan vs. measurement system/form

- Not to be confused with a measurement system/form
  - Measurement plan: An overview of all outstanding measurements. What do we do?
  - Measurement form: A (physical) form to record measured data. How do we record it?

Als we meten ontstaat het risico dat we onjuiste gegevens meten,
Probeer dus zoveel mogelijk van bestaande, beschikbare informatie uit te gaan!

Slimmer werken,
blije klanten

Measurement plan

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

No.	CTQ	Measurement procedure	Unit	Sample Size	Who?	When?	How will the data be analyzed?

- All measurements can be traced back to the intended CTQ, start with this
- Then, think carefully about the procedure that is performed to perform the measurement (see also Gage R&R as part of this chapter).

Slimmer werken, blije klanten

Measurement plan

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

No.	CTQ	Measurement procedure	Unit	Sample size	Who?	When?	How will the data be analyzed?

- What is measured (which unit)? - for example: time / distance
- What is the size of the sample? This can vary per unit and can be calculated with the help of a minitab. We often use a standard of 30. However, the reliability of this is highly dependent on:
  - population size
  - seasonal dependencies

Slimmer werken, blije klanten

Measurement plan

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

No.	CTQ	Measurement procedure	Unit	Sample Size	Who?	When?	How will the data be analyzed?

- Who will collect / measure the data? - e.g. Line or project staff
- In which period is the data measured? Think carefully whether this is season dependent!
  - Likely, the sale of ice cream in the winter is not the same as the sale of ice cream in the summer.

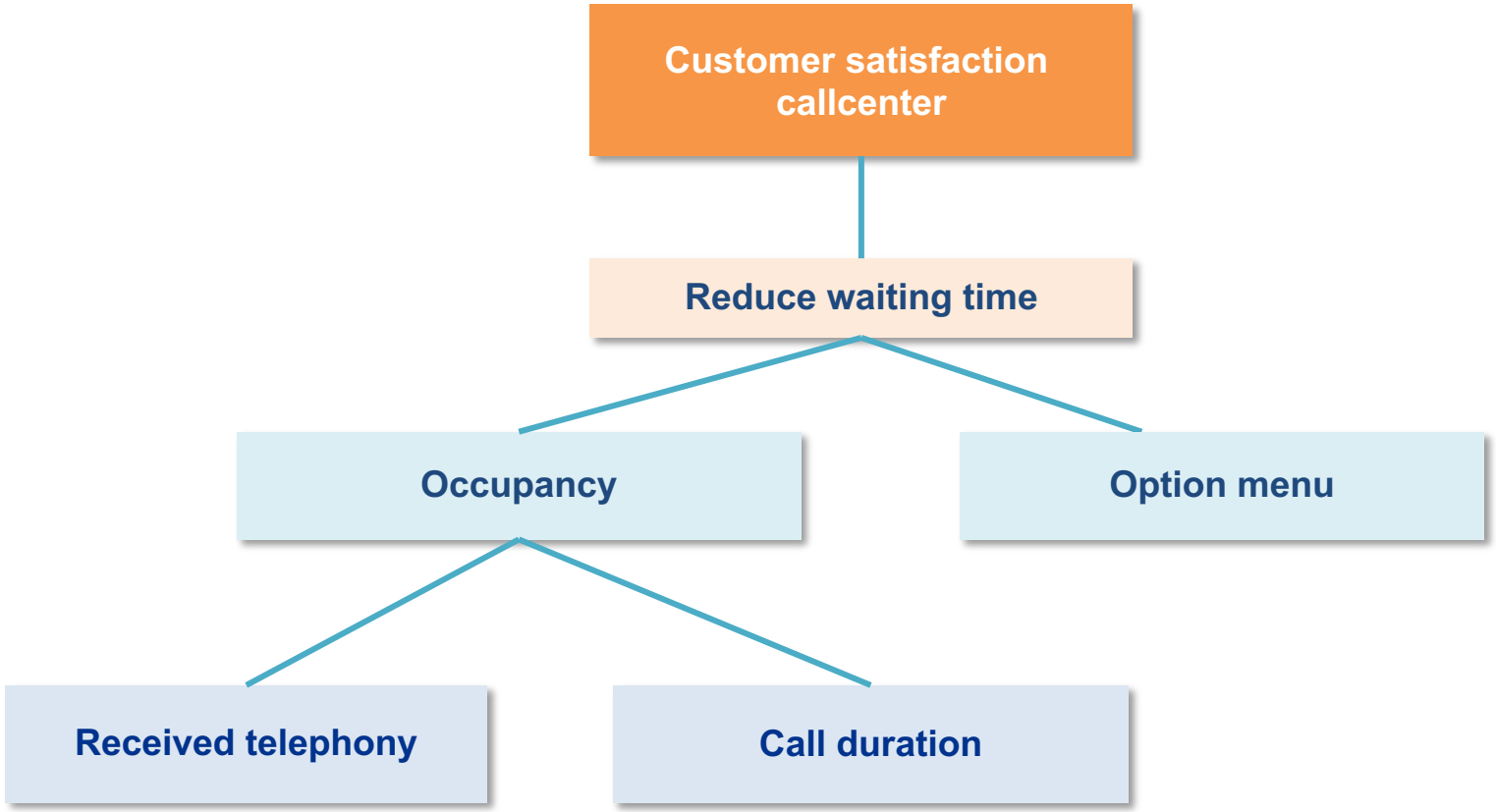
Slimmer werken, blije klanten

Measurement plan (example)

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

CTQ



Slimmer werken, blije klanten

Measurement plan (example)

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

No.	CTQ	Measurement procedure	Unit	Sample size	Who?	When?	How will the data be analyzed?
1	**Occupancy**	Total available time within the call center and its course per week.	Available time in minutes per day	4 weeks	Team leader	• september • october	• Histogram
2	**Received telephony**	Total telephony received on numbers 0470 and 0471.	Number of telephony received per day	4 weeks	Team leader	• september • october	• Histogram • Boxplot
3	**Call duration**	Total telephone converstation dureation per notification received.	Time in seconds per call	100 calls per employee	Project leader	• september • october • november	• Timeline graph

Slimmer werken,
blije klanten

Measurement Plan

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Exercise

Get started with making a measurement plan for the filter factory

No.	CTQ	Measurement procedure	Unit	Sample Size	Who?	When?	How will the data be analyzed?

Slimmer werken, blije klanten

Validate the measurement

We can also see measuring as a process.

So we also have to deal with variation when measuring data.

That is why we validate our process **repeatability** and **reproducibility.**

Gage repeatability and reproducibility (Gage R&R)

- Gage R&R is the sum of variation in measure that is found when the same item repeatedly recurs when tested by different operators.

Precision = Repeatability + Reproducibility

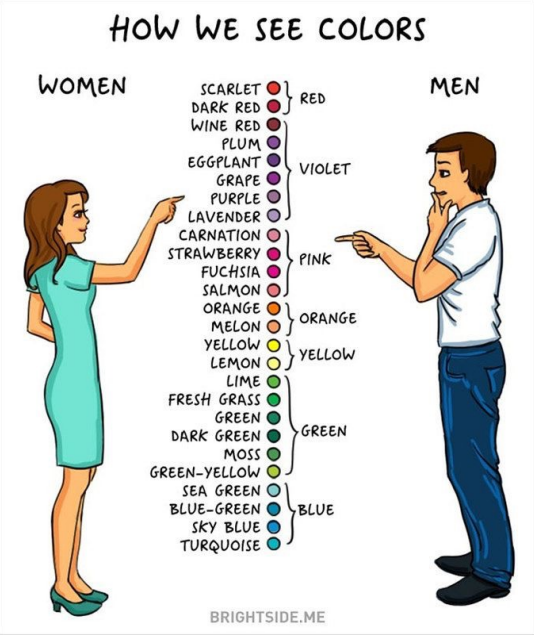
Measurement validation

Repeatability

- Do you get the same results if you measure a second time?
- For example measuring a second time at a different day/week/month

Reproducibility

- Do you get the same results if someone else is taking the measure?
- For example; using several observants.



Slimmer werken, blije klanten

Flatfile

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

What is it?

- 'A large Excelsheet'
- Basics for your analysis (import in Minitab)

What is in it?

- Results of measures for Y's and X's
- Every measure is one line

Customer	Address	Order No.	Date of Order	Item No.	Description	Price	Phone No.	Sales Staff No.	Sales Person
Paul Smith	38 Beech Road	2345	4/11/2001	456	Steam Iron	£35.45	01234-665577	78	Sue Sneath
Anne Chu	27 Ash Square	2359	4/11/2001	764	Toaster	£19.99	01234-897645	62	Bert Jones
Anne Chu	27 Ash Square	2359	4/11/2001	798	Kettle	£19.99	01234-897645	62	Bert Jones
Sean Page	19 Elm Lane	2361	5/11/2001	461	Microwave Oven	£125.00	01234-567483	78	Mrs Sneath
Joan Patel	16 Oak Close	2362	5/11/2001	764	Toaster New	£15.99	01234-192837	78	Sue Sneath

Slimmer werken, blije klanten

Sample

Sample

- A subset of the population that represents the population as a whole.

Why?

- Practical, and because of the costs often not possible to examine the whole population
- Not necessarily!

Sample size

- Observing often enough to see all the variations in the process
- Observing long enough to see variations over time (if the process is not stable)

General guideline for sample size = 30 or more

Sample

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

What is a Sample?

- A subset of your population (a group of people or things) that is representative of the entire population.

Why do you sample?

- Practically and in terms of costs, it is not possible to view the entire population.
- You take a sample to be able to make statements about the entire population;
- We use sampled data to perform analyses and to test hypotheses;
- Conduct additional sampling during the Analysis phase for further investigation of possible influencing factors.

How large should my sample size be?

- Measure often enough to view all variations in the process;
- Measure long enough to see variations over time (if a process is not stable);
- Rule of thumb ≥ 30

Slimmer werken, blije klanten

System of measure

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Instrument of measure:

- Stopwatch, questionair, observation, etc.

Way of measure:

- Does the chosen instrument provide useful results (accurately enough for analysis?)
- '10-bucket rule of thumb': does your scale have at least 10 outcomes (with continuous data)?



Slimmer werken, blije klanten

Sampling

How to sample?

- Retrieve data from systems (data warehouse, process flow, Excel, etc).
- Through a measurement form that you distribute to respondents.
- With your sample, try to think about what possible influence factors might be so that you carefully choose your group of respondents. In order to collect as much data as possible to be able to analyze.

Use of symbols

- We use other symbols for a population and a sample to clearly show the distinction.

Subject	Population-symbol	Sample-symbol
Number	N	n
Mean	μ	$\overline{x}$
Probability	P	p
Standard deviation	σ	s

Slimmer werken,
blije klanten

Simulation game



Slimmer werken,
blije klanten

End of day 3

Tomorrow:

- Six Sigma
  - Analysis phase (I)
- Lean Management
  - 3rd principle: Flow
  - 4th principle: Pull
- Questions?

Slimmer werken,
blije klanten

Exercise

In groups, get started with:

1. Making a VSM of the process
2. Design a measurement plan
3. Come up with improvements and select the top 3

Present to the management. The management takes the decision. Apply the 3 improvements to the process

Take 60 - 90 minutes



Slimmer werken, blije klanten

bureau tromp

LEAN &
SIX SIGMA

Green Belt training

Lean Six Sigma

Slimmer werken,
blije klanten

Day 4

Schedule day 3

- Analysis phase
  - Root-Cause Analysis (RCA)
  - Graphic analysis

- 3rd Principle Lean: Flow

- 4th Principle Lean: Pull

Slimmer werken,
blije klanten

Six Sigma structure | ANALYSIS



Result:

- Root-Cause Analysis (RCA)
- Graphic analysis
- Hypothesis testing (day 5)

Slimmer werken, blije klanten

Root Cause Analysis (RCA)

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analysis | Improve | Control

- RCA is a problem-solving method focused on identifying the root cause of problems and events.
- Often only the effects of the problem are fixed, and not the root cause itself.



We often resolve visible symptoms of a problem

While the root cause remains

Slimmer werken, blije klanten

Root Cause Analysis (RCA)

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Often used tools

- Cause & Effect diagram (Ishikawa)
- 5 x Why



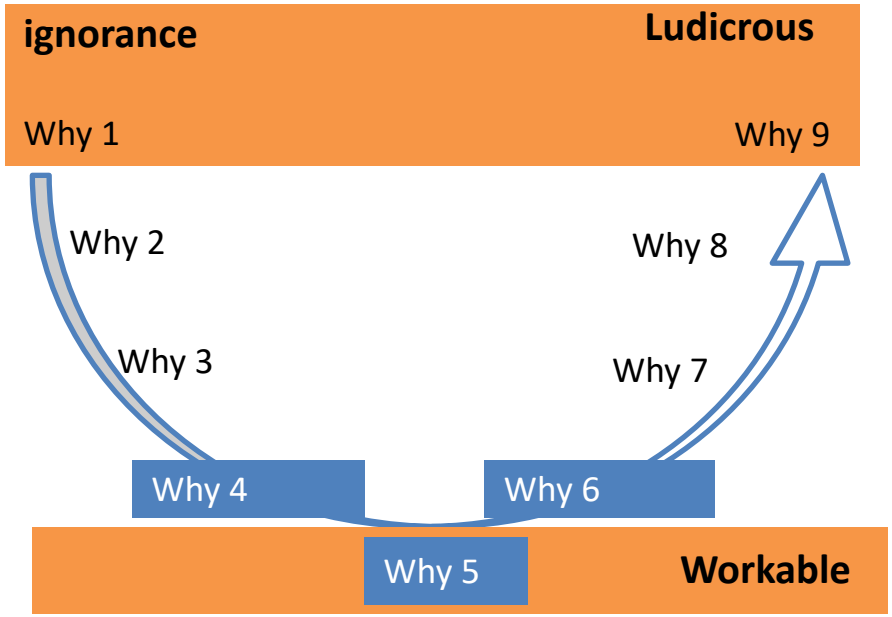
Slimmer werken,
blije klanten

5x Why

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

- The root cause is the root of the problem. When this is solved, the problem is prevented (prevention is better than cure)
- The technique of coming to this ground cause is called "5xWhy?"
- In theory, this seems like a very simple technique, but it takes practice to really master it well.
  - Ask on the right subjects to come to the root cause!



Slimmer werken, blije klanten

Problem

Our customer refuses to pay for the print work we have delivered

bureau tromp
LEAN & SIX SIGMA

Why?

The delivery was late, so the leaflets cannot be used

Reason 2

Reason 1

Why?

The work took longer than we expected

Reason 2

Why?

The ink for the printer ran out

Reason 2

Reason 1

Reason 1

Reason 2

Why?

The ink was all used on a large, last-minute order

Reason 1

Why?

We did not have enough ink in stock, and could not order new delivers on time

Solution

Slimmer werken, blije klanten

countermeasure

Find an ink supplier that can deliver in short tem, so that we can respond to customer demand with a minimum of inventory

Example: 5x Why?

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

1



Q : **WHY** has Photocopier stopped ?
A : Fault Occurred!

2



Q : **WHY** has a fault occurred ?
A : Paper Jammed !

3



Q : **WHY** Is paper jammed ?
A : Stuck in the compartment !

4



Q : **WHY** has it got stuck ?
A : Paper was damaged !

5



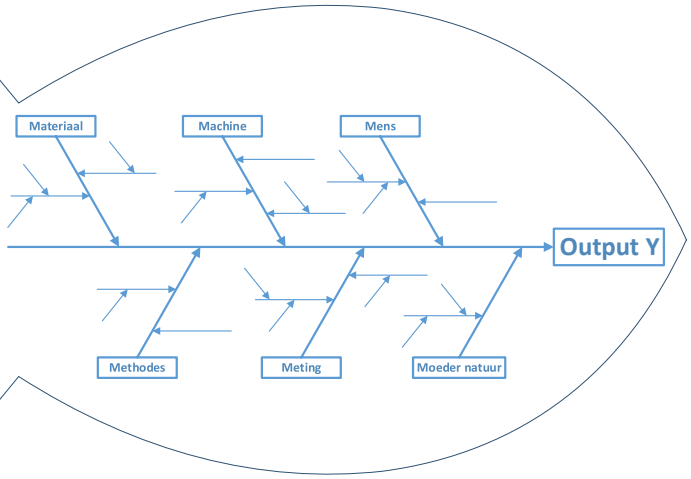
Q : **WHY** is the paper damaged ?
A : Box was dropped !

Root-cause → **Now start thinking of solutions**

Slimmer werken, blije klanten

Cause & Effect (Ishikawa)

- **Step 1:** Place a specific problem formulated as a question in the ‘ fish head’: Why…?
- **Step 2:** The causes deriving from the question are added to the head structure as fish bones. These are the 6M’s (Methods, Machines, Manpower, Materials, Measurement, Environment)
- **Step 3:** Use brainstorming techniques and focus on the question in the fish head.
- **Step 4:** Keep on questioning the named causes according to 5x Why?

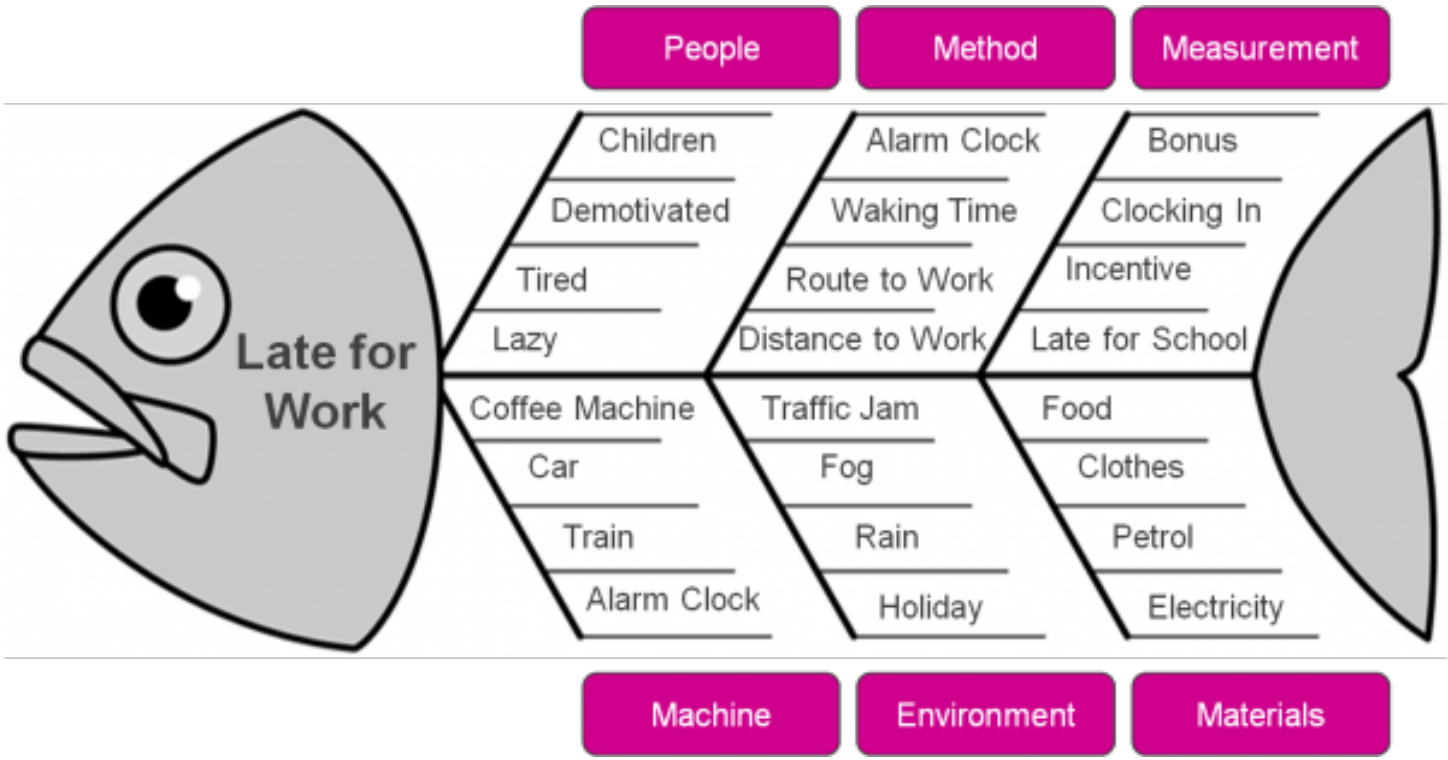


In service organisations:
- Employee
- Computer/IT
- Information
- Work method
- Customer/Supplier
- Management

Example: Cause & Effect

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



Slimmer werken, blije klanten

Six Sigma structure | ANALYSIS



Result:

- Root-Cause Analysis (RCA)
- Graphic analysis
- Hypothesis testing (day 5)

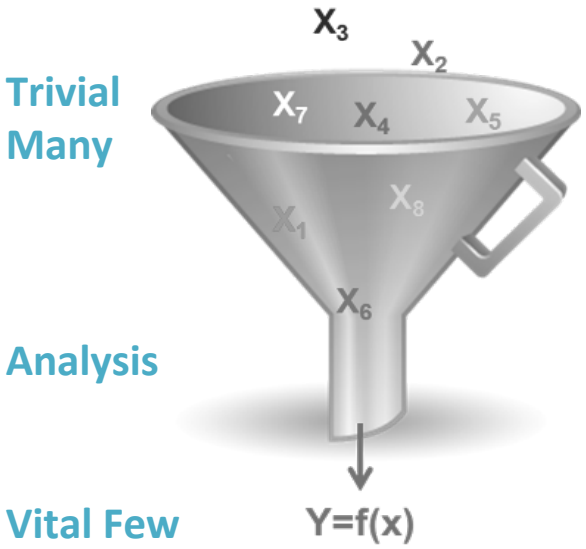
Slimmer werken, blije klanten

Graphic analysis

The goal of the analysis phase is to reduce possible causes (trivial many) to the most important causes (vital few).

This is done by analysing the data from the **measure phase**.

For example; performing a graphic analysis.



Slimmer werken, blije klanten

Graphic analysis: plan for action

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

- **Step 1:** Visual inspection of the data
  - What do I see? What does the data represent?
  - Which information is in the different columns?
  - Do I see outstanding or missing values?
- **Step 2:** Make a 'Graphical Summary' in Minitab
- **Step 3:** Examine if the data has a normal distribution

- **Step 4:** What does the process say; make a control chart
- **Step 5:** Process capability analysis
- **Step 6:** Set hypotheses
- **Step 7:** Use the right keys and draw your conclusions

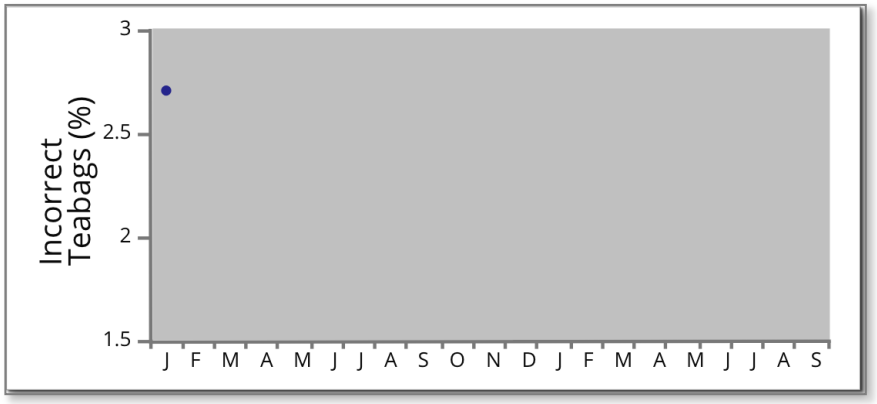
We will practice this next time!

Slimmer werken, blije klanten

Stability: Control chart

A control chart of the production of teabags

- The percentage of incorrectly produced teabags is registered
- In January: 2,7% incorrectly produced teabags

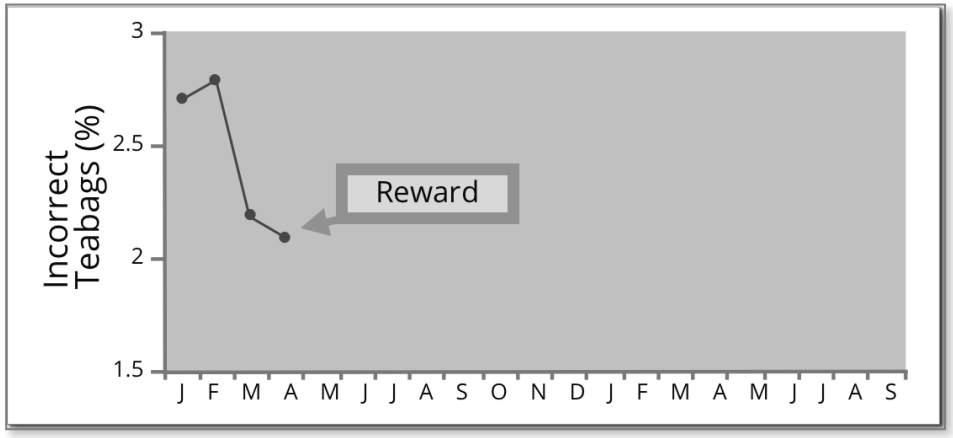


Source: Understanding variation: the key to managing chaos, Donald J. Wheeler – SPC

Stability: Control chart

- April: the percentage of incorrect teabags is 2,1%.
- The lowest percentage this year.

- The manager rewards the factory:
- “Pastry for everyone! You can be proud of what we achieved!”



Source: Understanding variation: the key to managing chaos, Donald J. Wheeler – SPC

Slimmer werken, blije klanten

Stability: Control chart

- July: Percentage of incorrect production increased three months in a row.
- The manager wants his rewards back: “Thanks for nothing!”

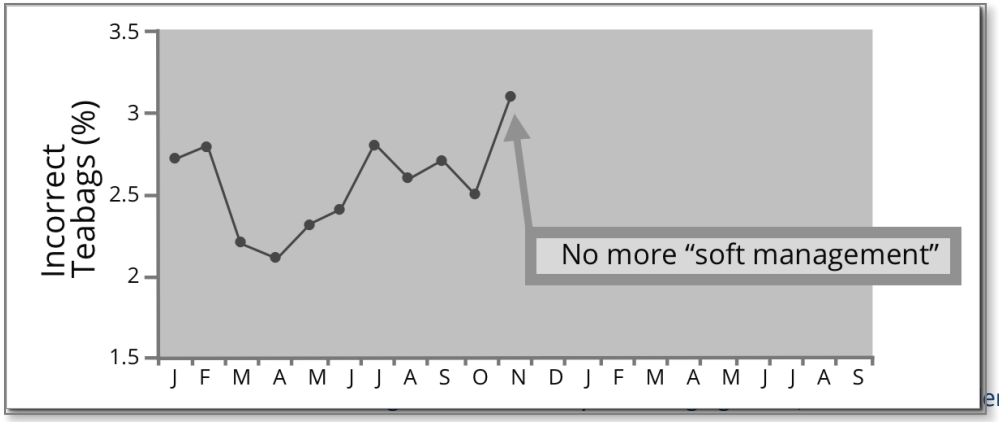
- The manager decides that this group has to be managed the hard way!



Source: Understanding variation: the key to managing chaos, Donald J. Wheeler – SPC

Stability: Control chart

- November: percentage of incorrect production is alarmingly high.
- Special meeting with the goal of solving the problem permanently.
- The manager gives an angry speech about the importance of reducing waste.
- The employees have no idea what to do.



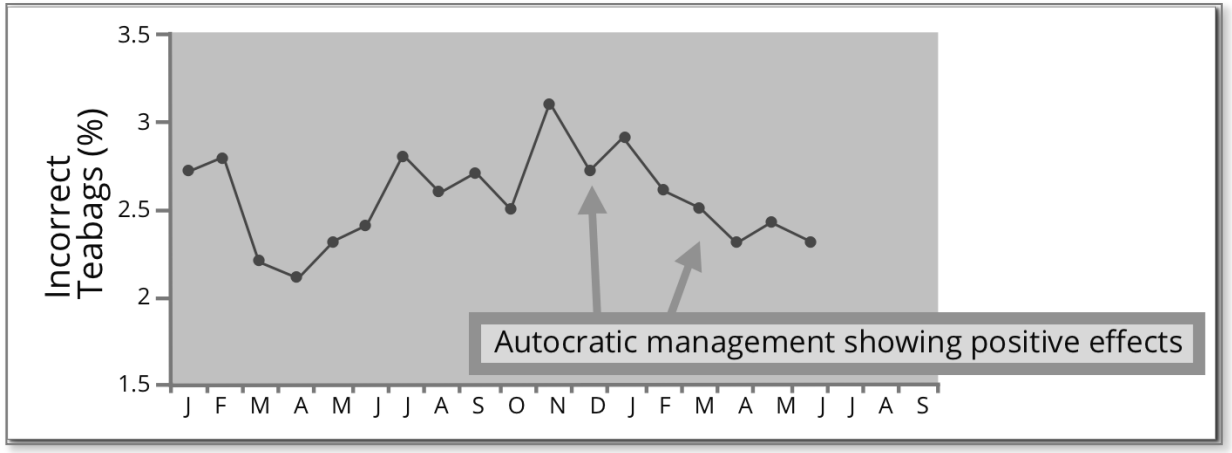
er – SPC

Slimmer werken, blije klanten

Stability: Control chart

- June: the manager sees a reduction in the percentage of incorrectly produced teabags. ” We are getting somewhere” !
- His conclusion: my autocratic management style is paying off.

- When actually, nothing in the process has changed..

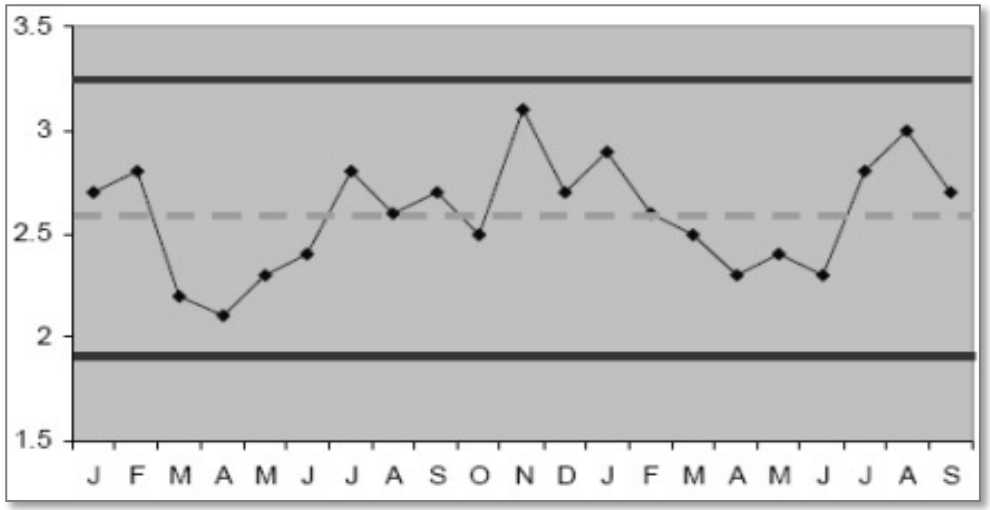


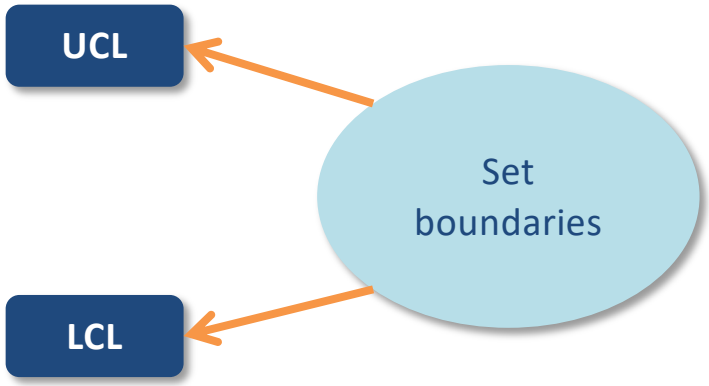
Source: Understanding variation: the key to managing chaos, Donald J. Wheeler – SPC

Slimmer werken, blije klanten

Stability: Control chart

- The control chart indicates that the process is subject to variation





Source: Understanding variation: the key to managing chaos, Donald J. Wheeler – SPC

Stability: Control chart

Manager:

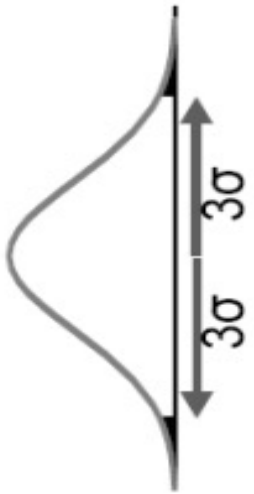
- "I made my decisions based on hard data – what can possibly be wrong?"

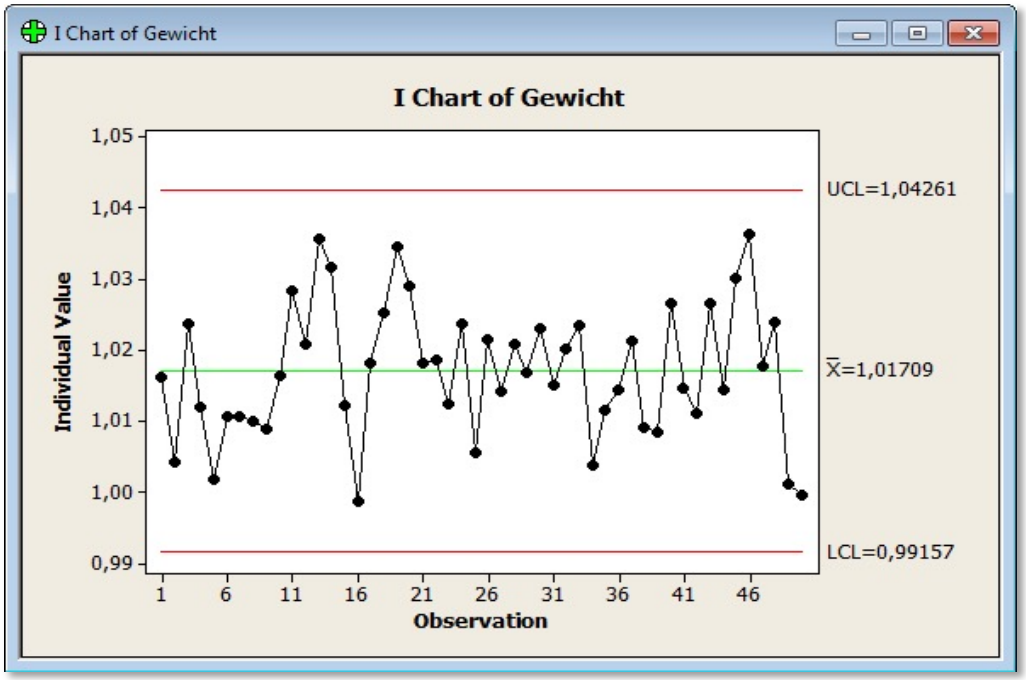
Green Belt:

- "Your decisions are made by interpreting high and low observations as signals, while in reality this was just noise.
- Look at the control chart: there was no actual significant change in the process".

Control chart

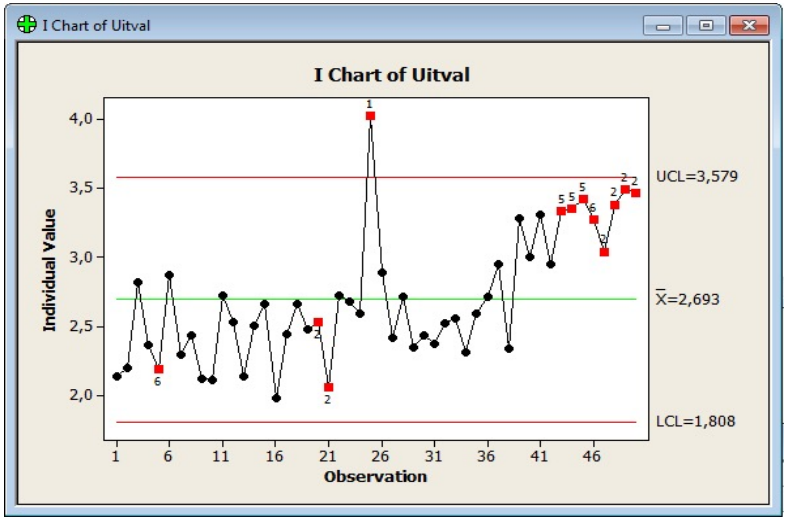
In a control chart the boundaries are marked at 3 Sigma .





Slimmer werken, blije klanten

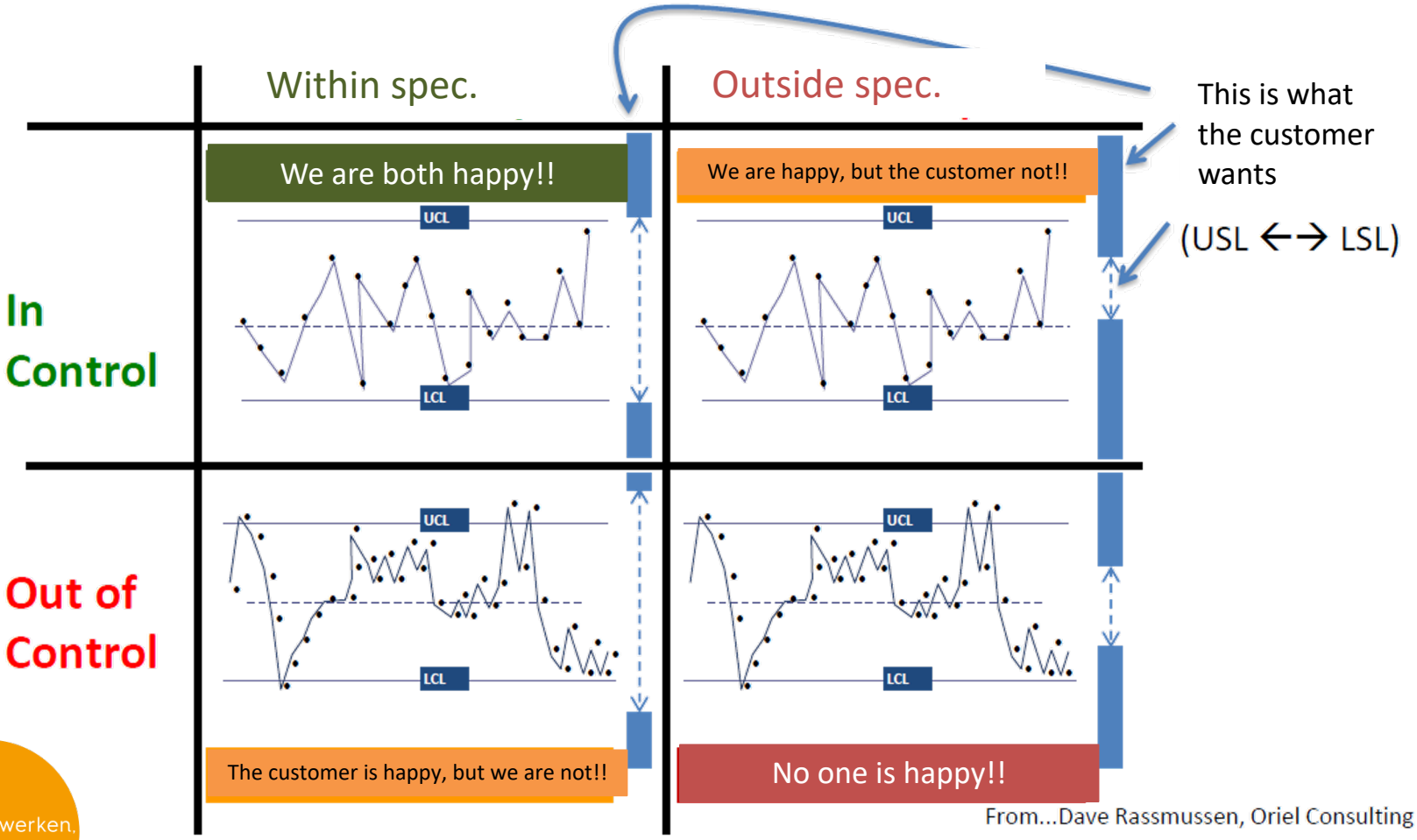
Control chart



Natural variation	Special variation
• Are always present and inherent to the process	• Occur now and then and are disruptive to the process
• Mutual influence of many small causes	• Influence of a demonstrable cause
• Difficult to find and manage	• Can be detected directly and removed

Example: Control chart

- Note: Control limit ≠ Customer specification limit



Pareto Chart (Common tool in LSS)

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

What is a Pareto chart?

- The Pareto Chart an useful tool within analyzing processes because it shows the cause/effect relationship of problems.

Why a Pareto Chart?

- The Pareto Chart helps to determine the origen of the biggest segment of the problems of the process.

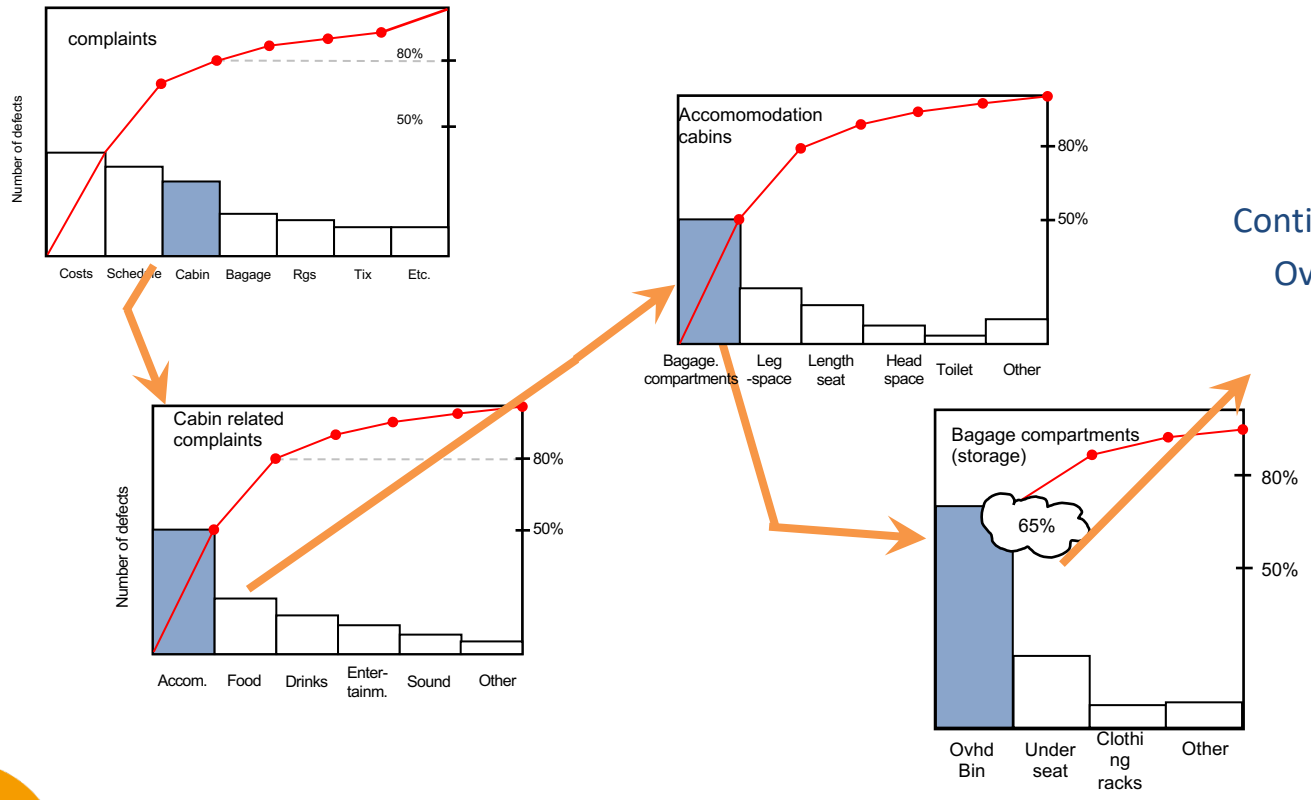
How do we measure?

Some analyses are easy to make in Excel. Next time we will also practice making (a Pareto) analyses in Minitab.

Slimmer werken, blije klanten

Pareto chart

- 80/20 Rule: 20% of the causes are responsible for 80% of the problems.
- Example: complaints of aviation company



Continue research:
Overhead bin

Slimmer werken,
blije klanten

Graphic analysis

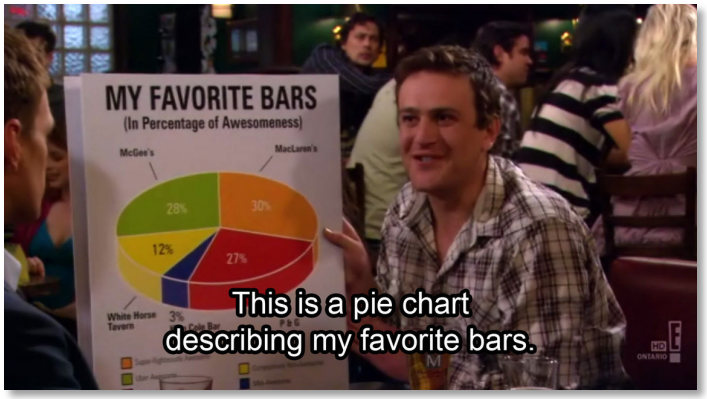
bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Different forms of graphic analyses:

- Histogram
- Boxplot
- Bar Chart
- Pie Chart

Some analyses are more easily done in Excel. Next time we will also practice with making analyses in Minitab.





Schedule day 3

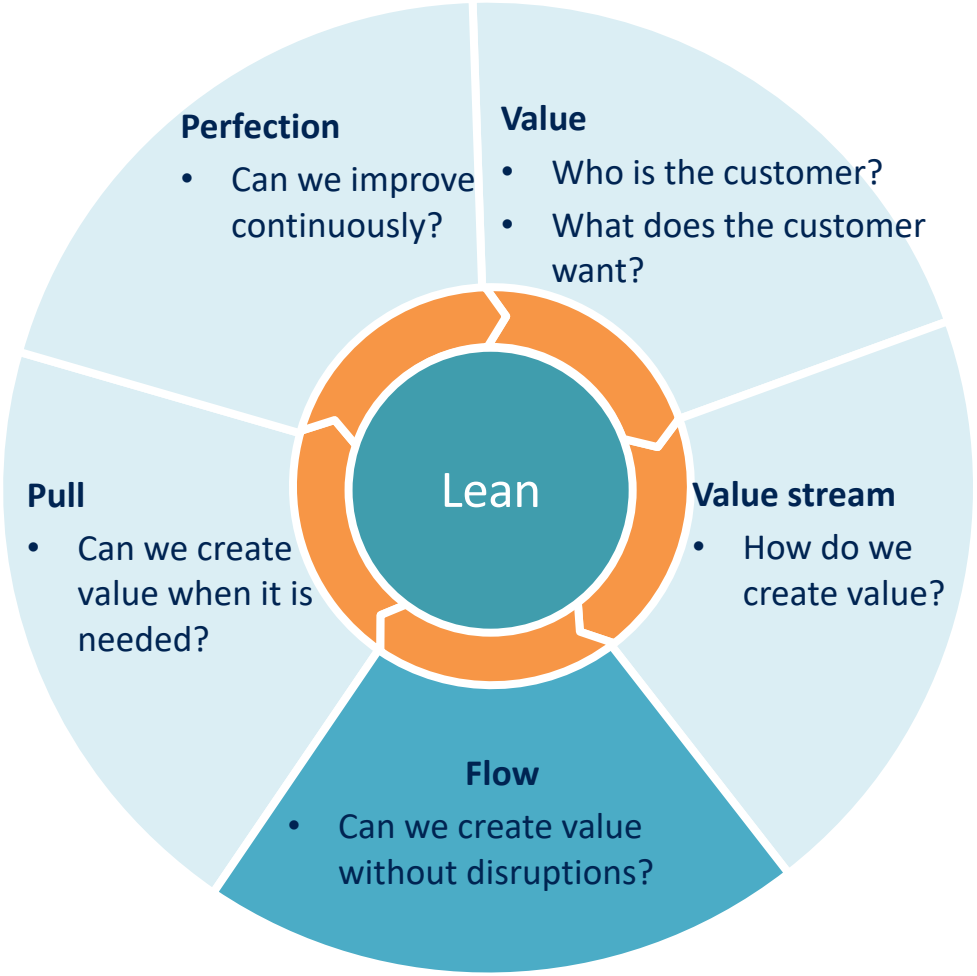
- Analysis phase
  - Graphic analysis
  - Root-Cause Analysis (RCA)

- 3rd Principle Lean: Flow

- 4th Principle Lean: Pull

Slimmer werken,
blije klanten

Principle 3: Flow



Slimmer werken, blije klanten

Flow

Flow reduces lead time

- Flow eliminates waste:
  - Stock
  - Transport
  - Waiting
  - Etc.
- Flow increases quality
- Reaching flow means overseeing the whole chain



Slimmer werken,
blije klanten

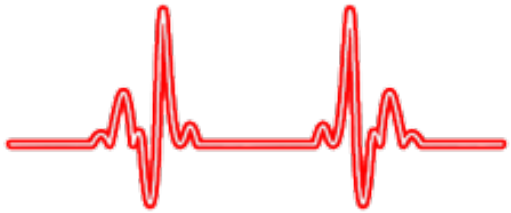
Flow: concepts

- **Takt time**
  - The ‘pace’ in which a costumer places orders
  - Takt time = effectively available production time/ customer demand

Exercise TAKT-time

The duration of one shift is 7,5 hour. Breaks and cleaning take up 45 minutes per shift. Customer demand is 920 products per day.

What is Takt time in seconds?



Slimmer werken,
blije klanten

Flow: concepts

Exercise TAKT-time

A shift is 7,5 hours. Breaks and cleaning takes up 45 minutes per shift. Customer demand is 920 products a day.

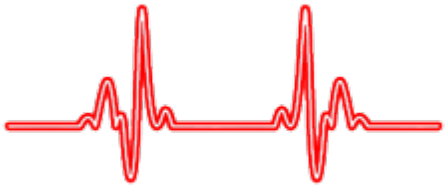
What is the takt time in seconds?

Elaboration

Takt time = effectively available production time / customer demand

Step 1: What is the effectively available production time?

= 7,5 hr x 60 minutes	= 450 minutes
minus 45 minutes	= 405 minutes
calculated into seconds	= 24.300 seconds
Step 2: What is customer demand?	= 920
Step 3: Taktime = 24.300 / 920	= 26 seconds



Slimmer werken, blije klanten

Flow: concepts

- **Process time** (PT)
  - Time in which the product is produced.
  - Consists of CVA, BVA and NVA
  - Total Process Time = Process time step A + B + C + …

- **Process lead time** (PLT)
  - Actual time needed for processing one product
  - Take interim stocks into account: these must first be eliminated. So is a snapshot.
  - Process lead time = process time + recovery time + waiting time

- **Process Cycle Efficiency** (PCE)
  - The ratio between time and the total lead time where value is added
  - Process efficieny = (total process time / process lead time) x 100%

Slimmer werken,
blije klanten

Flow: concepts

- Exit Rate (ER)
  - The speed with which products leave the process
  - Is determined by the Takt time or the Bottleneck
  - Expressed in units, eg 20 filters per hour
  - Exit rate = 1 time unit / stroke time or 1 time unit / bottleneck

Example Exit Rate

- The Bottleneck at the AH To Go is the ATM, which takes 15 seconds to make a payment. The Exit Rate is:

  1 minute / 15 seconds = 4 customers per minute

- Suppose that there is only one customer who wants to pin every 30 seconds (Takt time), the Exit Rate is:

  1 minute / 30 seconds = 2 customers per minute

Slimmer werken,
blije klanten

Flow: concepts



Little's law

- Alternative way to calculate the Process Lead Time (approximate)
- First, always calculate the Exit Rate(ER) from the previous slide
- Process Lead Time = intermediate stock / Exit Rate

Example Little's Law

- There are 10 customers in line at the AH To Go. The Exit Rate 4 customers per minute. The Process Lead Time according to the Law of Little is:

  10 customers / 4 per minute = 2.5 minutes

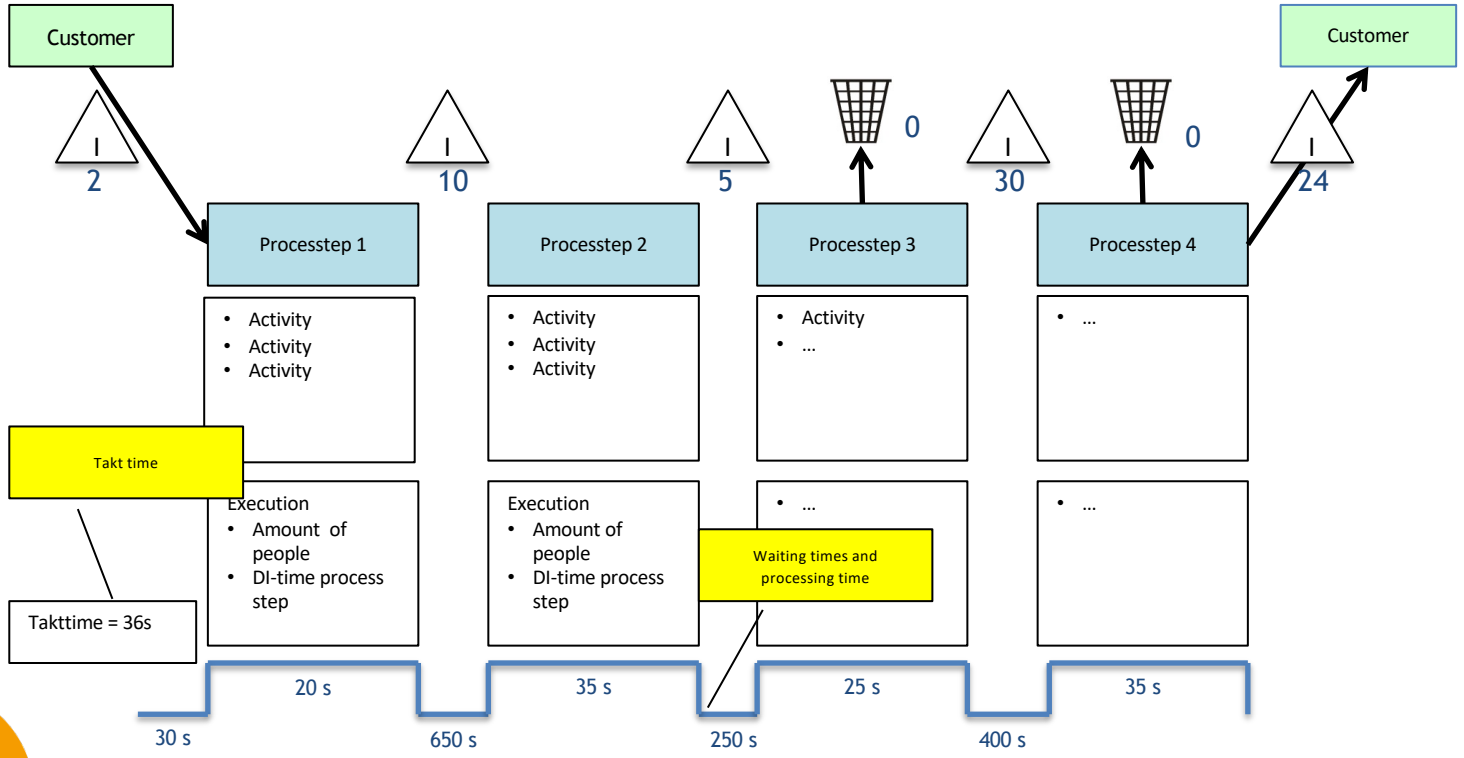
- An alternative way of calculating the Law of Little is to multiply the intermediate stock by the Bottleneck (or the Takt time if it is higher). You then get:

  10 customers * 15 seconds = 2.5 minutes

Slimmer werken, blije klanten

Lees meer!

Exercise



Slimmer werken, blije klanten

Exercise

- What is the Process time (in seconds)?
- What is the process lead time deriving from the measures in the process (in seconds)?
- What is the process cycle efficiency?
- What is the lead time according to Little's law?

You have 10 minutes.



Slimmer werken,
blije klanten

Elaboration

- What is the production time (in seconds)?

  Total Process Time = Process time step A + B + C + …

  20 + 35 + 25 + 35 = 115 seconds

- What is the Process lead time deriving from the process measures (in seconds)?

  Pro lead time = process time + recovery time + waiting time

  30 + 20 + 650 + 35 + 250 + 25 + 400 + 35 = 1445 seconds

- What is the process cycle efficiency?

  Process efficiency = (total process time / process lead time) x 100%

  (115 / 1445) x 100% = 8,0%

- What is the process lead time according to Little's law?
- Process Lead Time = intermediate stock / Exit Rate

  Stock = 2 + 10 + 5 + 30 = 47 units (does not include the finished 24 units)

  Exit Rate = 1 minute / 36 seconds = 1,67 products per min.

  Process Lead time = 47 units / 1,67 = 28,2 minutes (1692 seconds)

  Alternative method: 47 units x 36 seconds = 1692 seconds

Slimmer werken,
blije klanten

Recognizing flow

Characteristics of a process that is out of balance:

- There are bottlenecks;
- Work is stacking up at one or more steps in the process
- Production time bottleneck > Takt-time
- The expected Process lead time increases

How do you recognize it?

- Counting of stock: high (and increasing) intermediate stock
- Time samples: cultivation time > takt time
- Disproportional workload: big workload at bottleneck, little after bottleneck

Goal: cultivation time = 90% of takt time (safe margin of 10%)

- If production time < 90% takt time: too much waste (or muda)
- If production time > 90% takt time: there is a bottleneck

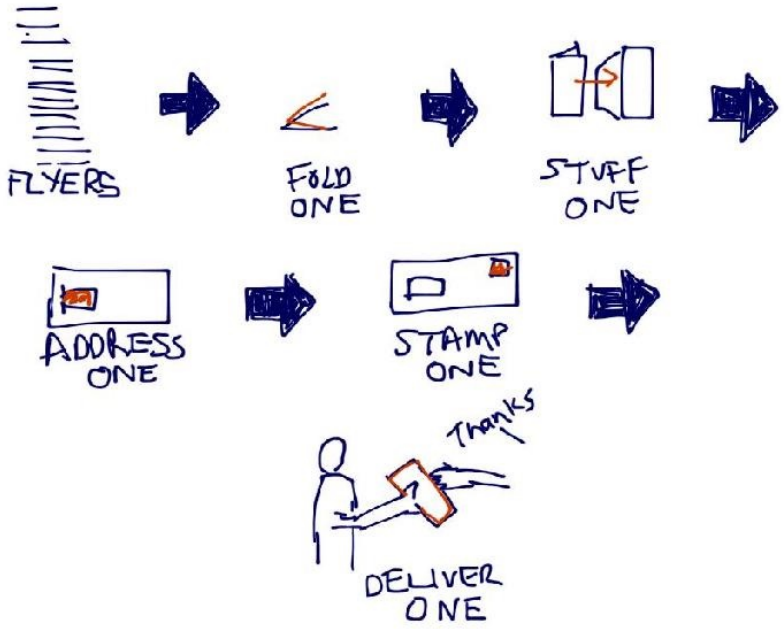
Slimmer werken,
blije klanten

One-piece-flow

One-piece-flow is the ‘ultimate Lean solution’:

- Little intermediate and closing stocks
- Increased quality
- Mistakes do not pass through to the next step in the process
- Employees are multi-employable
- Stable and robust

In practice a mixed situation is often better

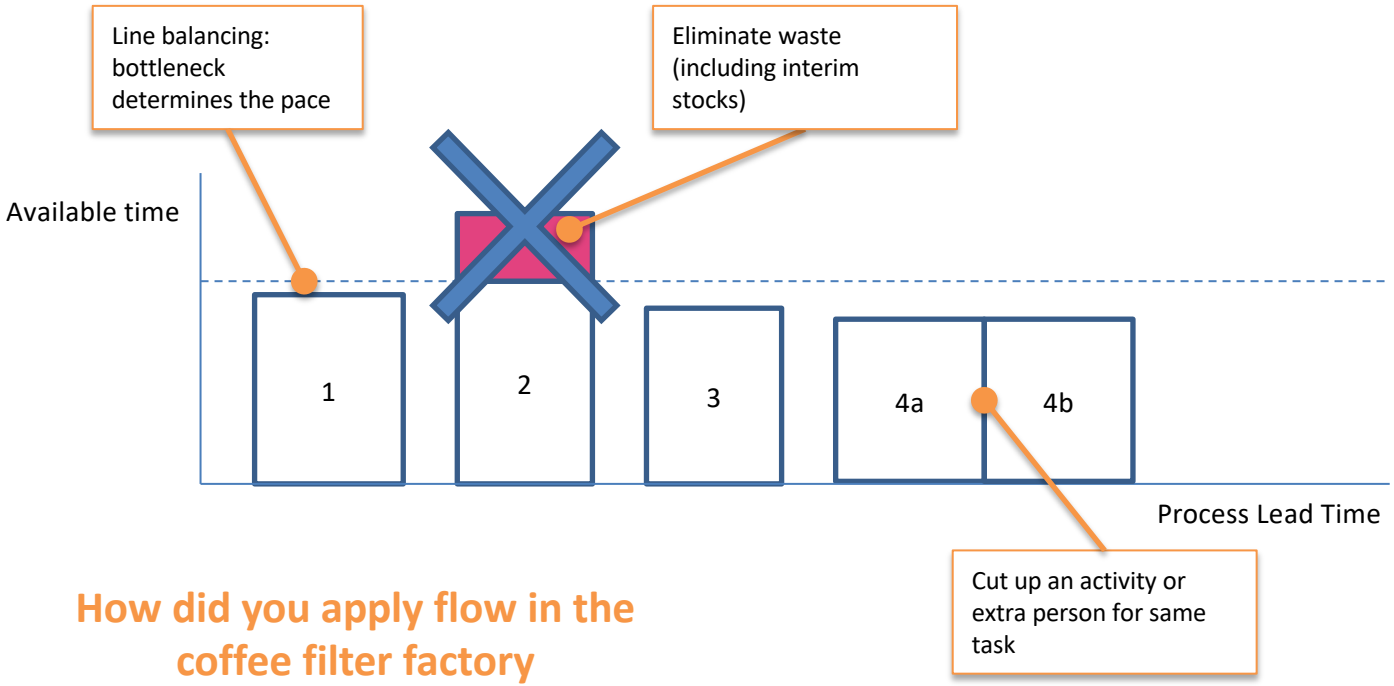


Slimmer werken, blije klanten

Create Flow

Roadmap:

- **Step 1:** Determine the maximum available time per process step (Takt tijd)
- **Step 2:** Eliminate waste
- **Step 3:** Deploy the people so that the Processing time < 90% Takt time



How did you apply flow in the coffee filter factory

Slimmer werken, blije klanten

Film: Flow



Slimmer werken,
blije klanten

Schedule day 3

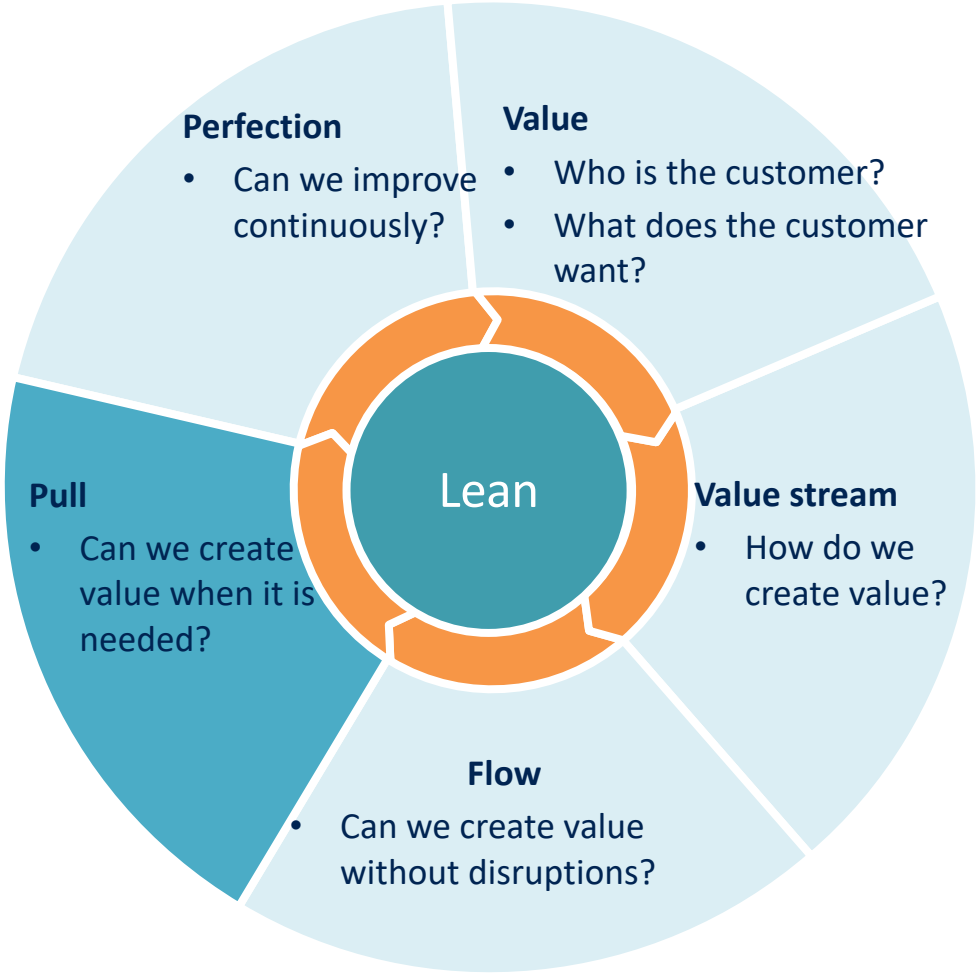
- Analysis phase
  - Graphic analysis
  - Root-Cause Analysis (RCA)

- 3rd Principle Lean: Flow

- 4th Principle Lean: Pull

Slimmer werken,
blije klanten

Principle 4: Pull



Slimmer werken, blije klanten

4th Principle: Pull

From push to pull

- Production based on customer demand
- Output is signal for new input (Kanban)
- Maximum amount of work is in progress

Benefits pull production

- Less overproduced goods
- Protection against growing stock



vs.



Slimmer werken,
blije klanten

Pull

1. Set a maximum for intermediate stock

A Useful tool for this is Kanban

Kan = visual Ban = board

2. Output is signal for new input

- Do not make products for which there is no customer demand (waste)
- Provides a decrease in interim and final stock and therefore less process lead time (PLT)

Help with maintenance of WIP-cap or pull-order

Examples

- Two bin kanban
- Production kanban
- Signal kanban



Slimmer werken, blije klanten

Designing a Pull system



Step 1: determine the current performance

- Determine the current Process Lead Time
- PLT = WIP / exit rate (approximately)

- Determine the current Process Cycle Efficiency
- PCE = (PT / PLT) x 100%

Step 2: Determine the desired performance

- Set the desired process cycle efficiency (company goal)
- Calculate the necessary PLT
- Calculate the WIP-cap (how many orders in the process are allowed in order to catch the desired PLT)

WIP = Work In Progress

Slimmer werken,
blije klanten

Pull in service industry

Many processes are set in motion by a customer:

- License application arrives via a system;
- Customer places an order by telephone;
- Customer enters a branch;
- Patient arrives at the emergency room.

But this does not mean that the value flow is structured according to the pull principle:

- Departments (internal customers) determine themselves where the priorities are;
- Blood collection from patients ("rainbow draw"): taking too many tubes with blood than necessary.



Slimmer werken,
blije klanten

Kenmerken van een Pull-systeem dienstensector

In the service sector, Pull often focuses on **information** and **people** (customers and employees)

Pull often takes the form of a Sequential Pull System:

- Maximum amount of work in progress (WIP cap)
- Process applications according to FIFO principle or other agreements
- Add capacity to fluctuating customer demand
- Service level agreements between departments (VOC)

Benefits pull in the service sector

- Higher reliability of services
- Process easier to control
- Improved staffing (flexible)



Slimmer werken, blije klanten

Assignment

Information about the current situation

- Exit Rate = 10 orders per hour
- WIP = 20 orders
- Process Time = 3 minutes per order
- Available time = 100 hours

Question 1

- Calculate the current PLT and PCE

Question 2

If management wants a PCE of 10% in the new situation, what is the matching PLT?

- What should the WIP-cap be in order to realise this?

Slimmer werken,
blije klanten

Elaboration

Elaboration question 1: Calculate current PLT and PCE

- Calculate the Process Lead Time:

  Process Lead Time = WIP / Exit Rate

  20 / 10 orders per hour = 2 hours (120 minutes)

- Calculate the Process Efficiency Cycle:

  Process efficiency = (total process time / process lead time) x 100%

  (3 minutes / 120 minutes) x 100% = 2,5%

Uitwerking

Question 2

If management wants a PCE of 10% in the new situation, what is the match

Process efficiency = (total process time / process lead time) x 100%

(3 minutes / process lead time) * 100% = 10%

(3 minutes / process lead time) = 0,1

Process Lead time = 3 minutes / 0,1 = 30 minutes (0,5 hour)

- What should the WIP-cap be in order to realise this?

Process Lead time = WIP / Exit Rate

0,5 hour = WIP / 10 orders per hour

WIP = 0,5 hour * 10 orders per hour = 5 orders

Slimmer werken,
blije klanten

Simulation game

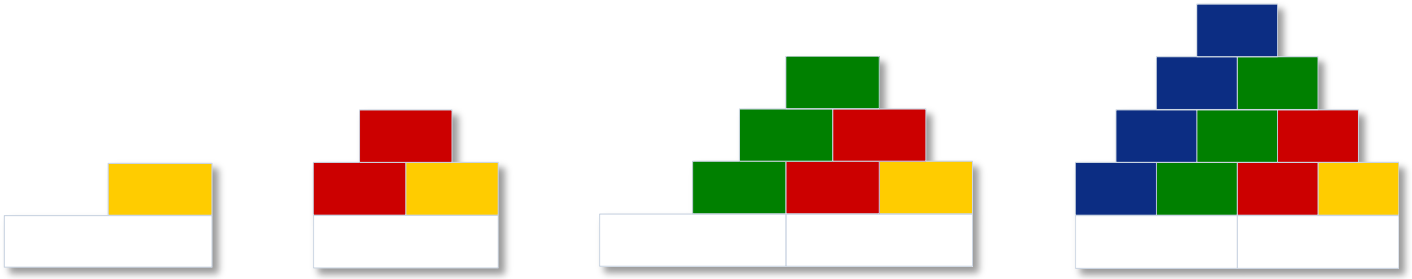
Experiencing Flow en Pull



Slimmer werken,
blije klanten

Simulation game

Experiencing Flow en Pull



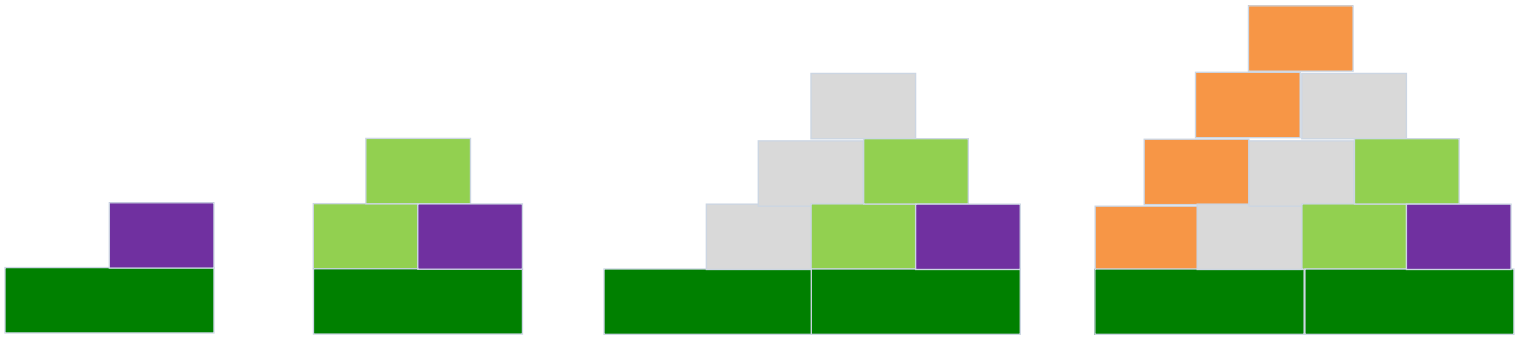
Step 1 **Step 2** **Step 3** **Step 4**

- No pre-work: Only start when you recived the semi-finished product
- No repairs: If a mistake is made, just pass it down as is.
- Work at normal speed (not too fast, not too slow)
- Don’t help your colleagues: max 1 person per station

Slimmer werken,
blije klanten

Simulation game

Experiencing Flow en Pull



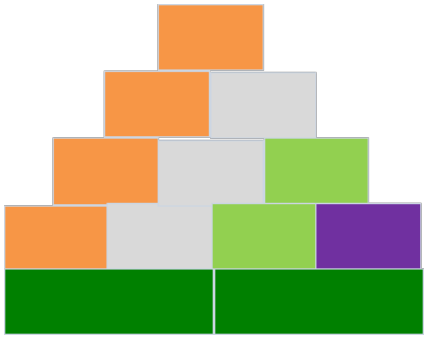
- No pre-work: Only start when you recived the semi-finished product
- No repairs: If a mistake is made, just pass it down as is.
- Work at normal speed (not too fast, not too slow)
- Don’t help your colleagues: max 1 person per station

Slimmer werken,
blije klanten

Simulation game

After each round:

- What is the process time?
- What is the Process Lead Time according to Little's Law?
- What is the Process Cycle Efficiency?
- What is the Exit Rate?



Slimmer werken,
blije klanten

End of day 4

Next time:

- Six Sigma
  - Minitab
- Lean Management
  - 5th principle: Perfection
- Questions?

Slimmer werken,
blije klanten

bureau tromp

LEAN &
SIX SIGMA

Green Belt training

Lean Six Sigma

Slimmer werken,
blije klanten

Day 5

Schedule day 5

- Minitab
- 5th Principle Lean: Perfection
- Practice exam

Slimmer werken,
blije klanten

Minitab

- Introduction Minitab
  - Introduction
  - Menu

- Analysis
  - Graphic analysis
  - Process capability and Yield calculation
  - Hypothesis testing

- Extra
  - Practice exercises
  - Z-tables

Slimmer werken, blije klanten

Minitab

Why Minitab?



To help us with the use of statistical methods

Minitab is a statistics program, and is:

- Easy to use
- Perfect match with Lean Six Sigma
- With lots of opportunities, more than we need
- Helping us with our limited knowledge of statistics
- Used in the entire world

Slimmer werken,
blije klanten

Minitab

Minitab is an aid

So:

- Minitab is not equal to Lean Six Sigma
- Minitab is not a tool for change management
- Minitab answers questions about the data YOU ask

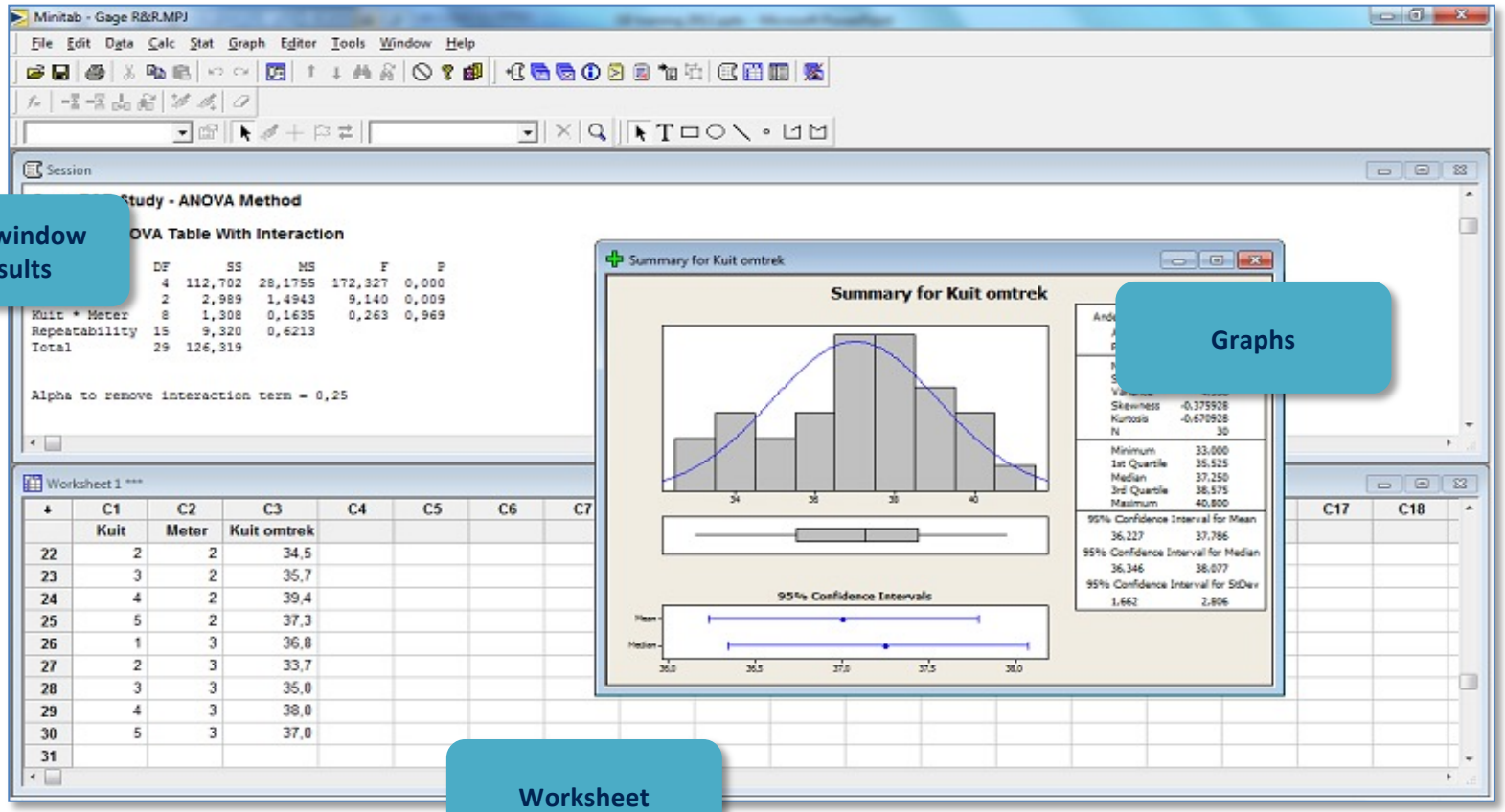
Three displays:

- Session
- Worksheet
- Projectmanager

Slimmer werken,
blije klanten

Minitab

What does Minitab look like?



Session window for results

Graphs

Worksheet

Slimmer werken, blije klanten

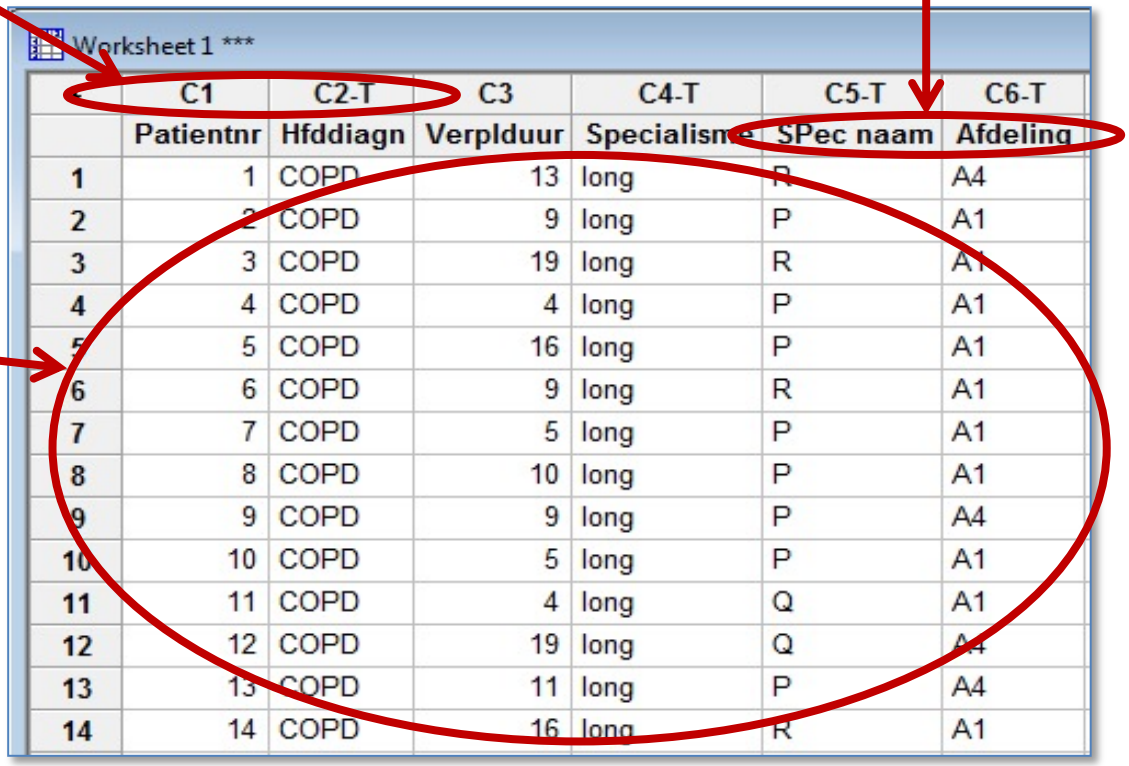
Minitab

What does Minitab look like?

Data type:
C1: numerical
C2-T: text

Column title

Data



Worksheet 1 ***

	C1	C2-T	C3	C4-T	C5-T	C6-T
	Patientnr	Hfddiagn	Verplduur	Specialisme	SPec naam	Afdeling
1	1	COPD	13	long	R	A4
2	2	COPD	9	long	P	A1
3	3	COPD	19	long	R	A1
4	4	COPD	4	long	P	A1
5	5	COPD	16	long	P	A1
6	6	COPD	9	long	R	A1
7	7	COPD	5	long	P	A1
8	8	COPD	10	long	P	A1
9	9	COPD	9	long	P	A4
10	10	COPD	5	long	P	A1
11	11	COPD	4	long	Q	A1
12	12	COPD	19	long	Q	A4
13	13	COPD	11	long	P	A4
14	14	COPD	16	long	R	A1

Slimmer werken,
blije klanten

Putting data into Minitab

There are different ways to put data into Minitab:

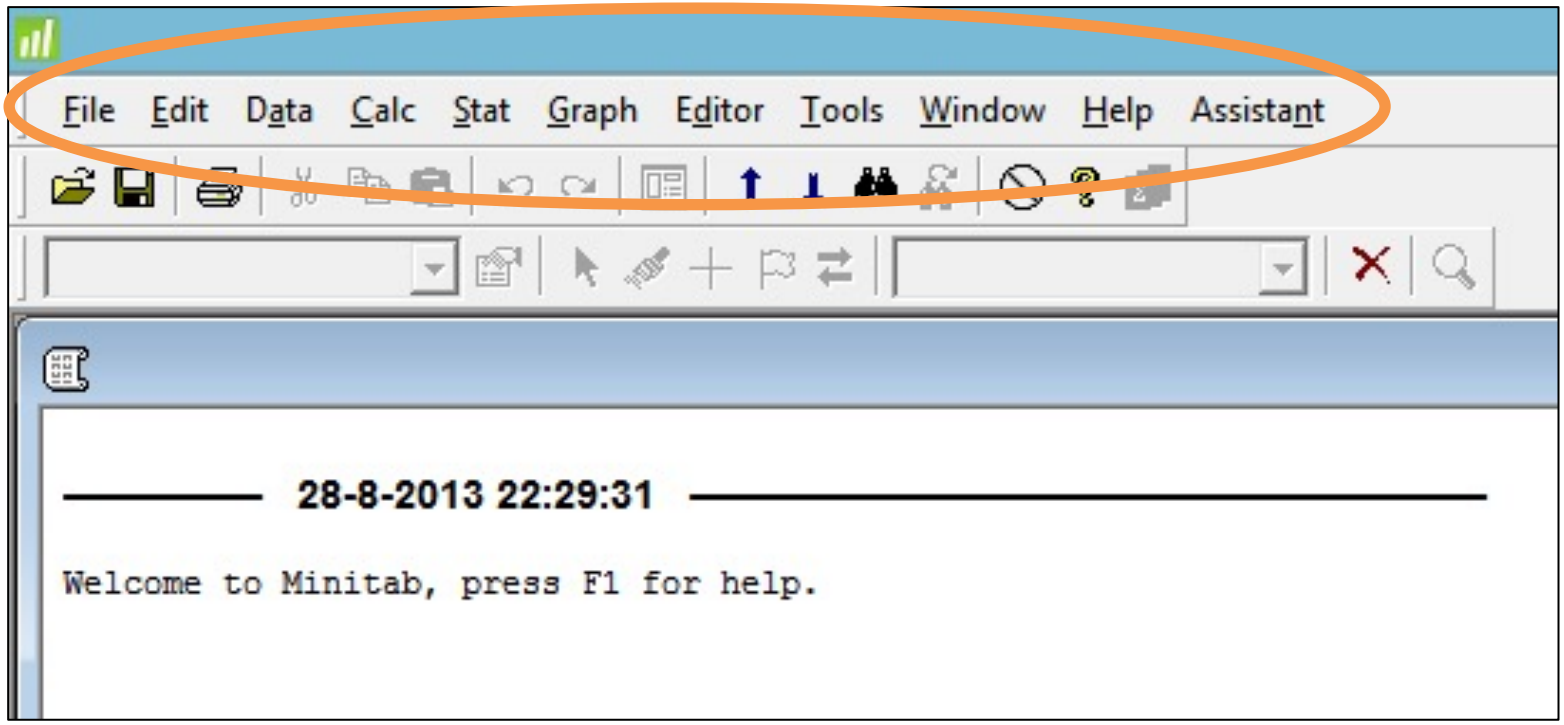
- Type data
- Copy paste data from an other application (for example Excel or Acces)
- Import data from Excel
- Use a ODBC-link to import (real time) data with a query

Because of the inconvenient way of data processing, the easiest way is to use Excel and then copy/import the data into Minitab!

Minitab menu

bureau tromp
LEAN & SIX SIGMA

Start Minitab and look…

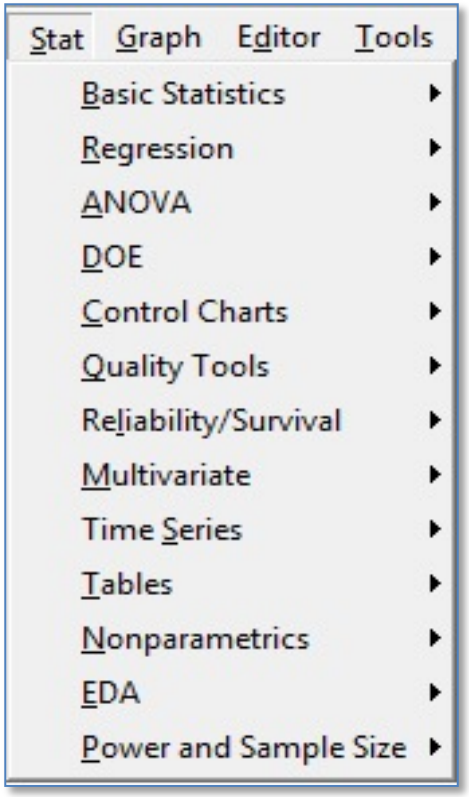


Slimmer werken,
blije klanten

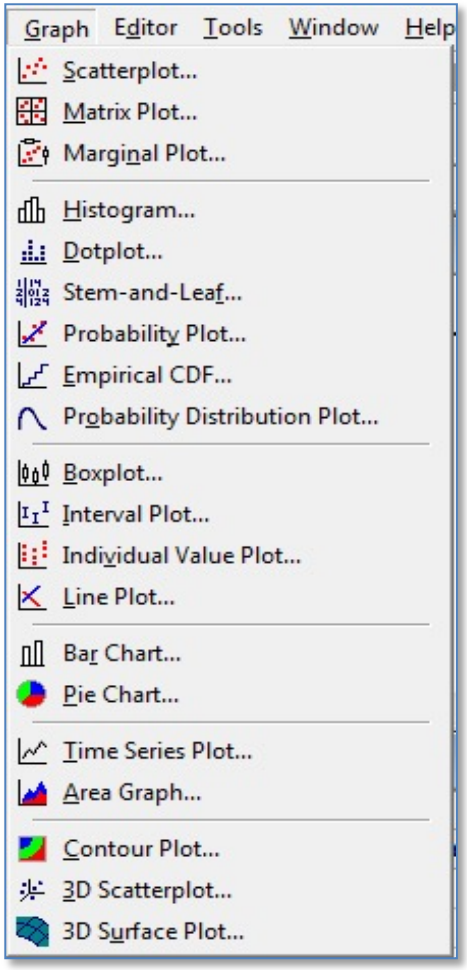
Minitab menu

Most used options: Stat and Graph

Stat menu

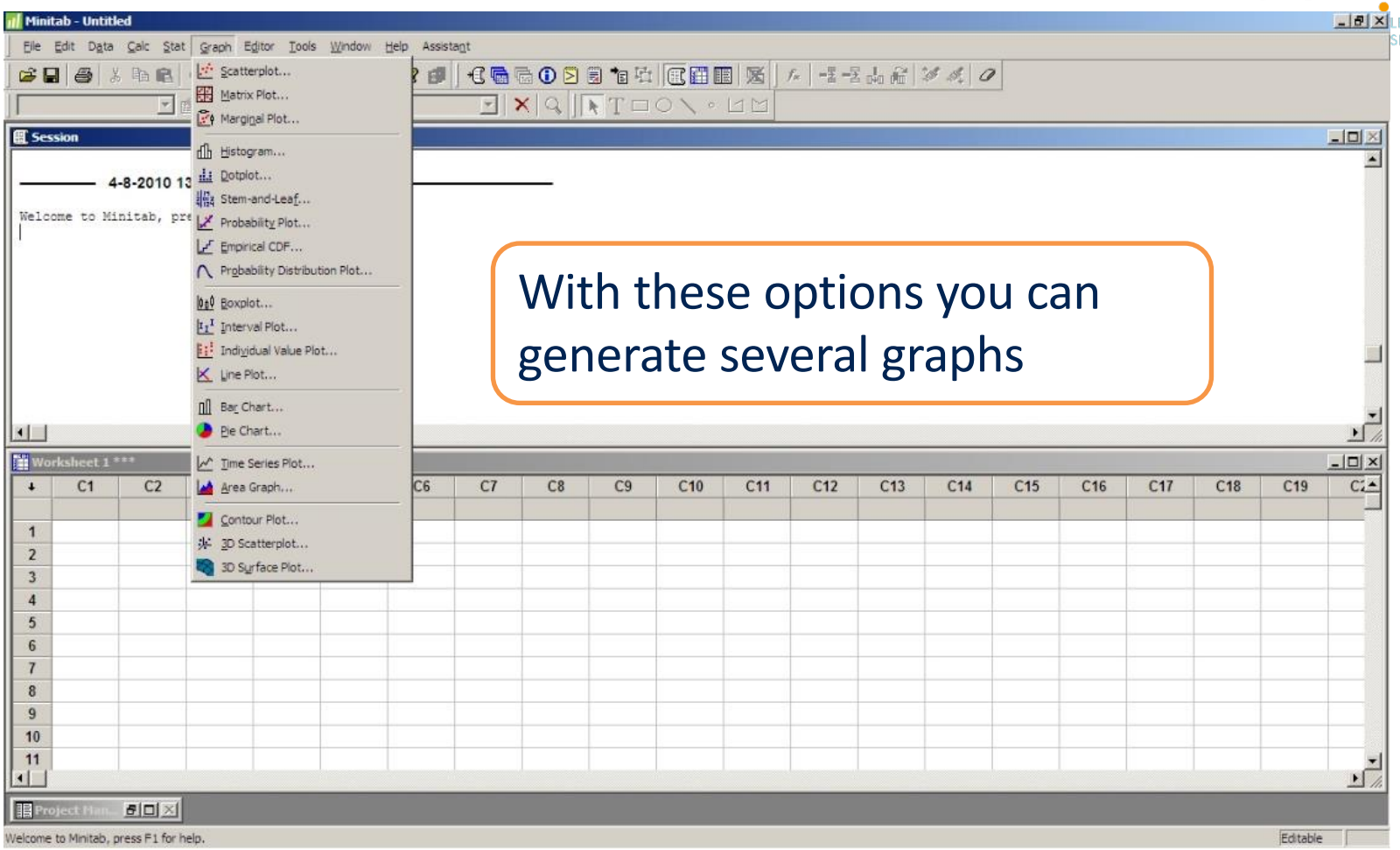


Graph menu



Slimmer werken,
blije klanten

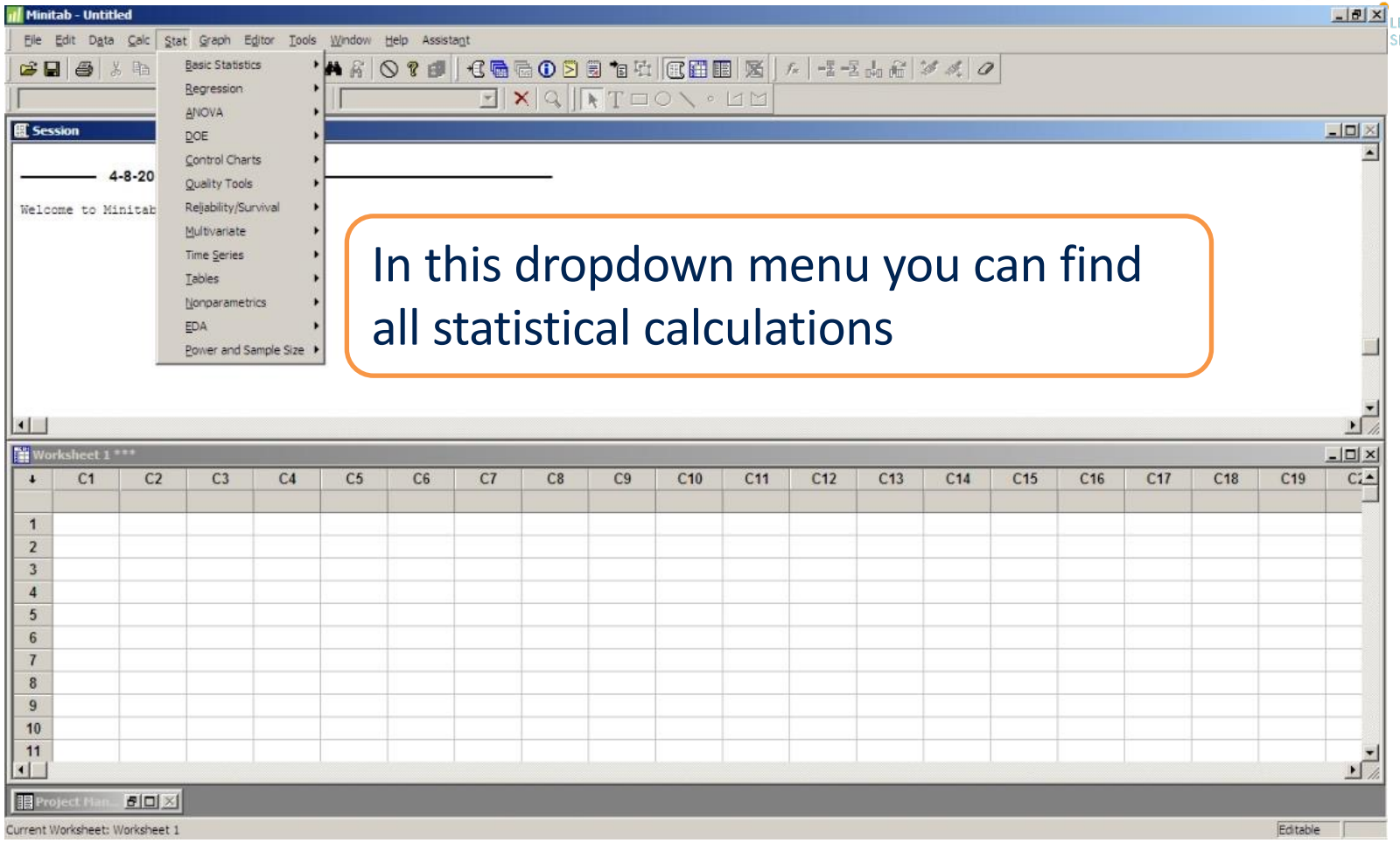
Minitab menu: Graphs



With these options you can generate several graphs

Slimmer werken, blije klanten

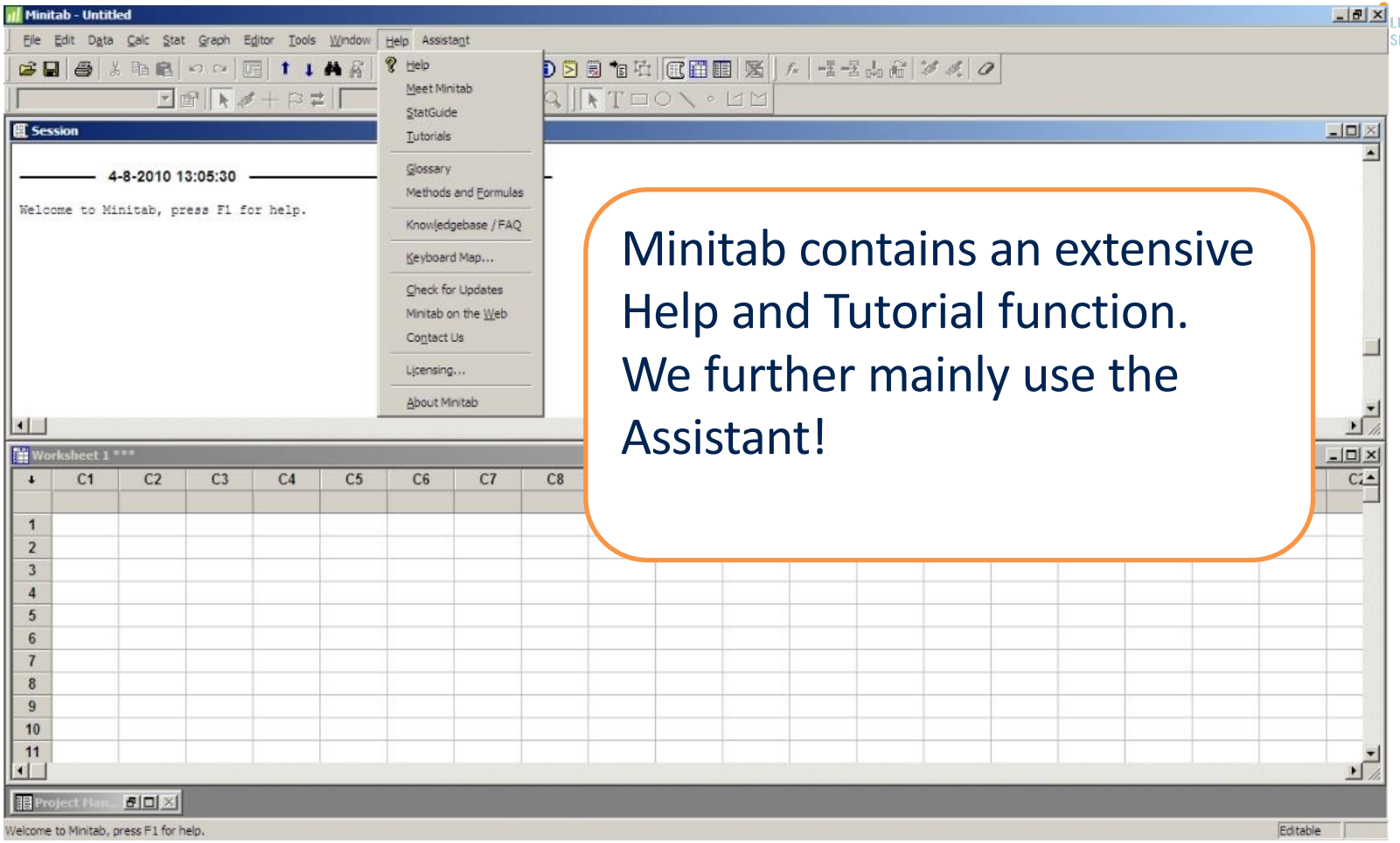
Minitab menu: Stat



In this dropdown menu you can find all statistical calculations

Slimmer werken, blije klanten

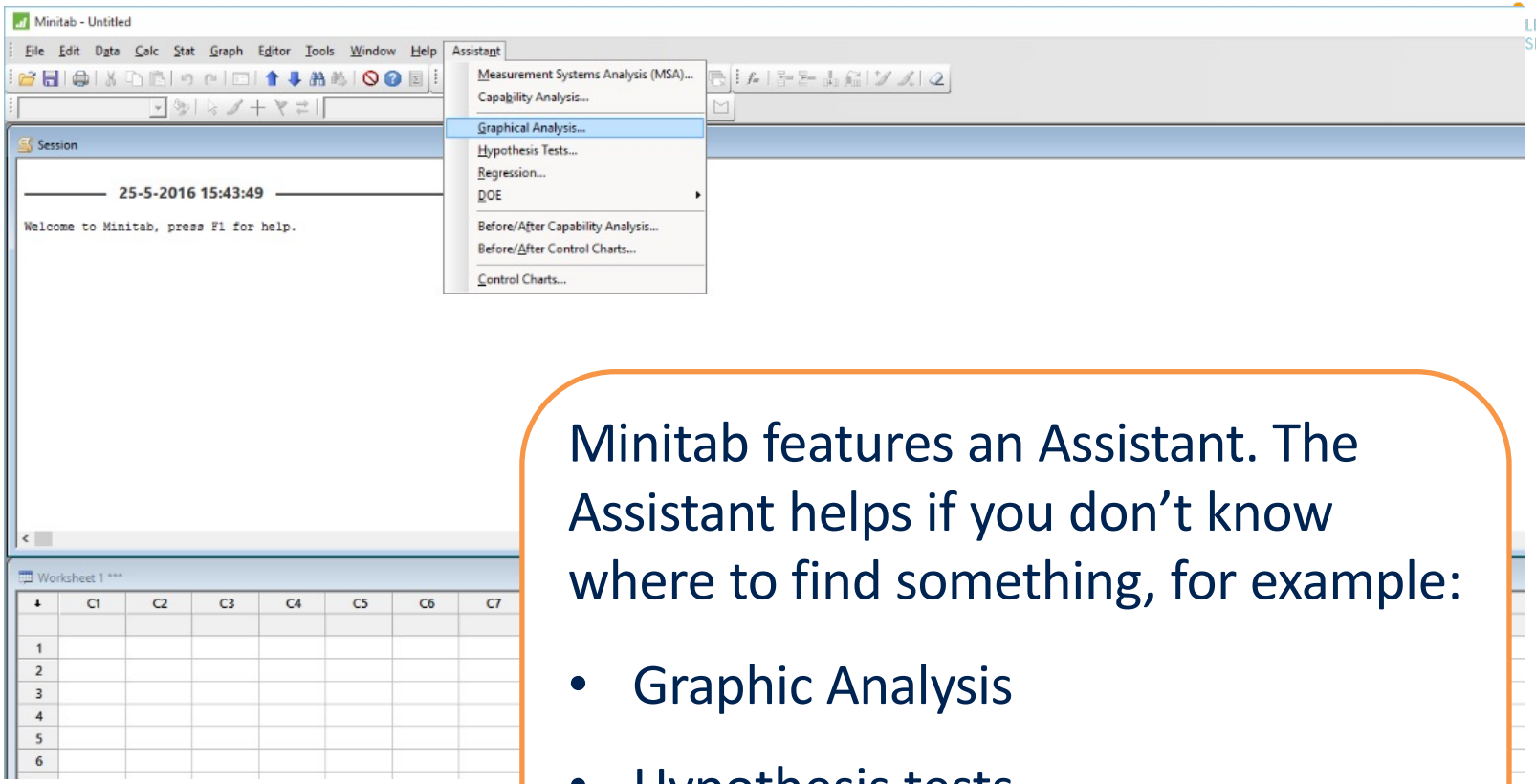
Minitab menu: Help



Minitab contains an extensive Help and Tutorial function. We further mainly use the Assistant!

Slimmer werken, blije klanten

Minitab menu: Assistant



Minitab features an Assistant. The Assistant helps if you don't know where to find something, for example:

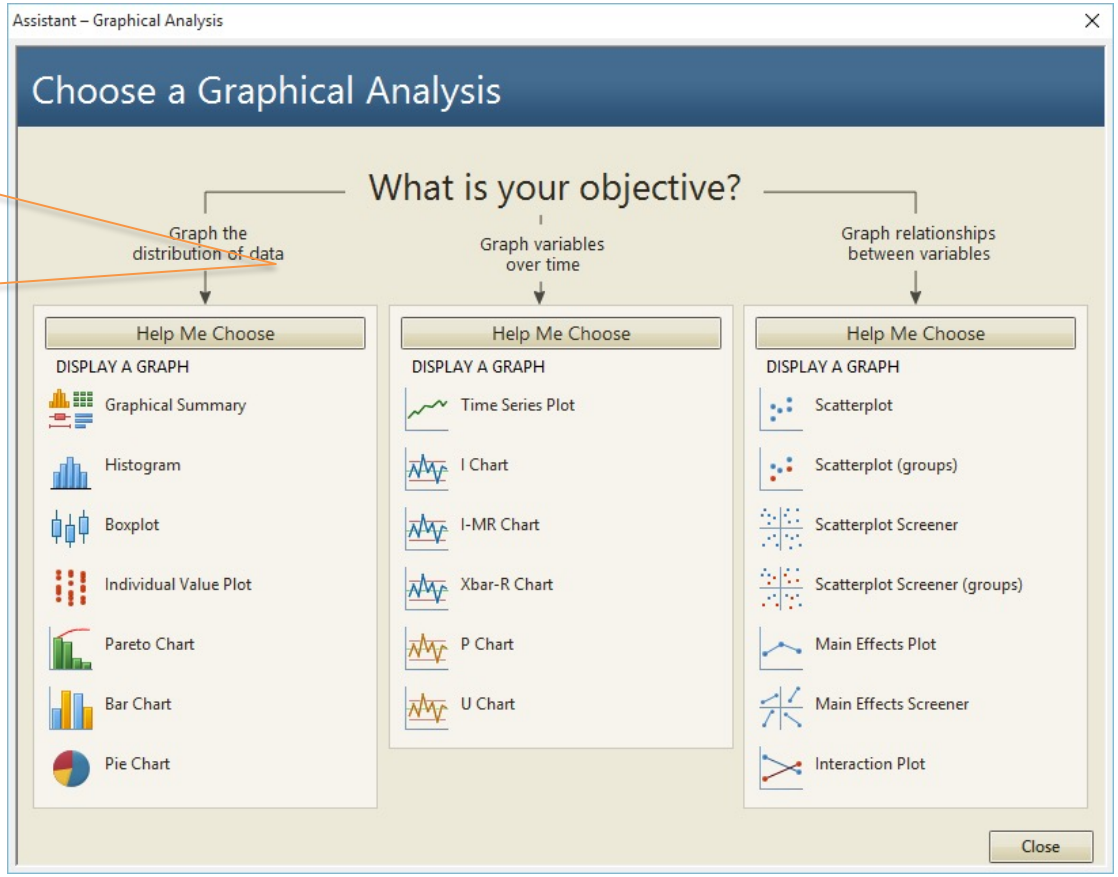
- Graphic Analysis
- Hypothesis tests

Slimmer werken, blije klanten

Minitab Assistant: Grafic analysis

We limit our use of Minitab to the most common tools:

- Control Chart
- Graphic Summary
- Histogram
- Boxplot
- Pareto Chart
- Bar Chart
- Pie Chart



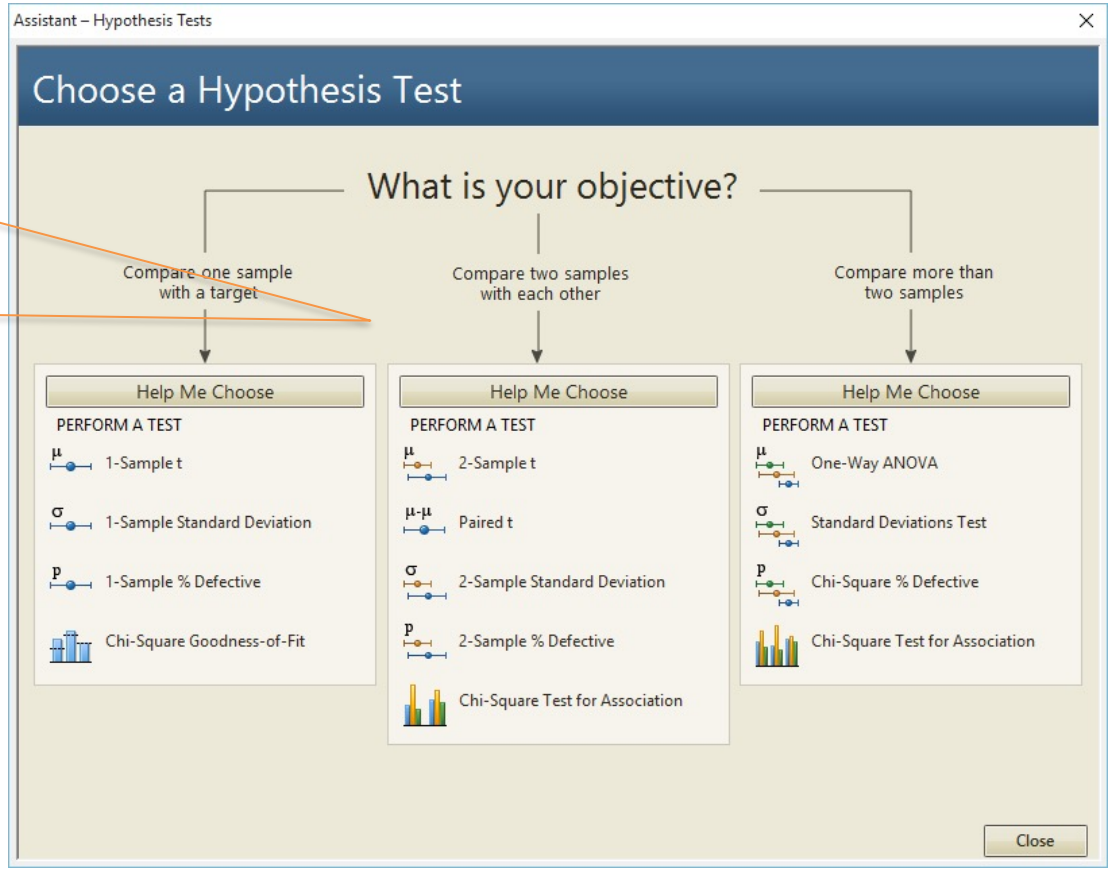
Please note: It is faster and better to make a Bar and Pie Chart in Excel (and therefore we perform those functions there!)

Slimmer werken, blije klanten

Minitab Assistant: hypothesis testing

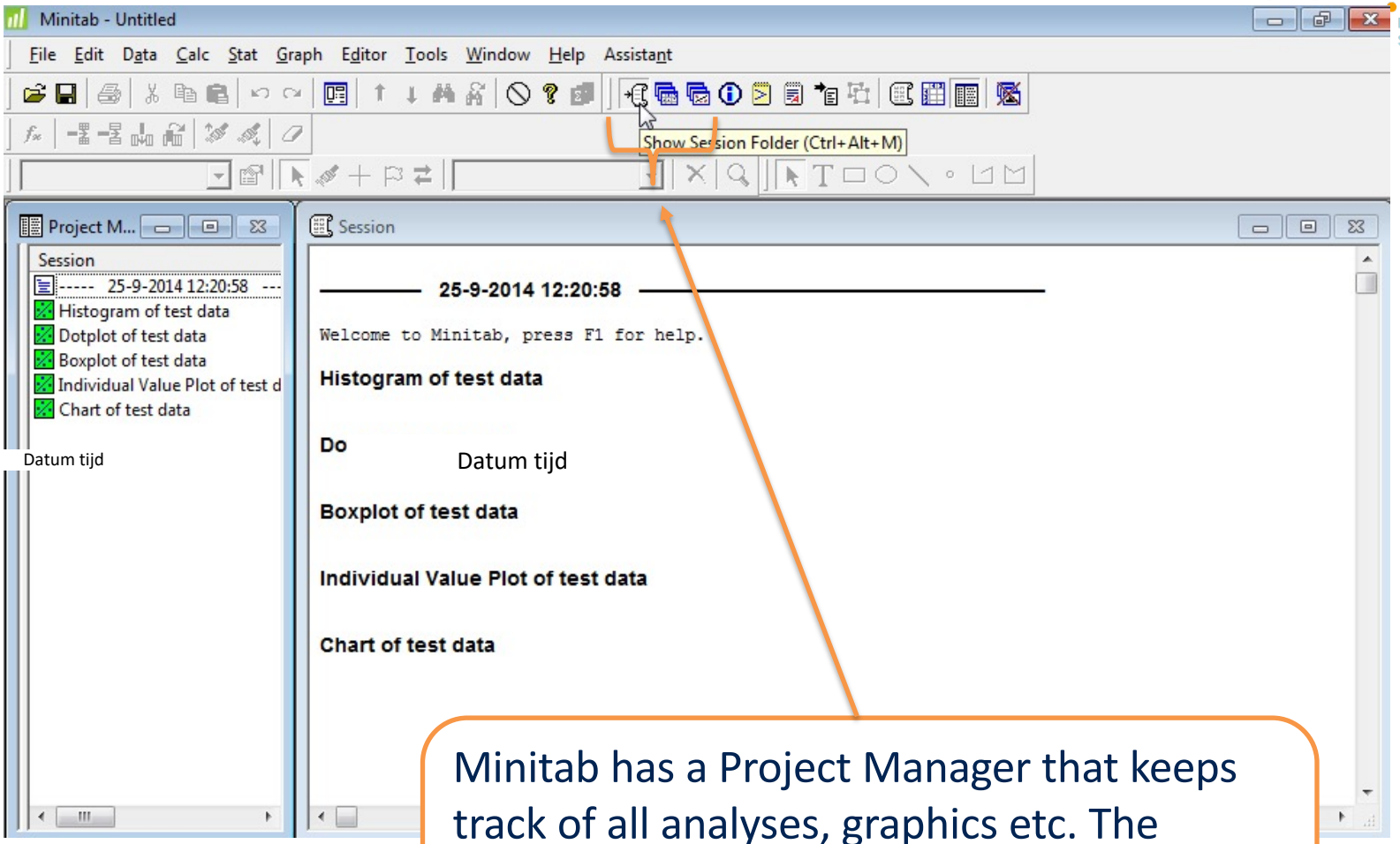
Here we also limit our use to the most common tools:

- 1-Sample t-test
- 2-Sample t-test
- One-Way ANOVA



Slimmer werken, blije klanten

Minitab menu: Project Manager



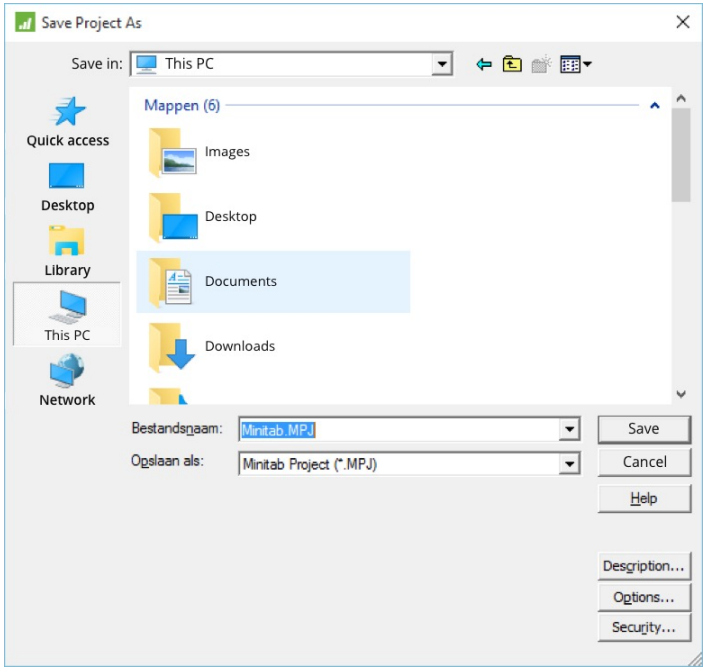
Minitab has a Project Manager that keeps track of all analyses, graphics etc. The Session Folder shows this summary.

Slimmer werken, blije klanten

Saving a project

- File > Save Project As > Choose an appropriate location and name

- The saved file gets a .MPJ extension = Minitab Project File



Slimmer werken,
blije klanten

Minitab

- Introduction Minitab
  - Introduction
  - Menu

- Analysis
  - Graphic analysis
  - Process capability and Yield calculation
  - Hypothesis testing

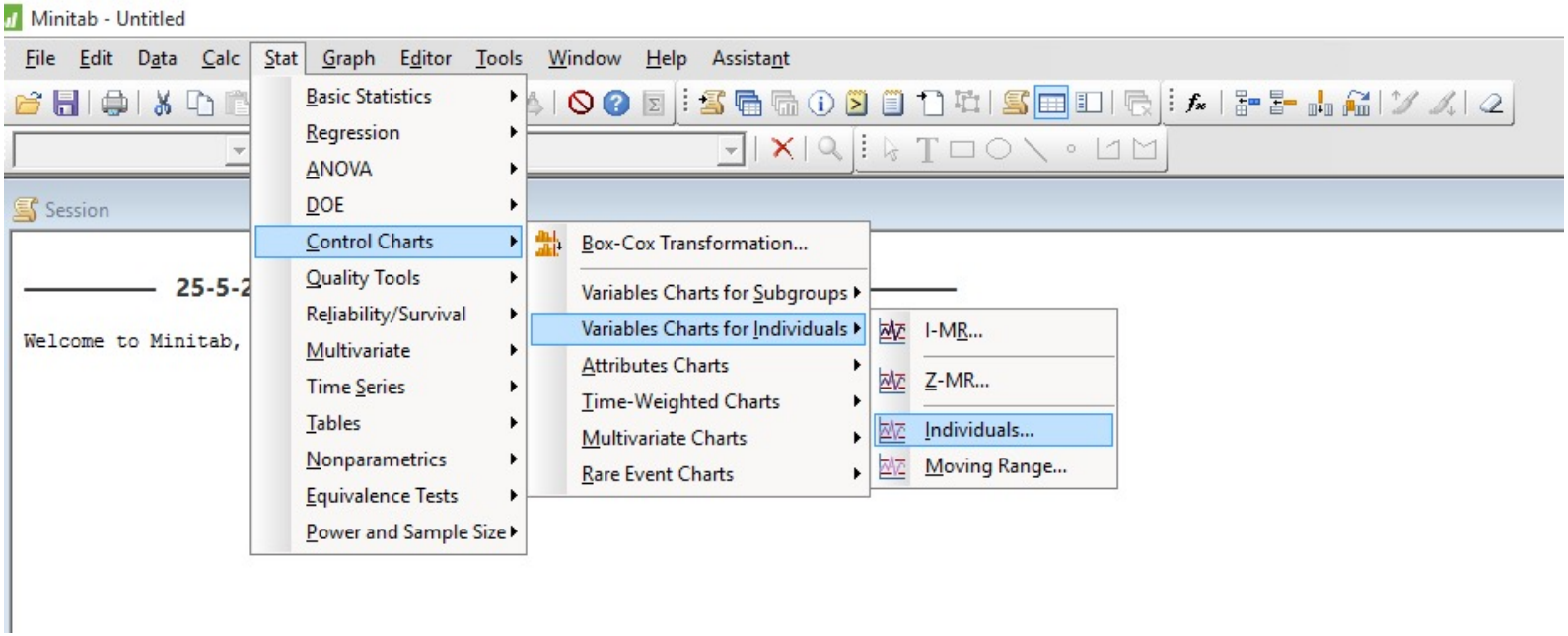
- Extra
  - Practice questions
  - Z-tables

Slimmer werken,
blije klanten

Control chart

Via Stat > Control Charts

- Shows trends, shifts or patterns in the output of a process in time.
- Important instrument to understand how a process progresses.

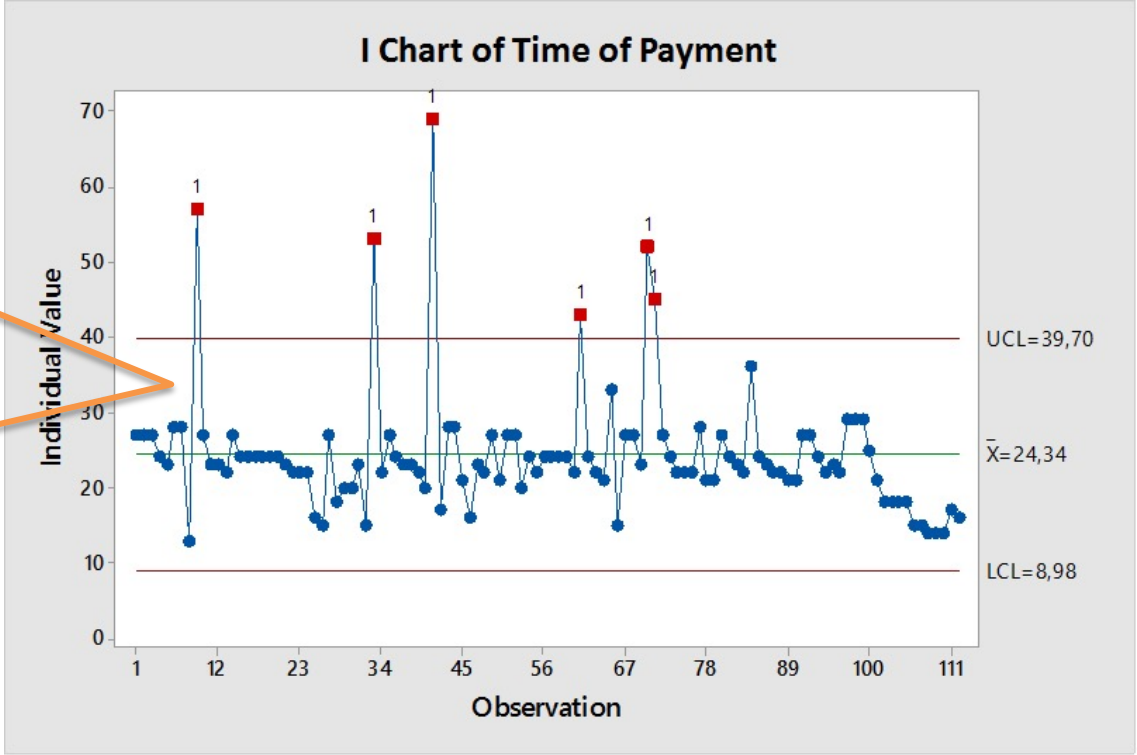


Slimmer werken,
blije klanten

Control Chart

A control Chart gives an answer to the question; is my proces in control?

- All measures between the UCL and LCL? Process is in control
- A single measure outside control limits? Incident, no action
- Multiple measures outside limits? Action necessary, process not in control

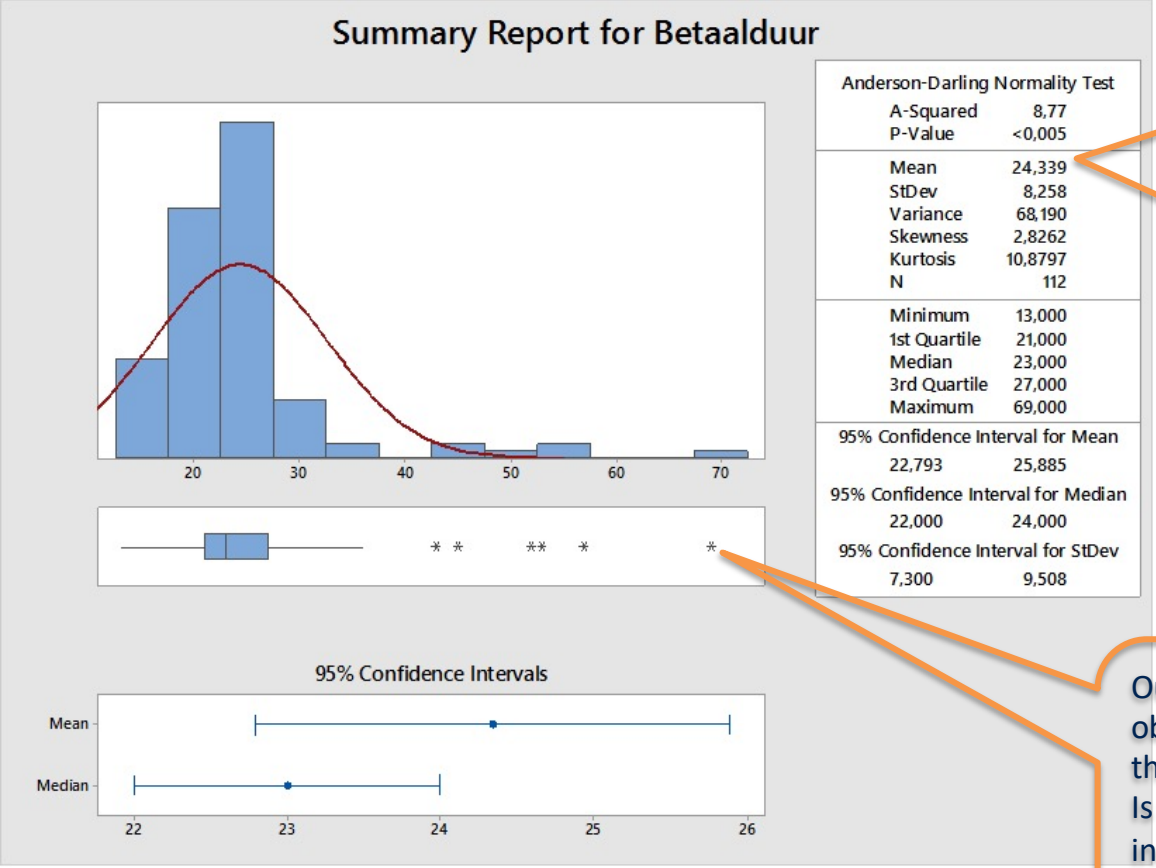


Slimmer werken, blije klanten

Graphic summary

Via Stat > Basic Statistics

- Graphical representation of statistical data.



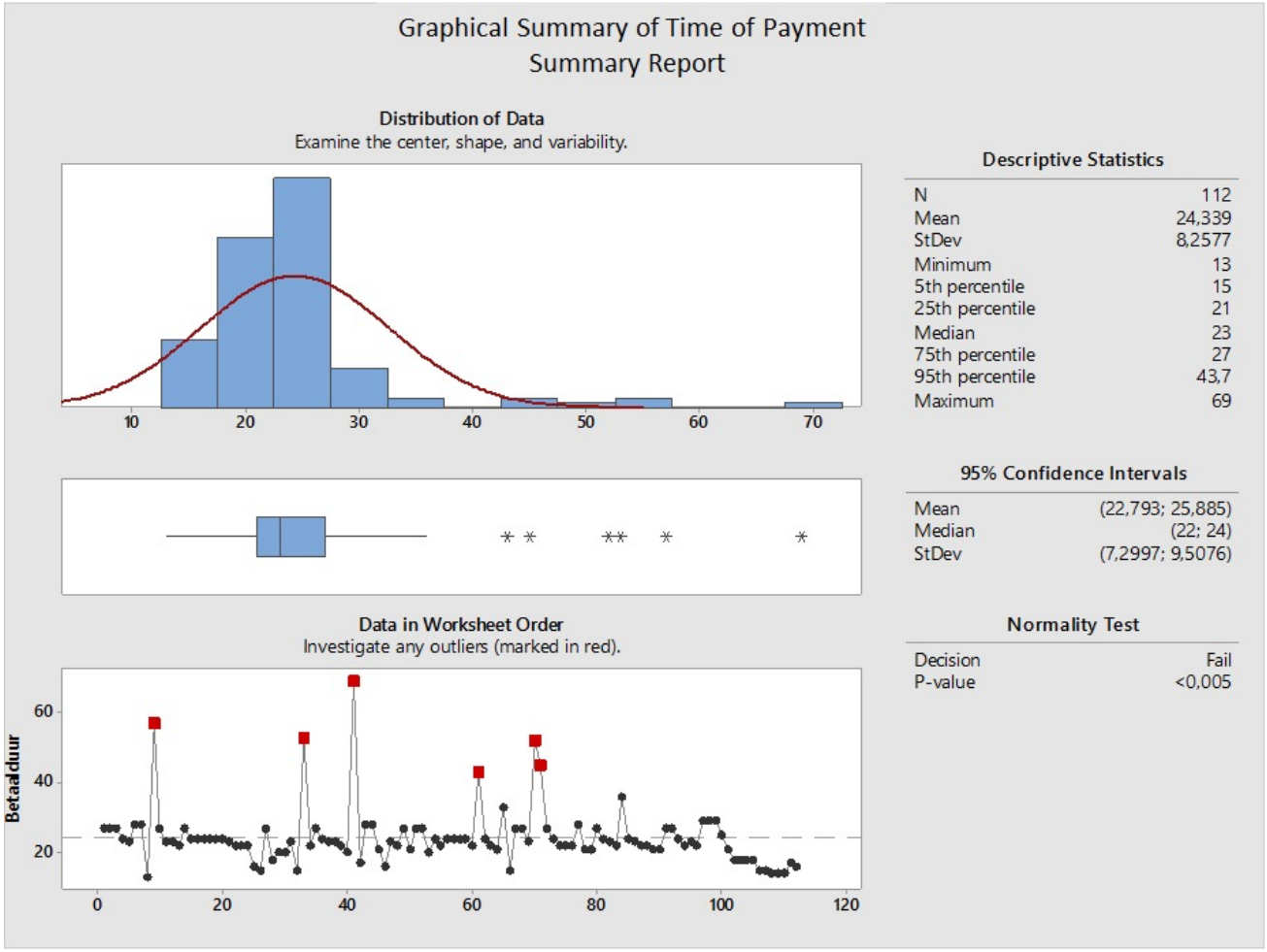
- N = number of observations
- StDev = Sigma-value (standard deviation)

Outliers: extreme observations relative to the rest
Is this observation an incident or should we call for action?

Slimmer werken, blije klanten

Graphic summary

Via Assistant

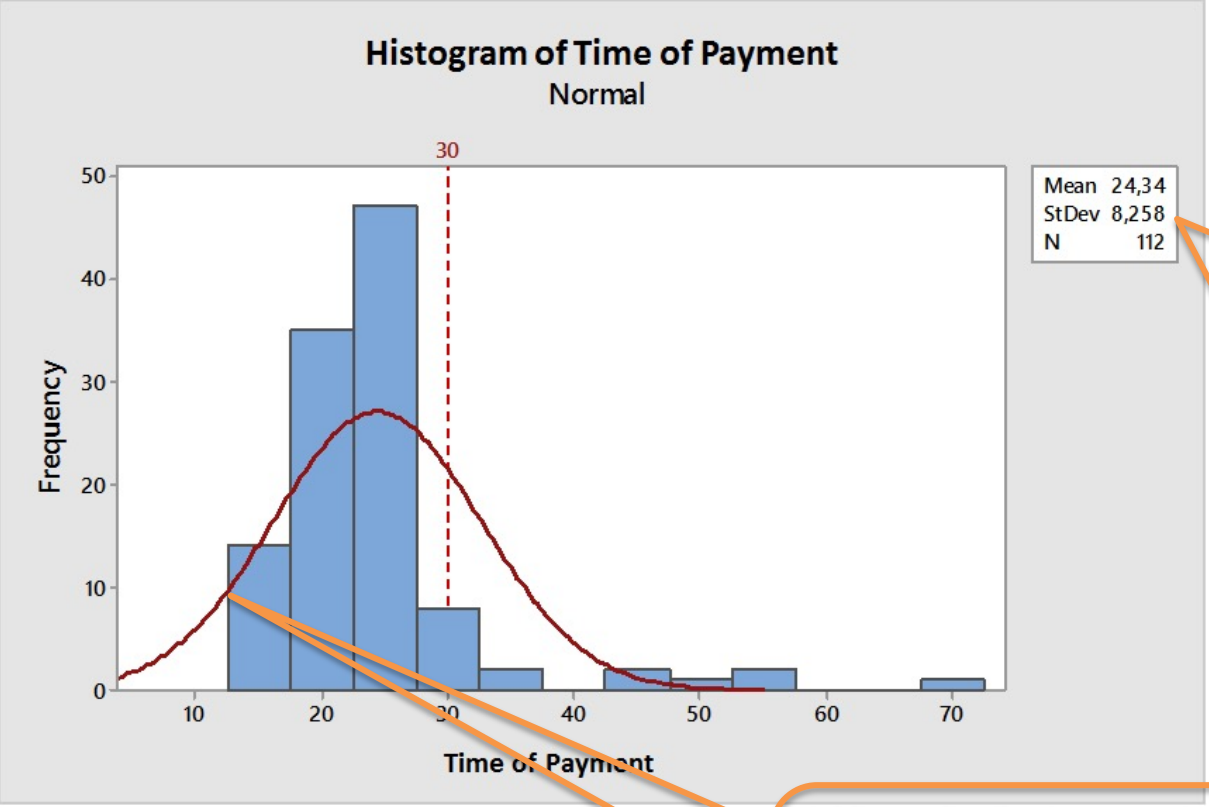


Slimmer werken, blije klanten

Histogram

Via Graph > Histogram

- Simple representation of the distribution of continuous data.



Strictly seen almost the same information as in graphical summary, but without statistical information

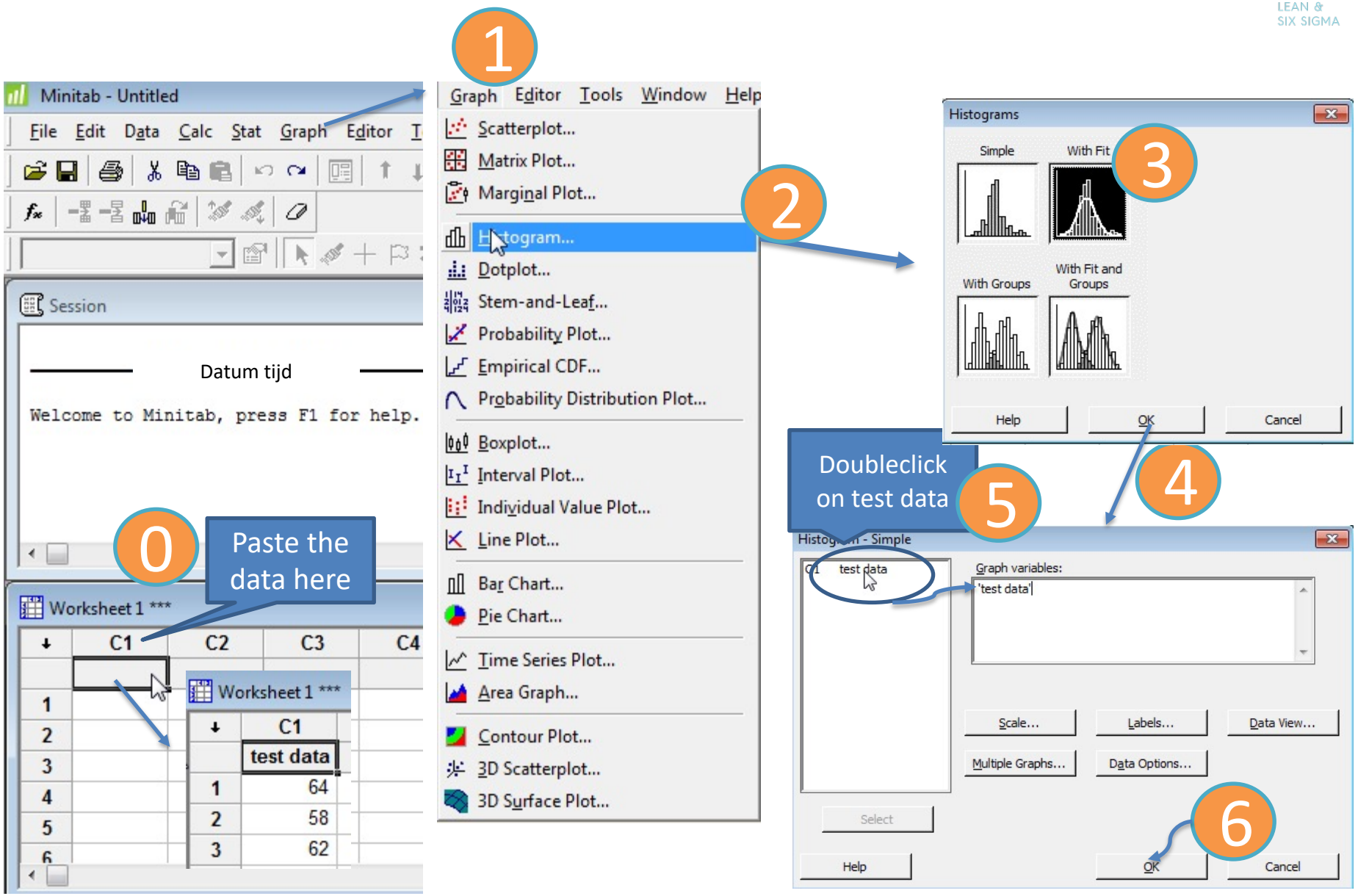
Better to use in communication for management / projectgroup.

Adding a distribution curve is optional ('with fit').

You can add a limit to the graph by clicking on your right mouse button and selecting > add > reference line

Slimmer werken, blije klanten

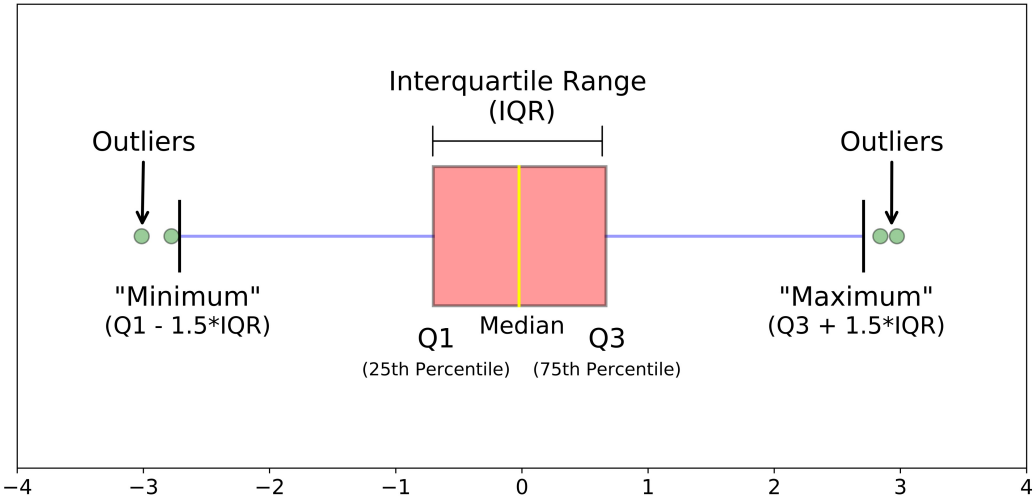
Example: Making a Histogram

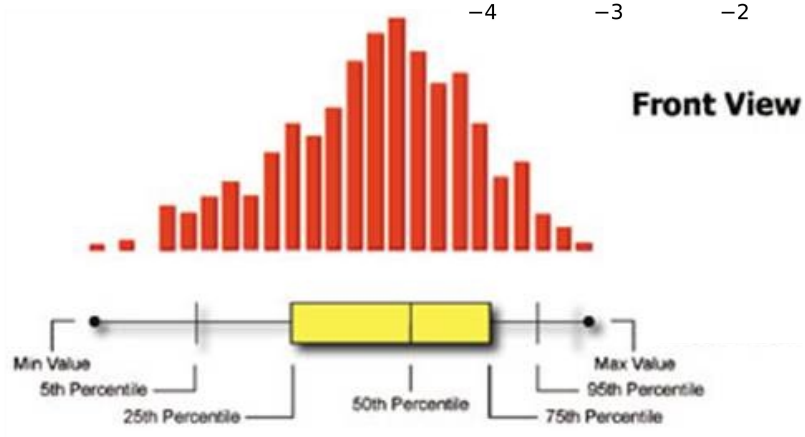


Boxplot

Via Graph > Boxplot

- Simple way of displaying the position and range of continuous data.
- Makes it possible to rapidly compare data sets.



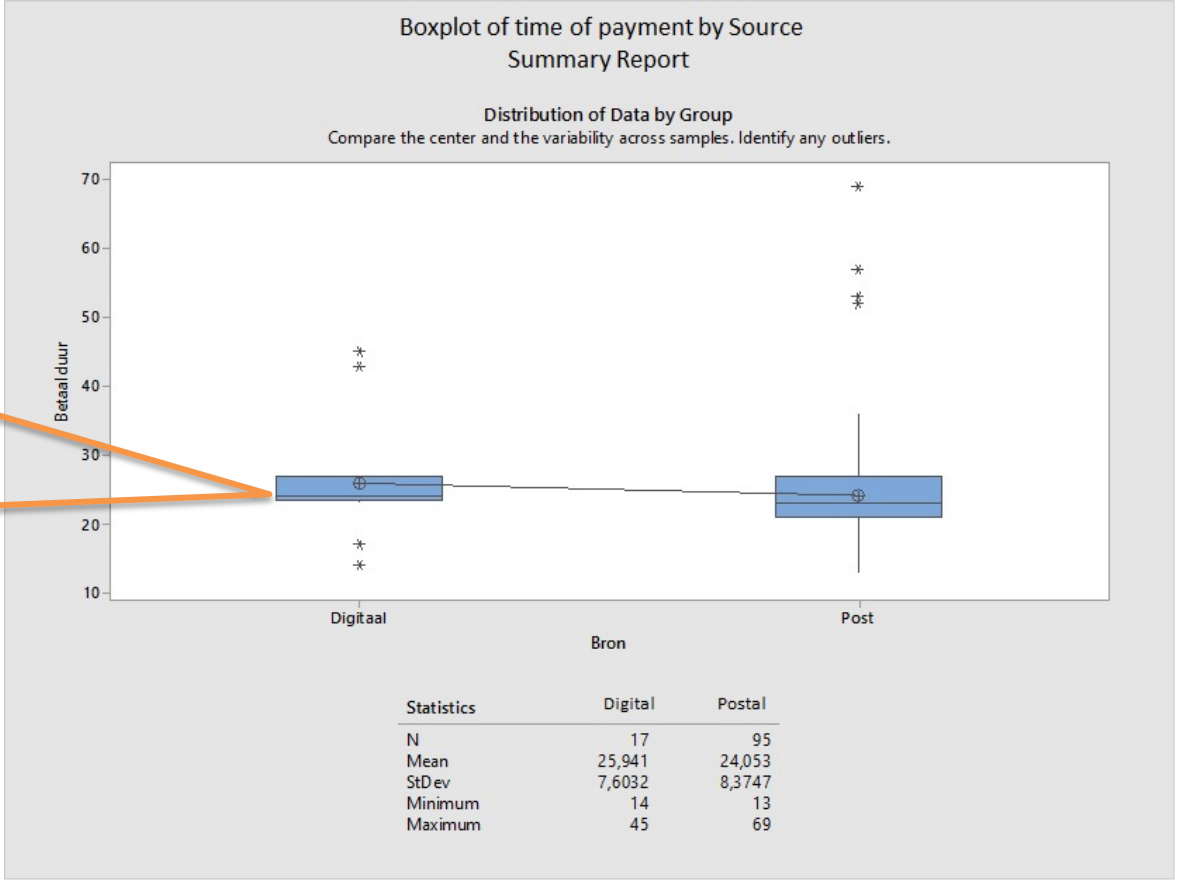


Slimmer werken,
blije klanten

Boxplot

Boxplotting makes it possible to compare different data sets

The 2-sample t-test for statistic difference is easier however



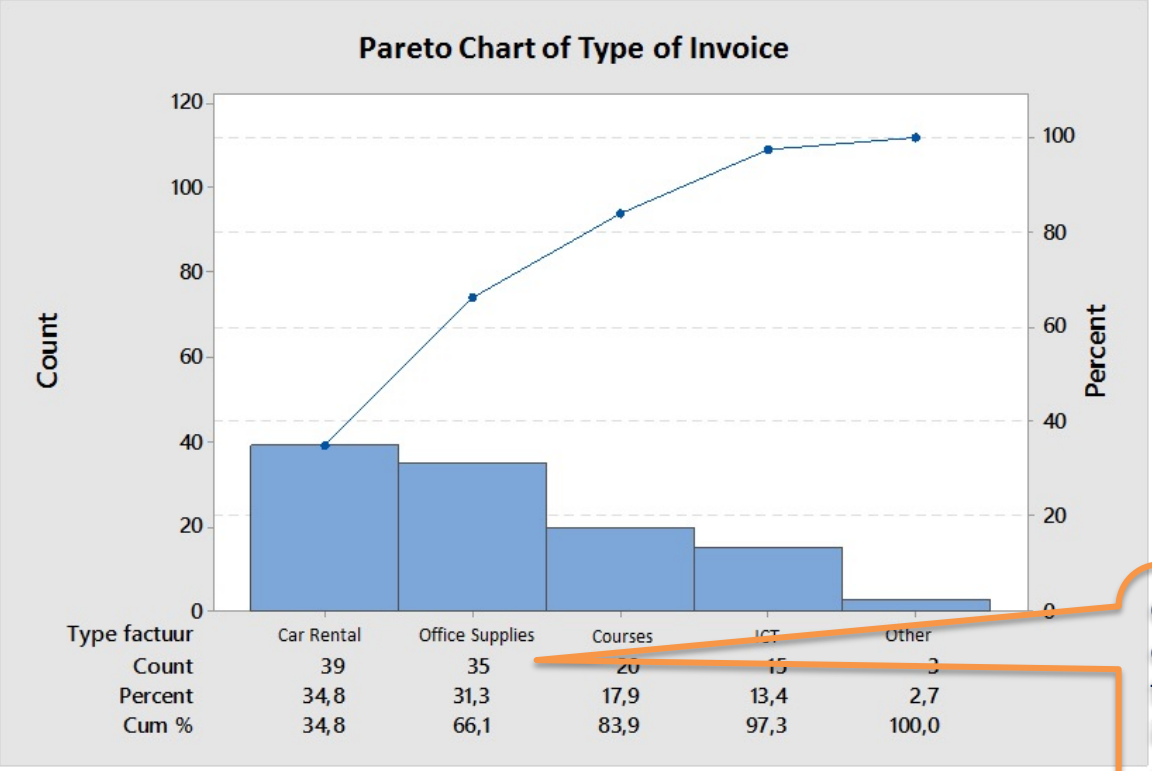
Statistics	Digital	Postal
N	17	95
Mean	25,941	24,053
StDev	7,6032	8,3747
Minimum	14	13
Maximum	45	69

Slimmer werken, blije klanten

Pareto chart

Via Stat > Quality Tools

- 80/20 Rule: 20% of the causes is responsponsible for 80% of the problems.

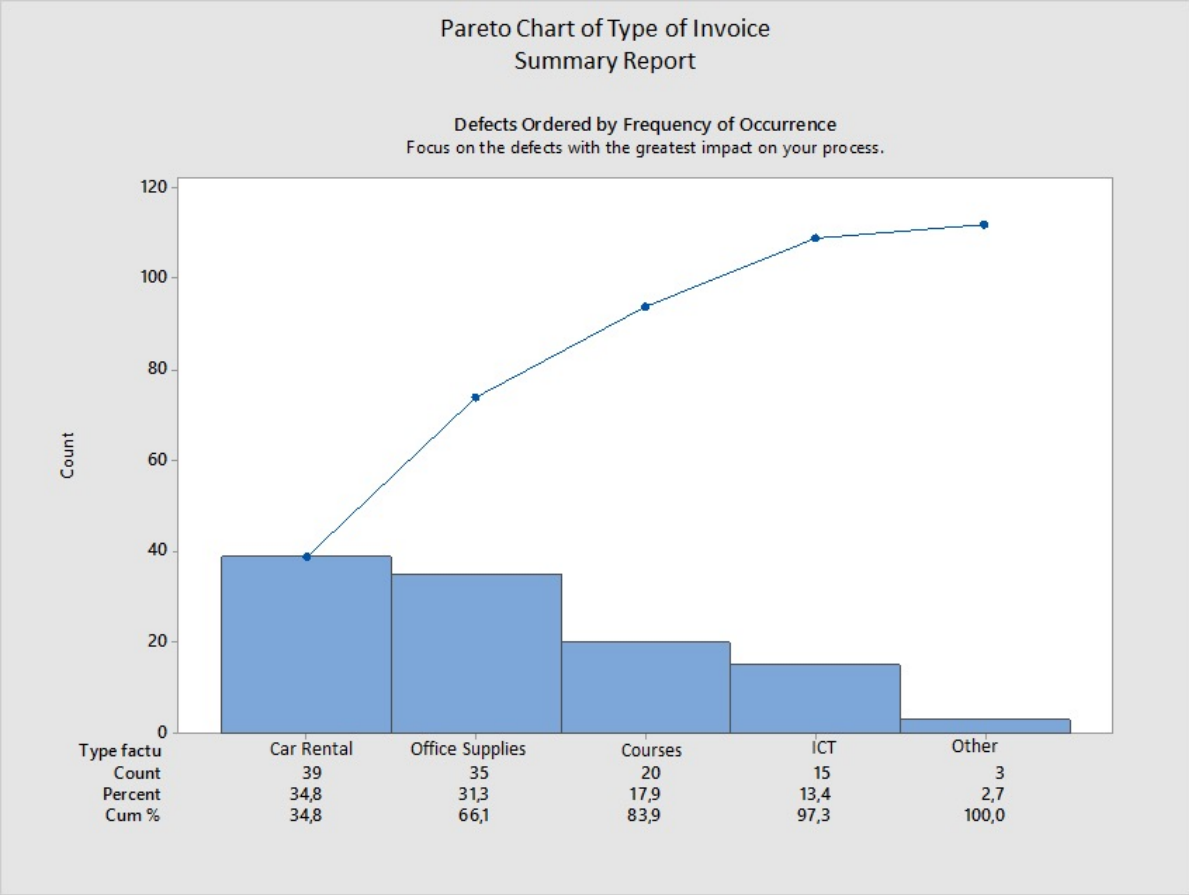


Graphical overview of most important factors (for instance defects or complaints)

Slimmer werken, blije klanten

Pareto chart

Via Assistant (cumulative percentage is missing)



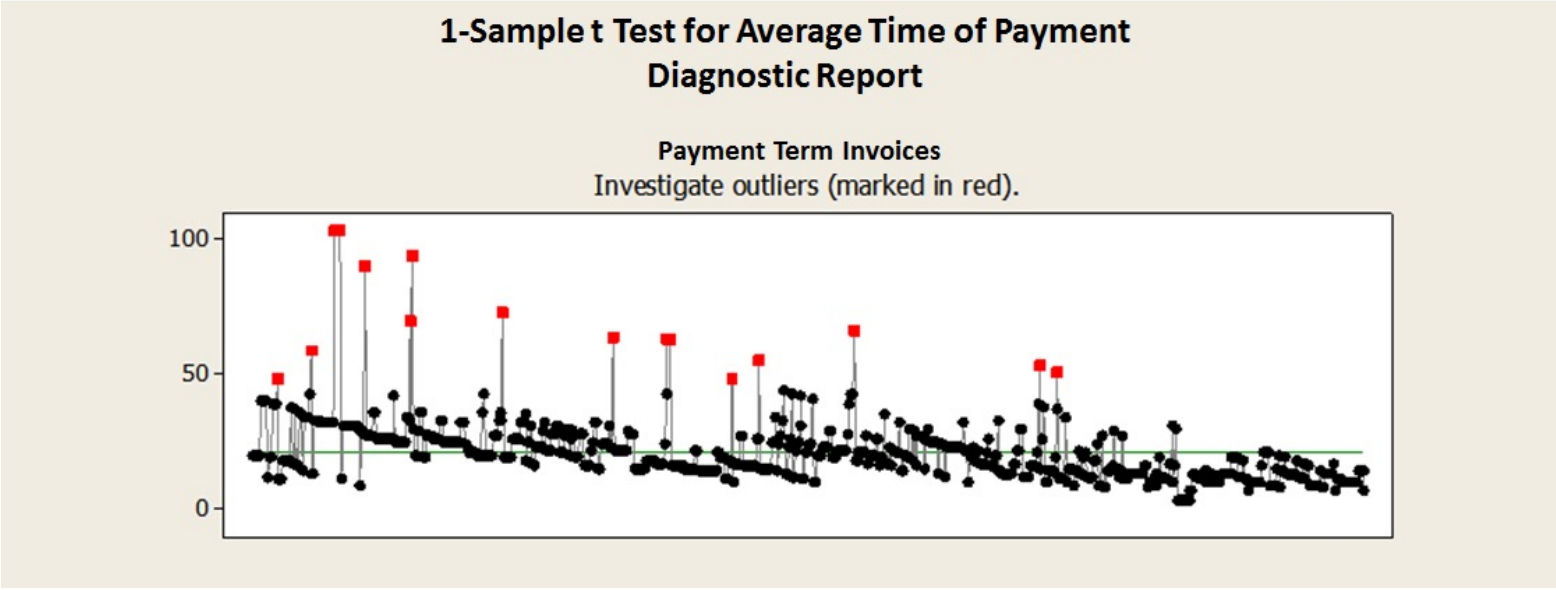
Slimmer werken, blije klanten

Run Chart (time series plot)

bureau tromp
LEAN & SIX SIGMA

Via Stat > Time Series

- Display of trends, shift or patterns in a process with continuous or discrete data.



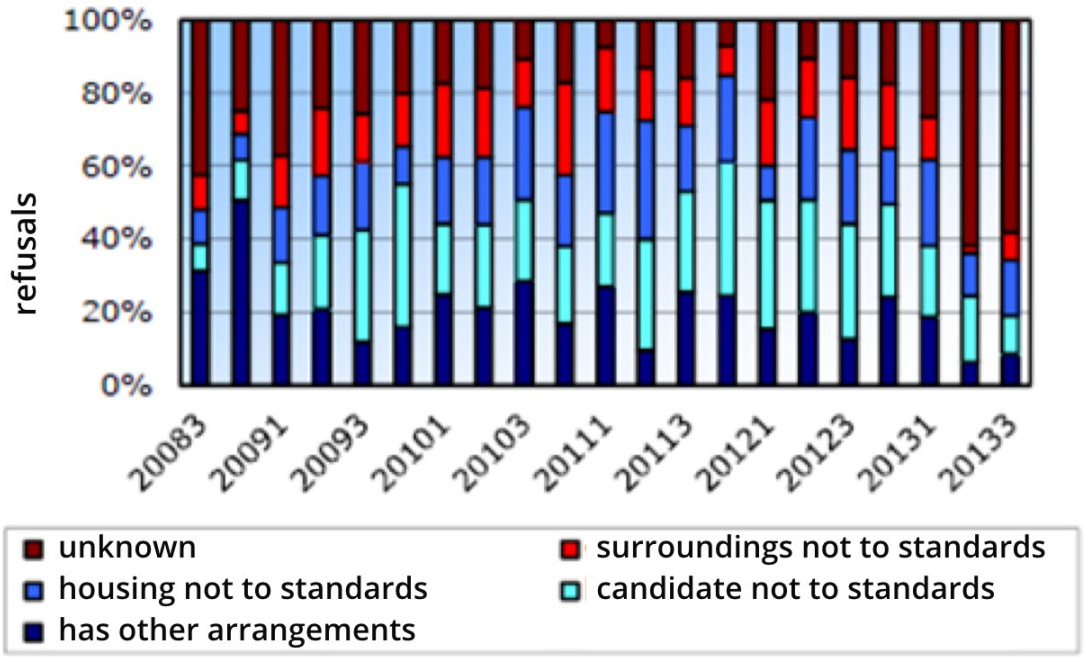
Slimmer werken,
blije klanten

Bar Chart

Via Graph > Bar Chart / Via Excel

- Display of distribution of data frequency

Figure 4.1 Percentage of refusals

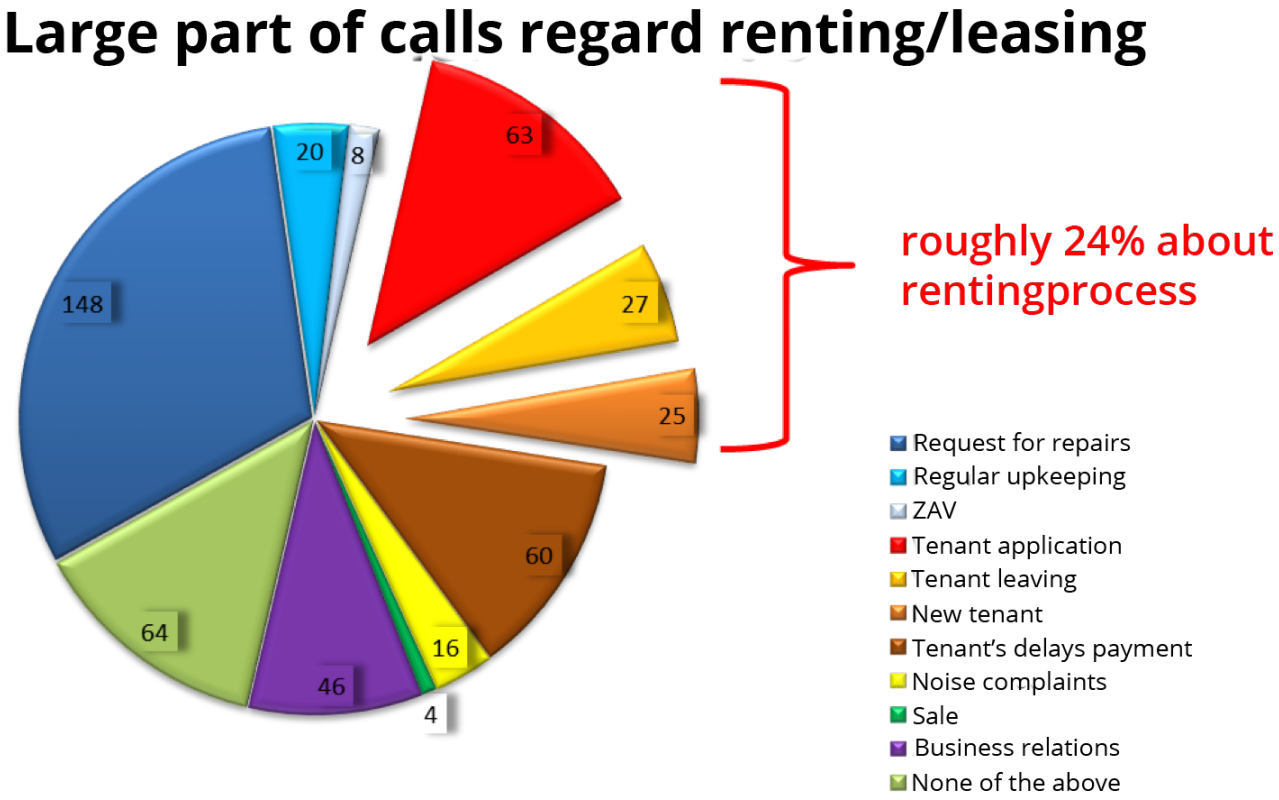


Slimmer werken, blije klanten

Pie Chart

Via Graph > Pie Chart / Via Excel

- Display of discrete data in relation to frequency.



Slimmer werken, blije klanten

Exercise: Graphic Analysis in Minitab

Open the Excel file (tab Facturen) and use Minitab to make the following:

1. The Control Chart for ‘time until payment’
2. The Graphic summary of ‘time until payment’
3. A Histogram with distribution curve and pay limit of 30 days for ‘Time until payment’
4. A Pareto Chart of the ‘type of invoice’

You can find the result in earlier slides. You are of course allowed to practice with different information/input.

Slimmer werken,
blije klanten

Minitab

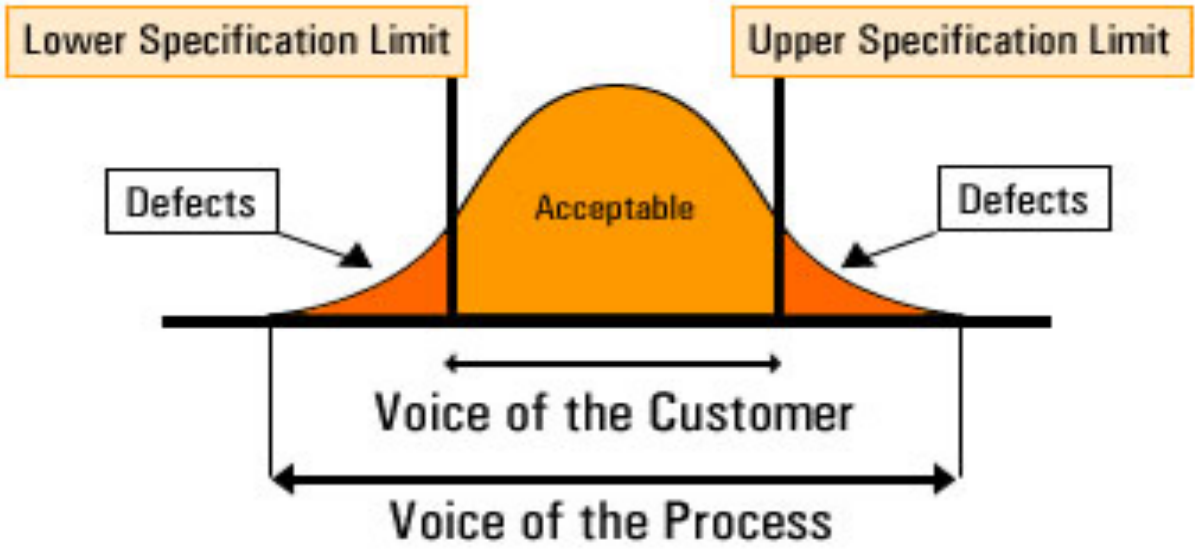
- Introduction Minitab
  - Introduction
  - Menu

- Analysis
  - Graphic analysis
  - Process capability and Yield calculation
  - Hypothesis testing

- Extra
  - Practice questions
  - Z-tables

Slimmer werken, blije klanten

Reiteration VoC and VoP

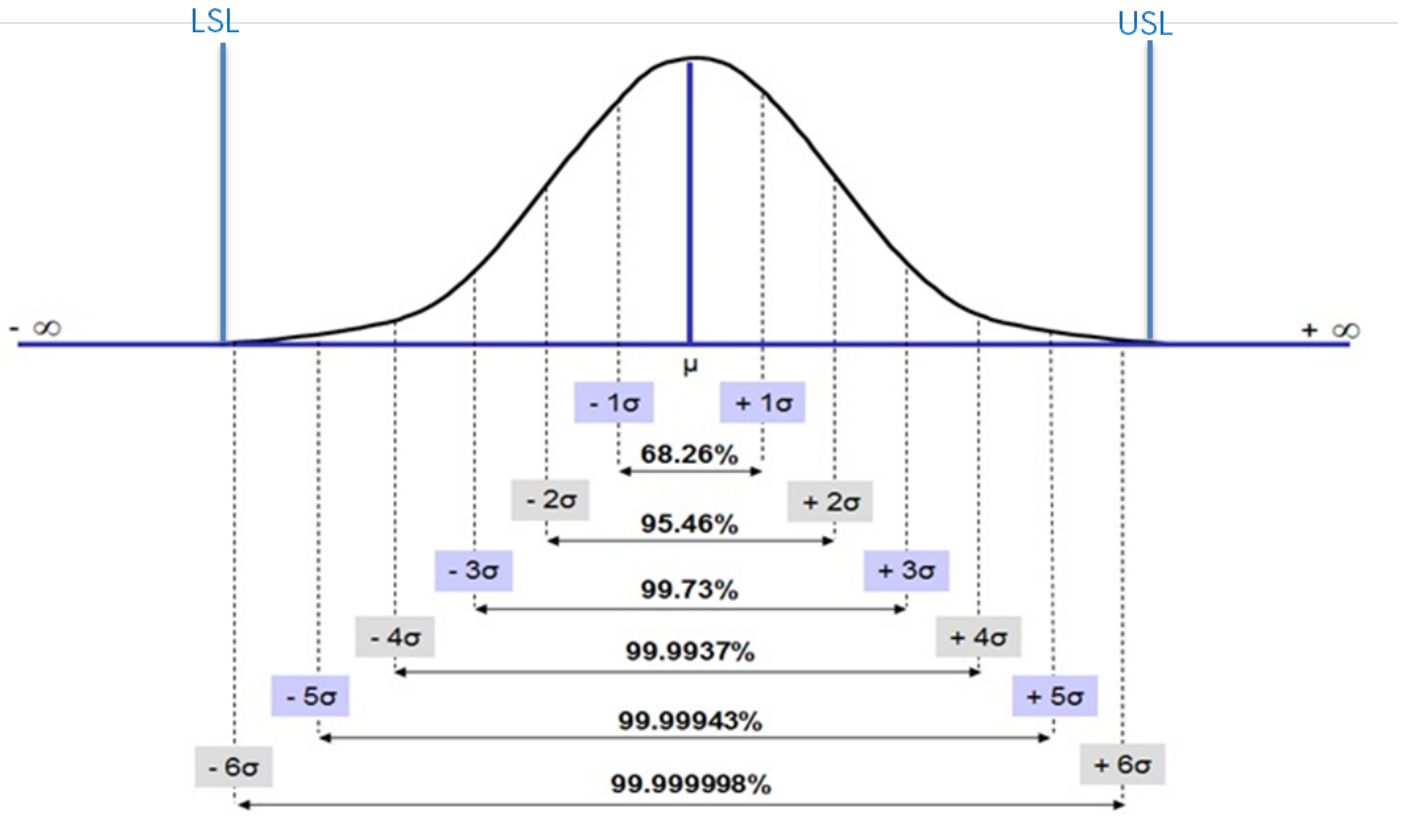


Slimmer werken,
blije klanten

Reiteration σ

bureau tromp
LEAN & SIX SIGMA

% Observations

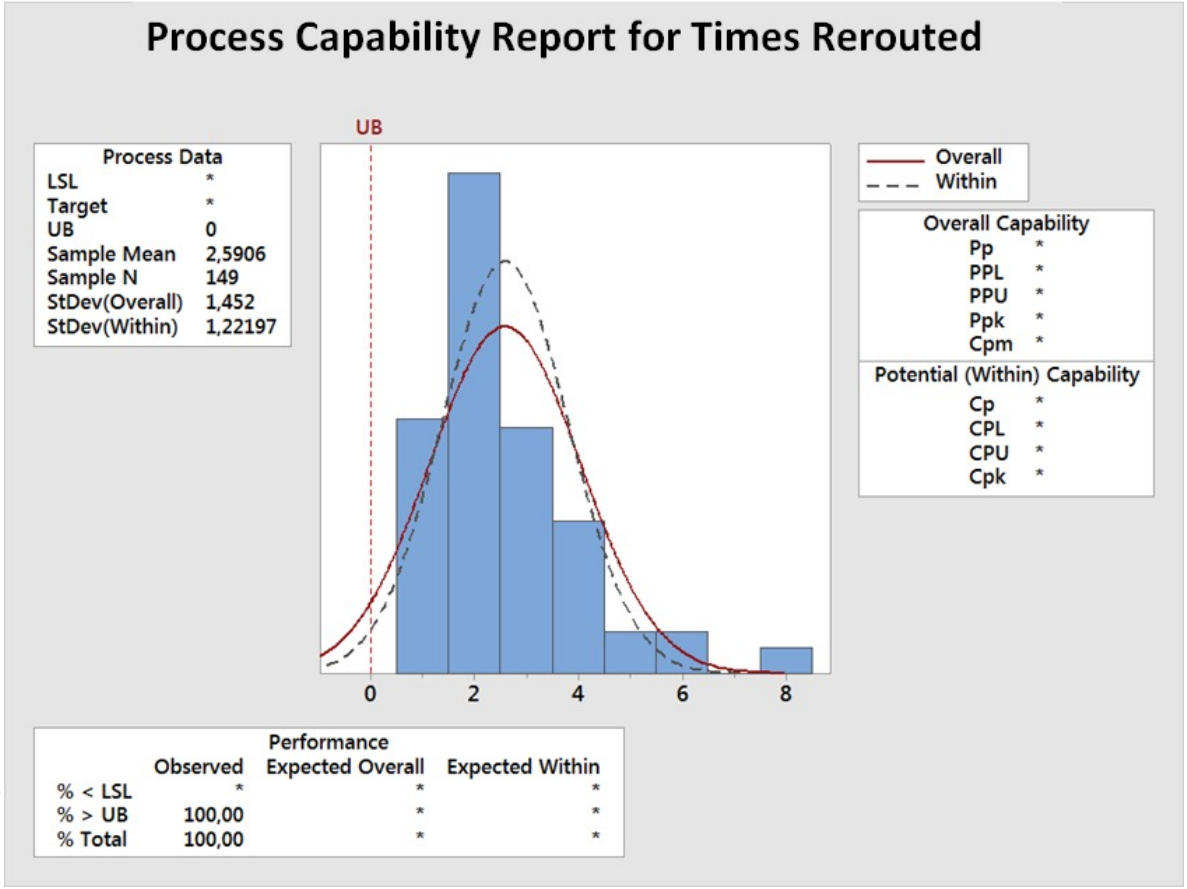


Slimmer werke
blije klanten

Reiteration Process Capability

How is the process performance in relation to customer demand?

How big is my problem?

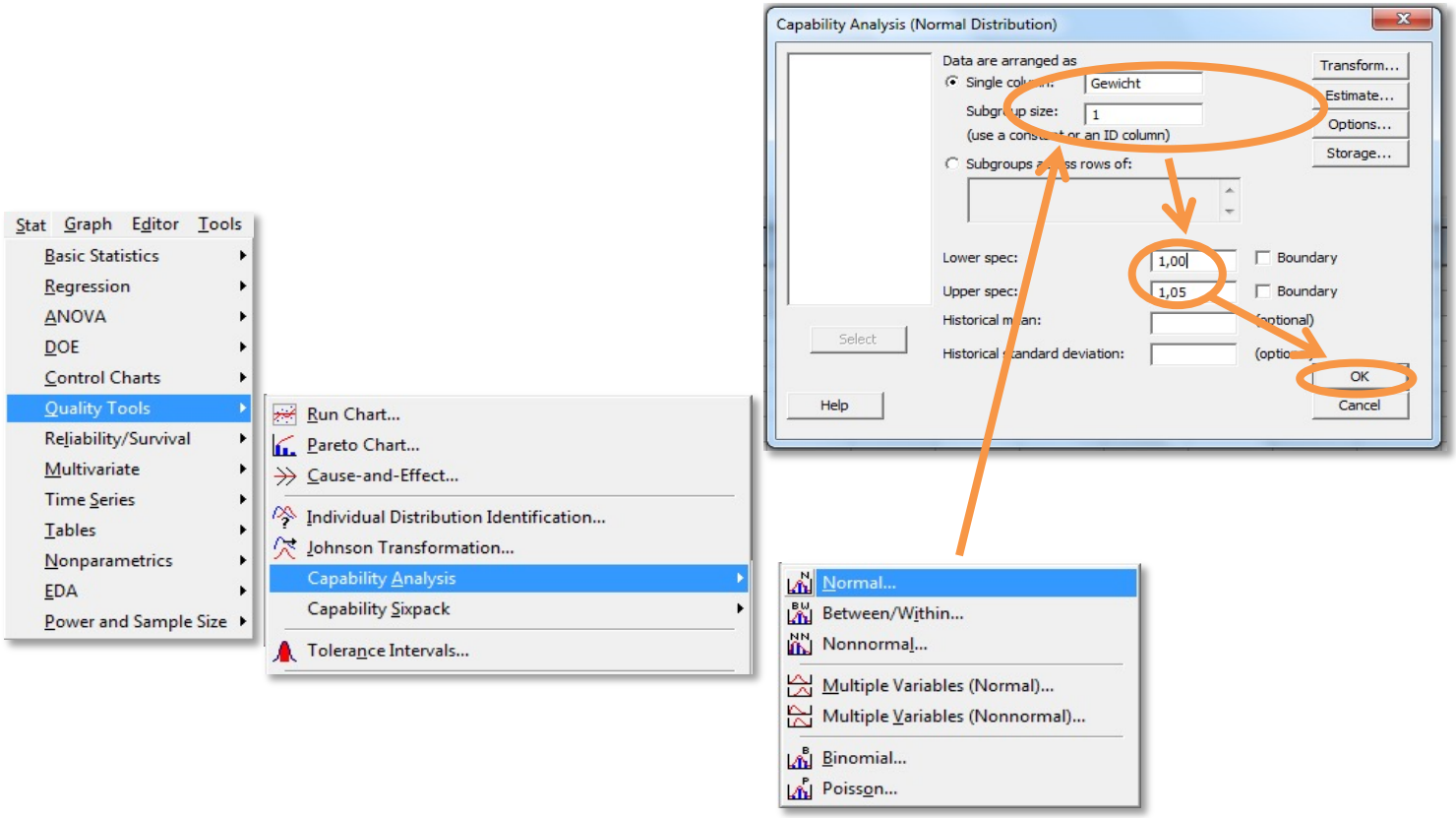


Slimmer werken, blije klanten

Process capability analysis

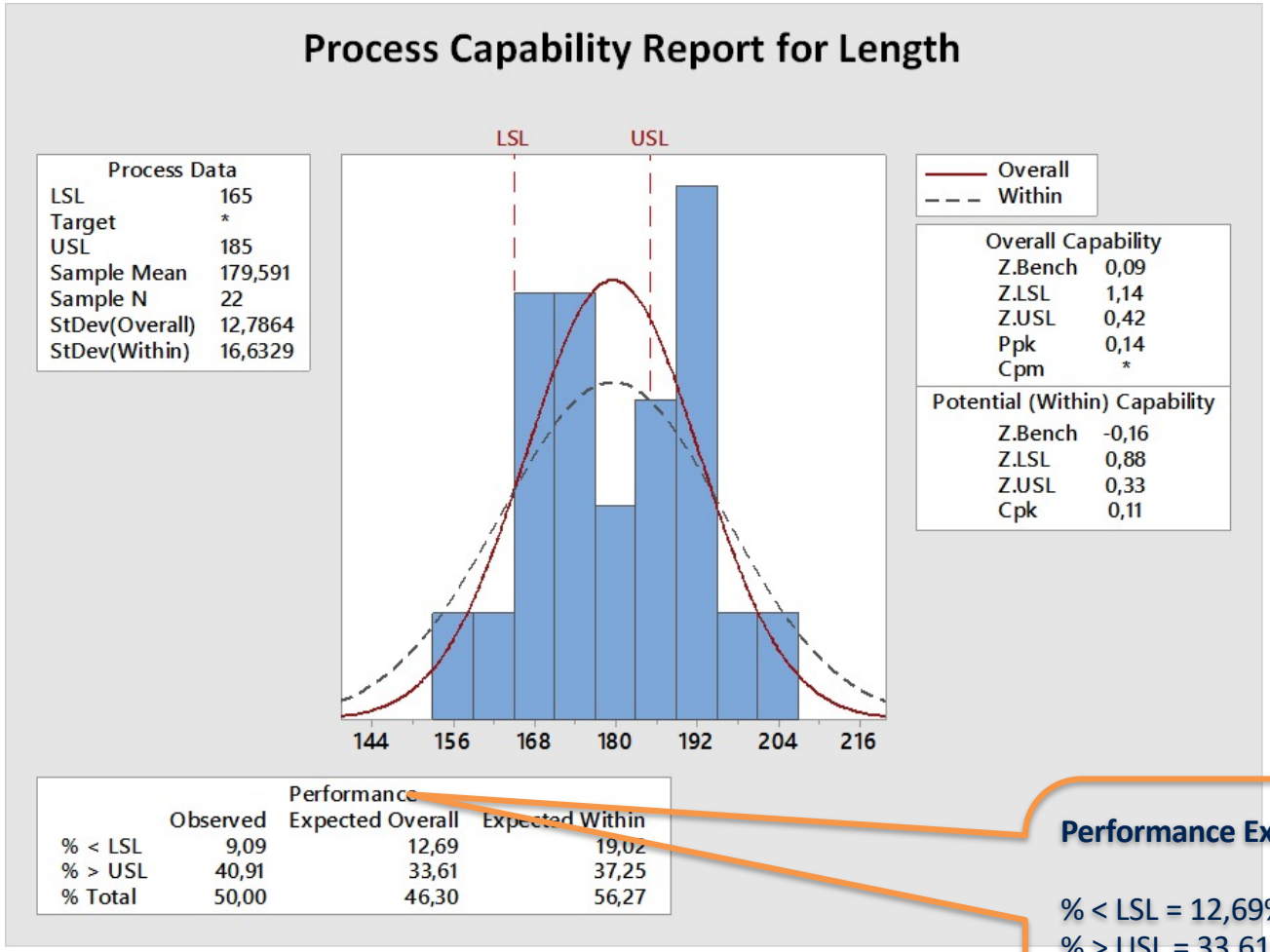
Via > Graph > Quality Tools

- Indicates how the output of the process meets the requirements of the customer.



Slimmer werken,
blije klanten

Capability Analysis



Performance Expected Overall %:

% < LSL = 12,69% = defects below LSL
% > USL = 33,61% = defects above USL
% Total = 46,30% total defects

Total = 100 – 46,30 = 53,7%

Slimmer werken, blije klanten

Process performance analysis

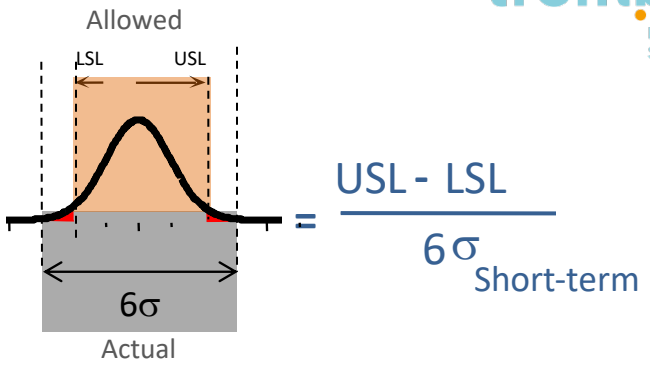
Process Capability indicates to which extent the process is in line with specific limitations.

- Cp: Performance in case the process would be centred
- Cpk: Realistic display of the presentation

Slimmer werken,
blije klanten

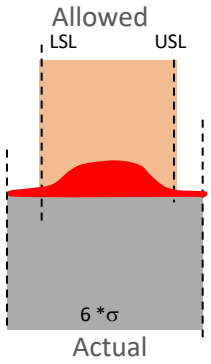
Proces Capability: Cp value

$$C_p \text{ (Capability / potential)} = \frac{\text{Allowed process variation}}{\text{Actual process variation}}$$



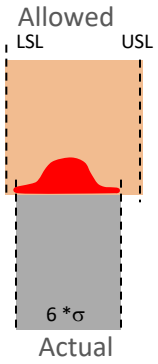
$$= \frac{USL - LSL}{6\sigma_{\text{Short-term}}}$$

$C_p < 1$



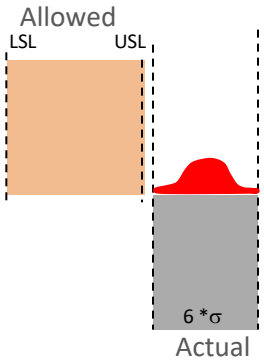
% Defects
5% (?)

$C_p > 1$



% Defects
< 5%

$C_p > 1$



% Defects
>> 5%

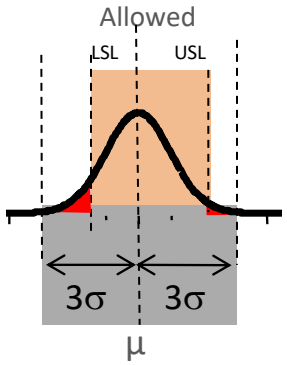
C_p value therefore says nothing about the actual % defects!!

C_p value says something about the potential % defects!!
(Does the 'VOP' variation fits within the 'VOC' LSL and USL)

Slimmer werken,
blije klanten

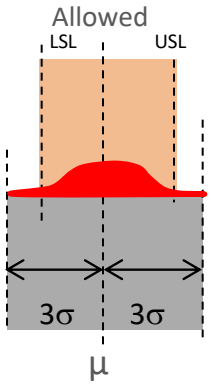
Proces Capability: Cpk value

C_{pk} (Capability) (potential katayori *) = smallest distance of the mean relative to LSL or USL / Actual process variation



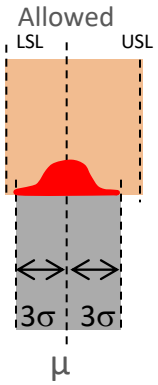
$$= \text{Min}\left(\frac{\mu - LSL}{3\sigma}, \frac{USL - \mu}{3\sigma}\right)$$

$C_p < 1$



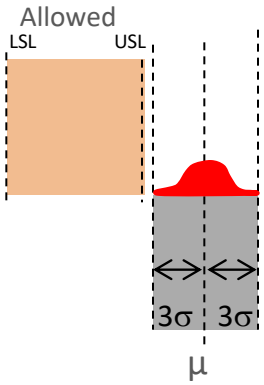
$C_{pk} < 1$

$C_p > 1$



$C_{pk} > 1$

$C_p > 1$



$C_{pk} << 1$ and even negative.

Cpk value does say something about the actual % defects!!

Slimmer werken, blije klanten

* Katayori (Japans) = deviation, difference

Minitab

- Introduction Minitab
  - Introduction
  - Menu
- Analysis
  - Graphic analysis
  - Yield calculation
  - Hypothesis testing
- Extra
  - Practice questions
  - Z-tables

bureau tromp
LEAN & SIX SIGMA

Slimmer werken, blije klanten

Hypothesis testing

bureau tromp
LEAN & SIX SIGMA



What?

- Testing of analyses
- Verification of possible causes

Why?

- Confirmation of differences between two or more outcomes
- Statistical confirmation of improvements

The null hypothesis (H_0)

- Describes the status-quo or the status wherein nothing has changed (‘there is no difference’)

The alternative hypothesis (H_a)

- The alternative hypothesis represents the modification (‘there is a difference’)

We draw conslusions based on probability

A decision can differ from reality

Slimmer werken,
blije klanten

Hypothesis testing

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

P-value

- The P-value represents the ‘plausibility’ of the null hypothesis
- It is at the critical alpha-value where the null hypothesis gets rejected
- If the probability of the null hypothesis is lower than 0,05, we reject the null hypothesis

Rule of thumb:
When P is low, H_0 has to go!!!

Slimmer werken,
blije klanten

Reliability testing

Performing statistical tests still leaves a certain amount of uncertainty. Nobody is 100% sure whether or not the decision is truly correct.

The nullhypothesis is rejected if the result of analysis leads to the conclusion that the assumption is most unlikely ($p < 0,05$).

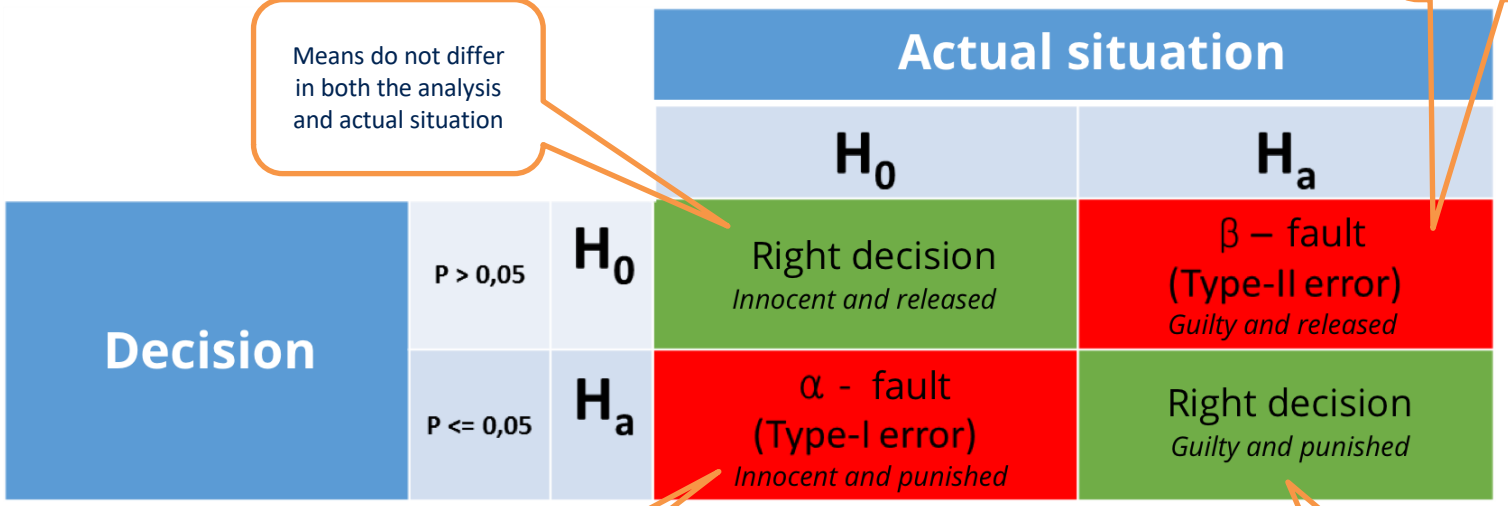
		Actual situation	
		H_0	H_a
Decision	H_0	Right decision	β – fault (Type-II error)
	H_a	α - fault (Type-I error)	Right decision

Alpha and Bèta risks

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

There is a possibility that H_0 can be wrongly approved or rejected.



Standard test value: α = 0,05 (95% certainty)

Slimmer werken, blije klanten

Hypothesis testing: plan

bureau tromp
LEAN & SIX SIGMA

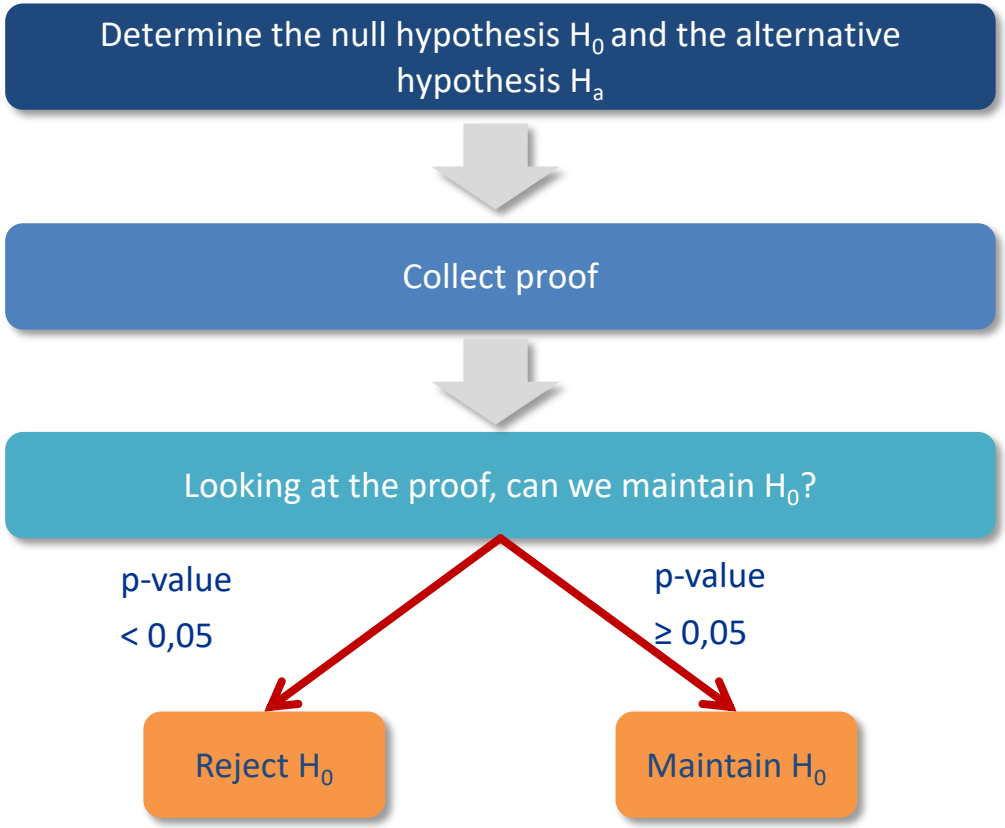
Define | Measure | Analyse | Improve | Control

1. What do I want to know?
2. How do I want to test this?
3. What is my null and alternative hypothesis?
4. What is the p-value of the executed test?
5. What is the result of my test and what does it mean for my decision?

- NO data-analysis without understanding of the process
- First brainstorming of the root cause, then data collection
- ALWAYS verify the quality of the data
- Always discuss the results and the meaning of these results in the project group!!

Slimmer werken, blije klanten

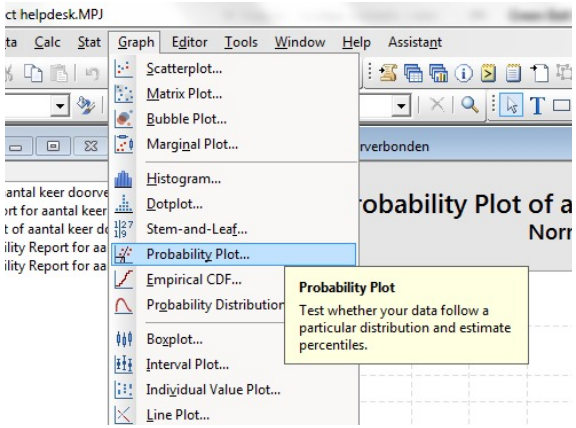
Hypothesis testing: plan

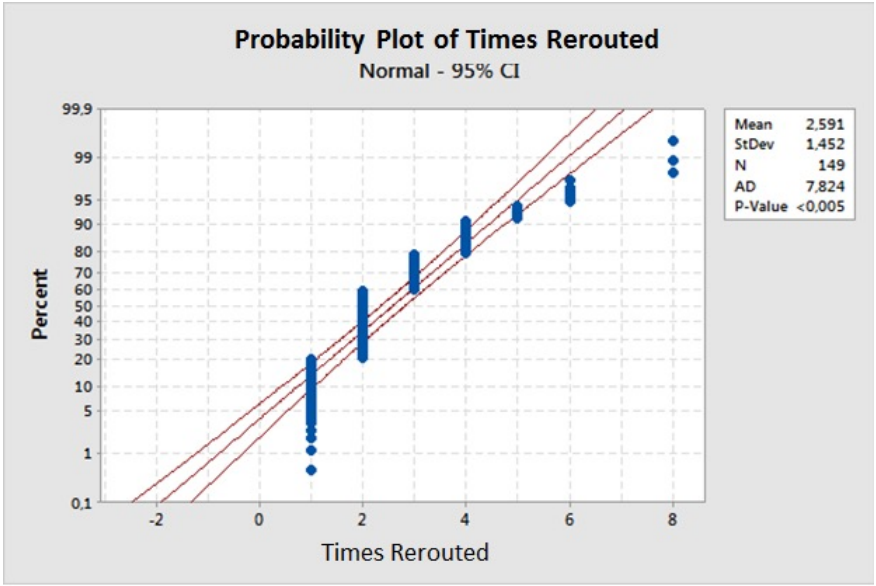


Is the data distributed normally?

Via Graph > Probability Plot

- Make a probability plot to check if the data is distributed normally.





Slimmer werken,
blije klanten

Exercise: Testing normal distribution

Example (see Excel file):

The following lengths result from a sample (in cm's):

190, 154, 191, 172, 167, 195, 186, 160, 182, 170, 185, 175, 168, 187, 178, 190, 166, 205, 194, 171, 189, 176

Is this sample normally distributed?

Plan:

- What is the null hypothesis?
- What is the alternative hypothesis?
- What is the p-value?
- Is the length of the people in this sample normally distributed?

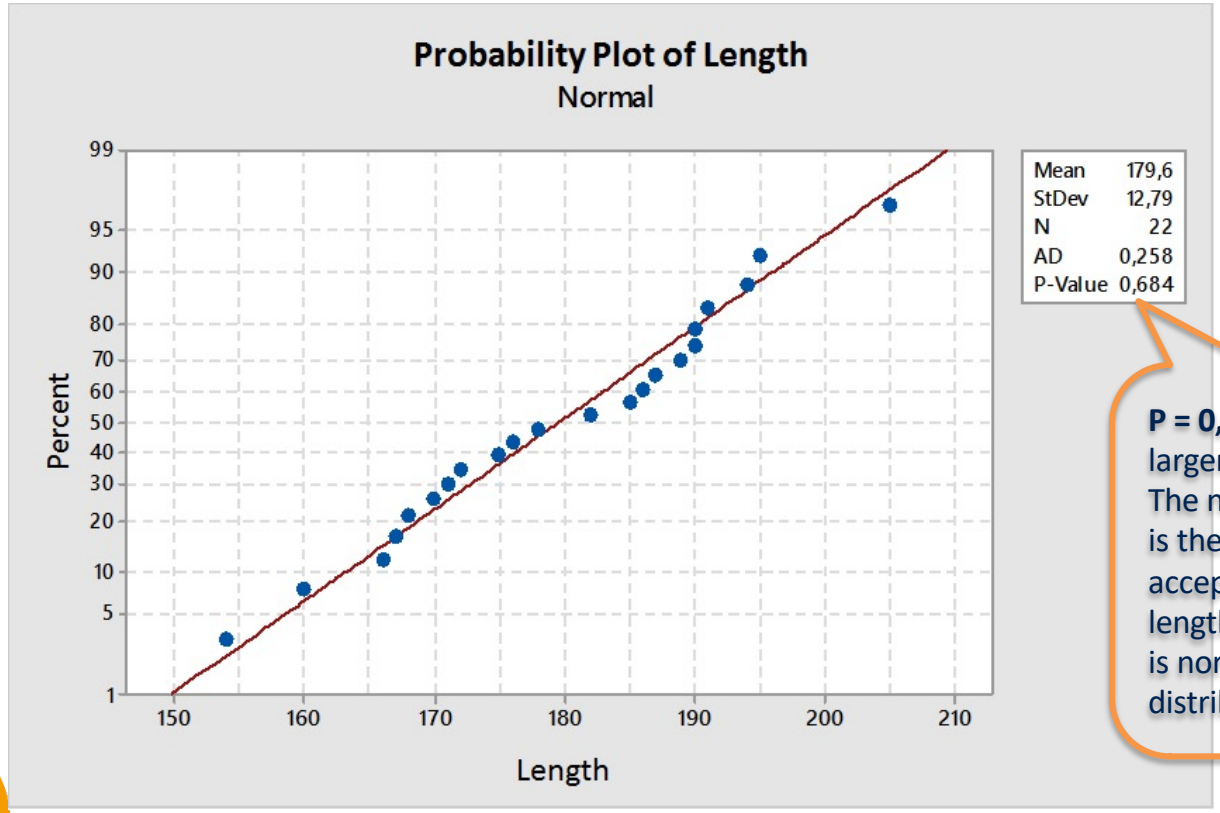
Elaboration: Testing normally distributed data

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

H_o : Values are normally distributed

H_a : Values are not normally distributed



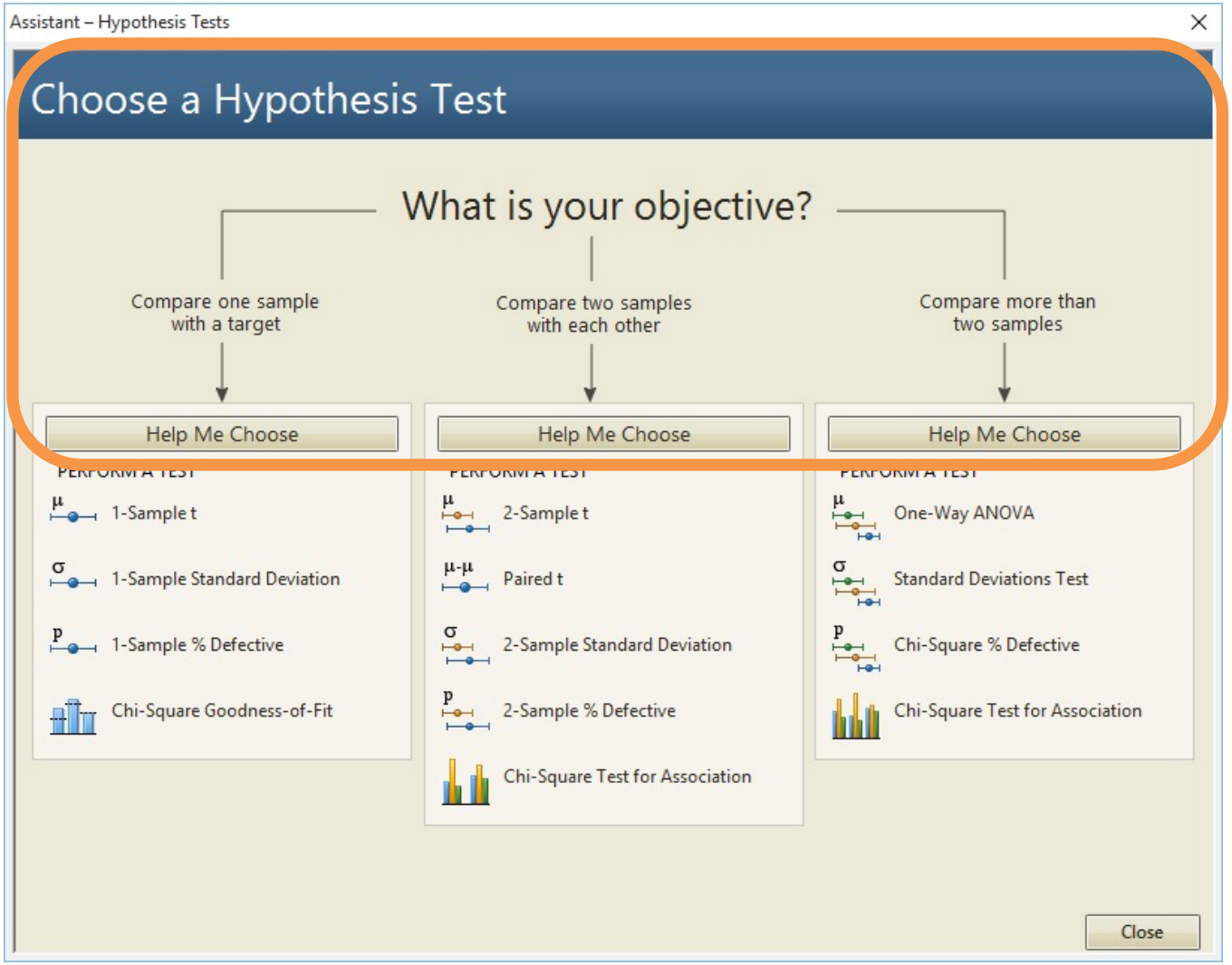
P = 0,684 and is larger than 0,05. The null hypothesis is therefore accepted; the length in the group is normally distributed!

Slimmer werken, blije klanten

Assistant in Minitab

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control



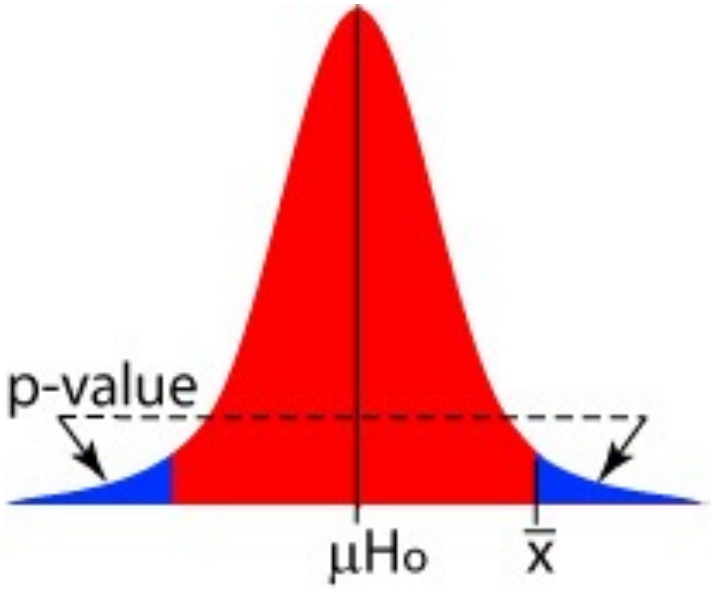
Slimmer werken, blije klanten

Two-sided test

Lets us test if there is a significant difference:

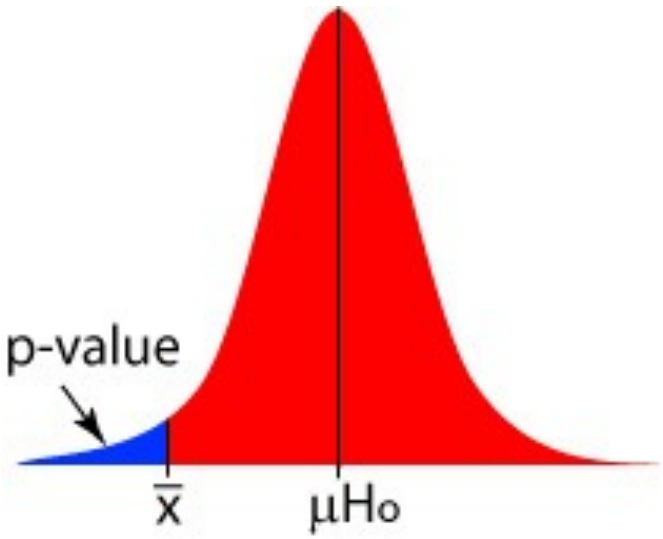
$H_0: \mu = \bar{x}$

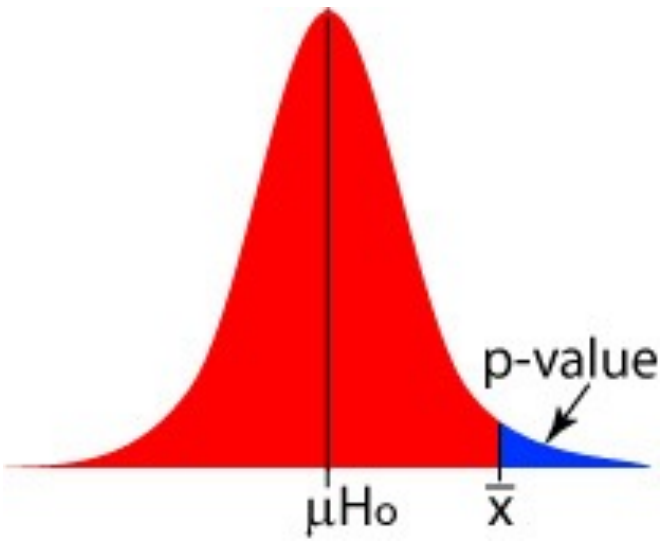
$H_a: \mu \neq \bar{x}$



One-sided test

We test if $\bar{x}$ is significantly bigger or smaller (but not both!) than the mean μ:





Hypothesis testing

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Kinds of hypotheses analyses

- Norml distribution tests (see example)
- One sample t-test
- Two sample t-test
- Paired t-test
- One-way ANOVA

Slimmer werken,
blije klanten

One sample t-test

Via Stat > Basic Statistics > 1-sample t-test

When?

- Testing whether the mean of a normal distributed population is equal to a certain, earlier specified, value.
- Within 1 population
- Also known as *Students' t-test*

Example:

- Is the burning time of a light bulb as long as the producer says it is?
- Is the average length of my group higher than the national average?

Exercise: One sample t-test

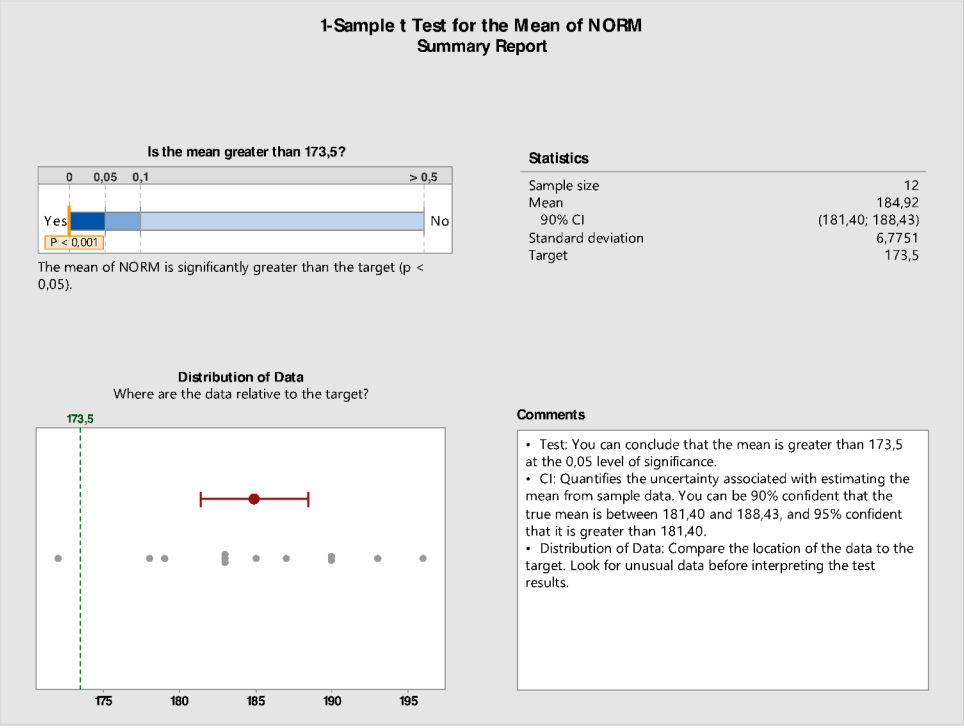
bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Question: Does the average length of our sample deviate from the national average of 173,5 cm?

Perform a:

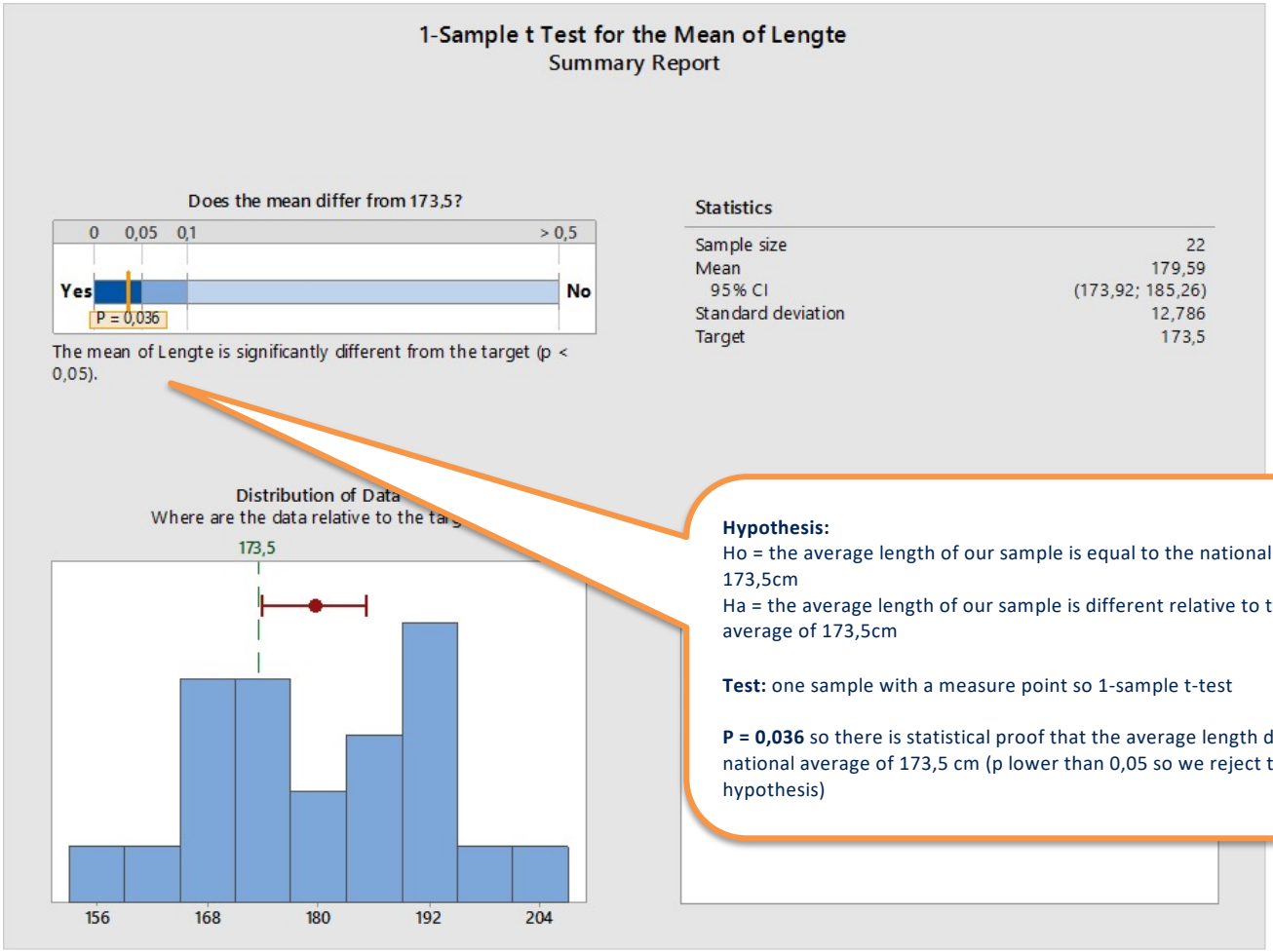
- One-sided test - Normal
- Two-sided test - Assistent



Slimmer werken, blije klanten

Elaboration: One sample t-test

Two-sided (via Assistant)



Hypothesis:
Ho = the average length of our sample is equal to the national average of 173,5cm
Ha = the average length of our sample is different relative to the national average of 173,5cm

Test: one sample with a measure point so 1-sample t-test

P = 0,036 so there is statistical proof that the average length differs from the national average of 173,5 cm (p lower than 0,05 so we reject the null hypothesis)

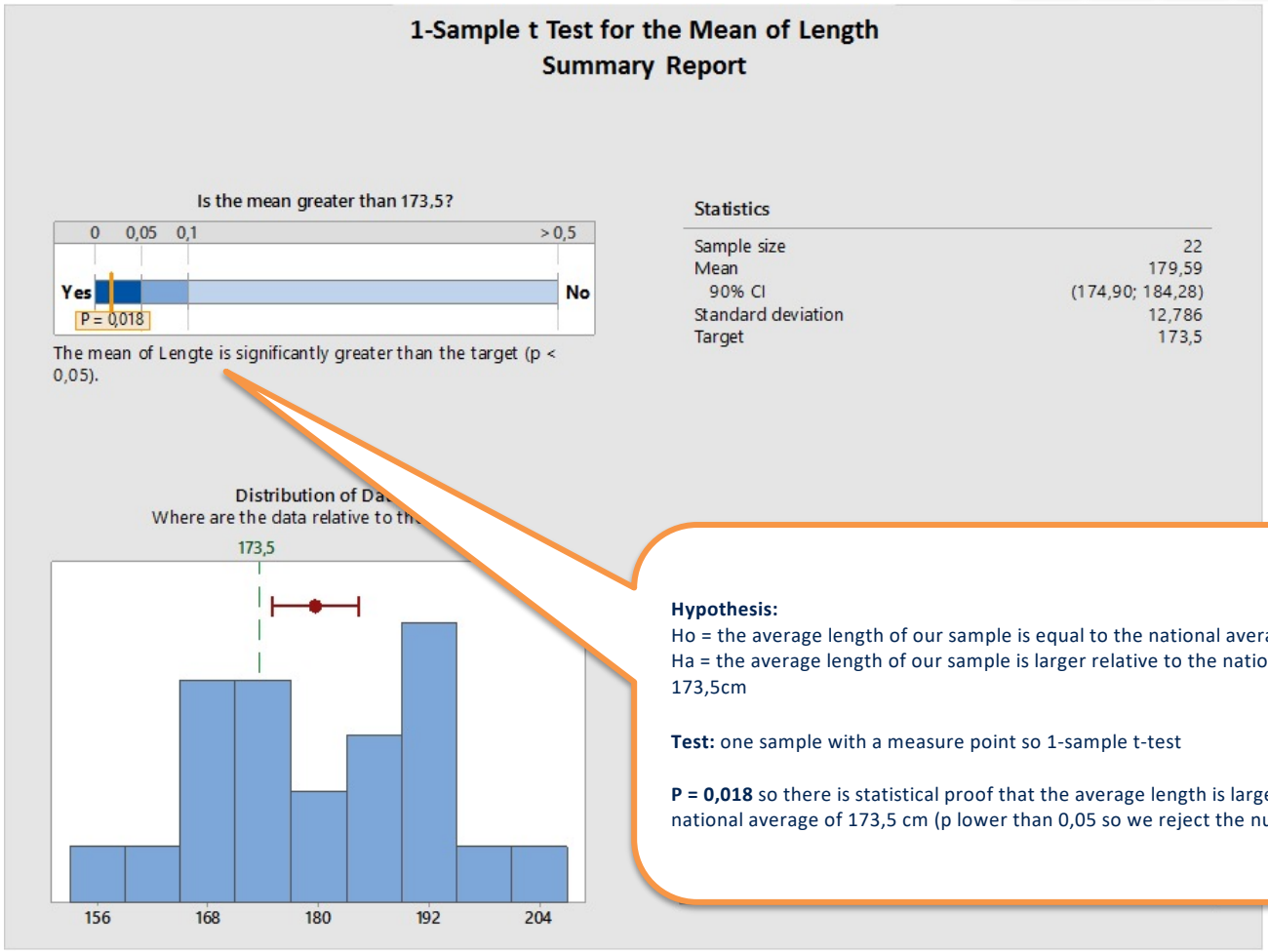
Slimmer werken, blije klanten

Elaboration: One sample t-test

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

One-sided (via Assistant)



Hypothesis:
Ho = the average length of our sample is equal to the national average of 173,5cm
Ha = the average length of our sample is larger relative to the national average of 173,5cm

Test: one sample with a measure point so 1-sample t-test

P = 0,018 so there is statistical proof that the average length is larger compared to the national average of 173,5 cm (p lower than 0,05 so we reject the null hypothesis)

Slimmer werken, blije klanten

Elaboration: One sample t-test (via menu)

One-Sample T: Length

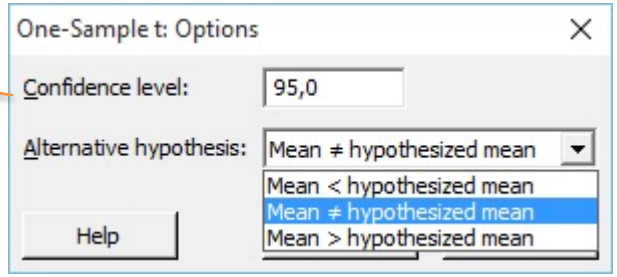
Output in Session windowsof Minitab

```
Test of μ = 173,5 vs ≠ 173,5

Variable   N    Mean  StDev  SE Mean        95% CI          T      P
Length    22  179,59  12,79     2,73  (173,92; 185,26)  2,23  0,036
```

One-Sample T: Length

You can select 'one-sided' of 'two-sided' via options




```
Test of μ = 173,5 vs > 173,5

Variable   N    Mean  StDev  SE Mean  95% Lower Bound      T      P
Length    22  179,59  12,79     2,73           174,90  2,23  0,018
```

Slimmer werken,
blije klanten

Two sample t-test

Via Stat > Basic Statistics > 2-sample t-test

When?

- Test whether the means of two normally distributed samples are equal

Example:

- The average burning time of a Philips lightbulb vs. an Osram lightbulb
- The average length between men and women

Exercise: Two sample t-test

Question: Is the average length of men different from the average length of women in our measure ?

Perform a:

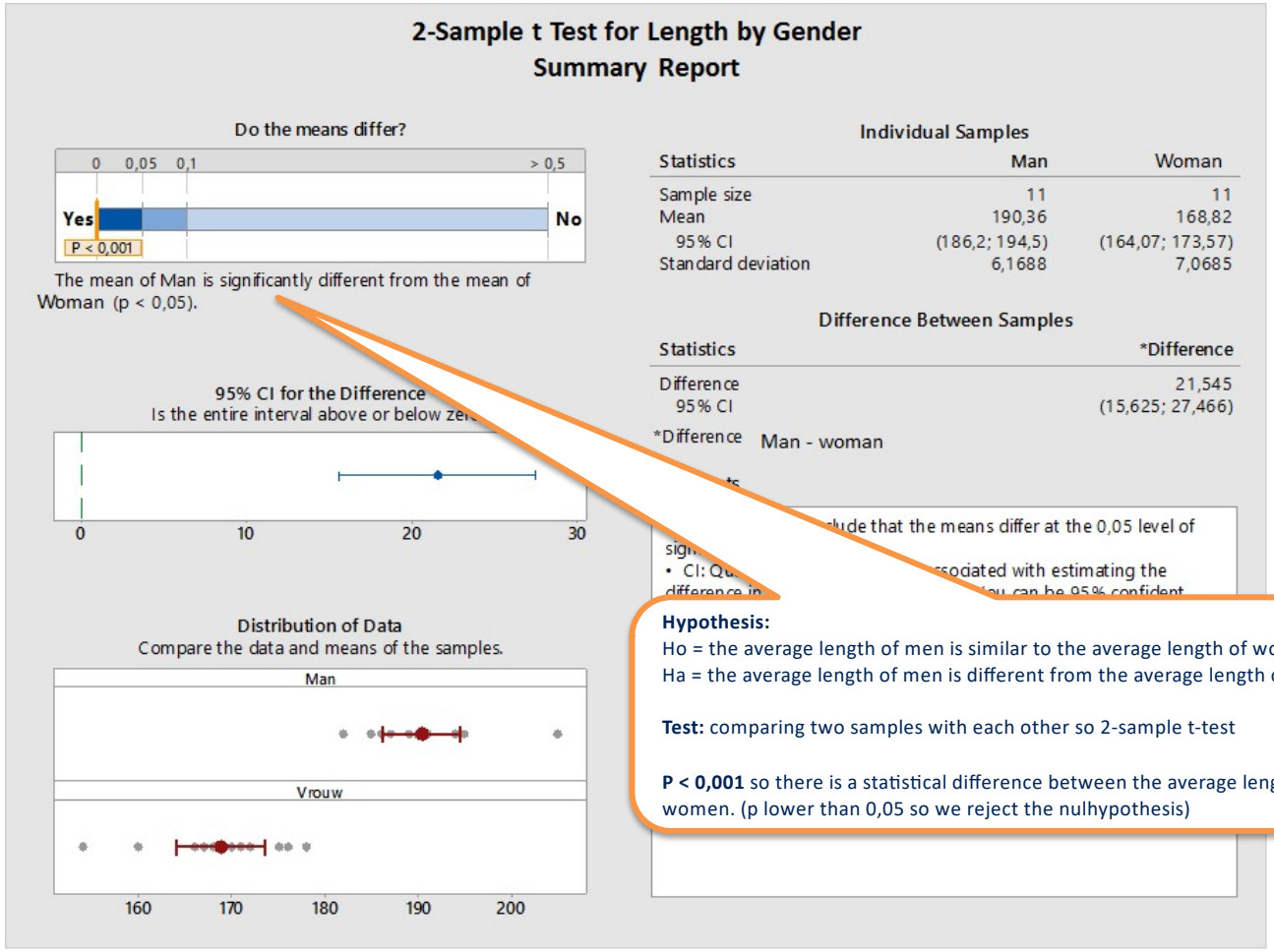
- One-sided test
- Two-sided test

Elaboration: Two sample t-test

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Two-sided



Hypothesis:
Ho = the average length of men is similar to the average length of women
Ha = the average length of men is different from the average length of women

Test: comparing two samples with each other so 2-sample t-test

P < 0,001 so there is a statistical difference between the average length of men and women. (p lower than 0,05 so we reject the nulhypothesis)

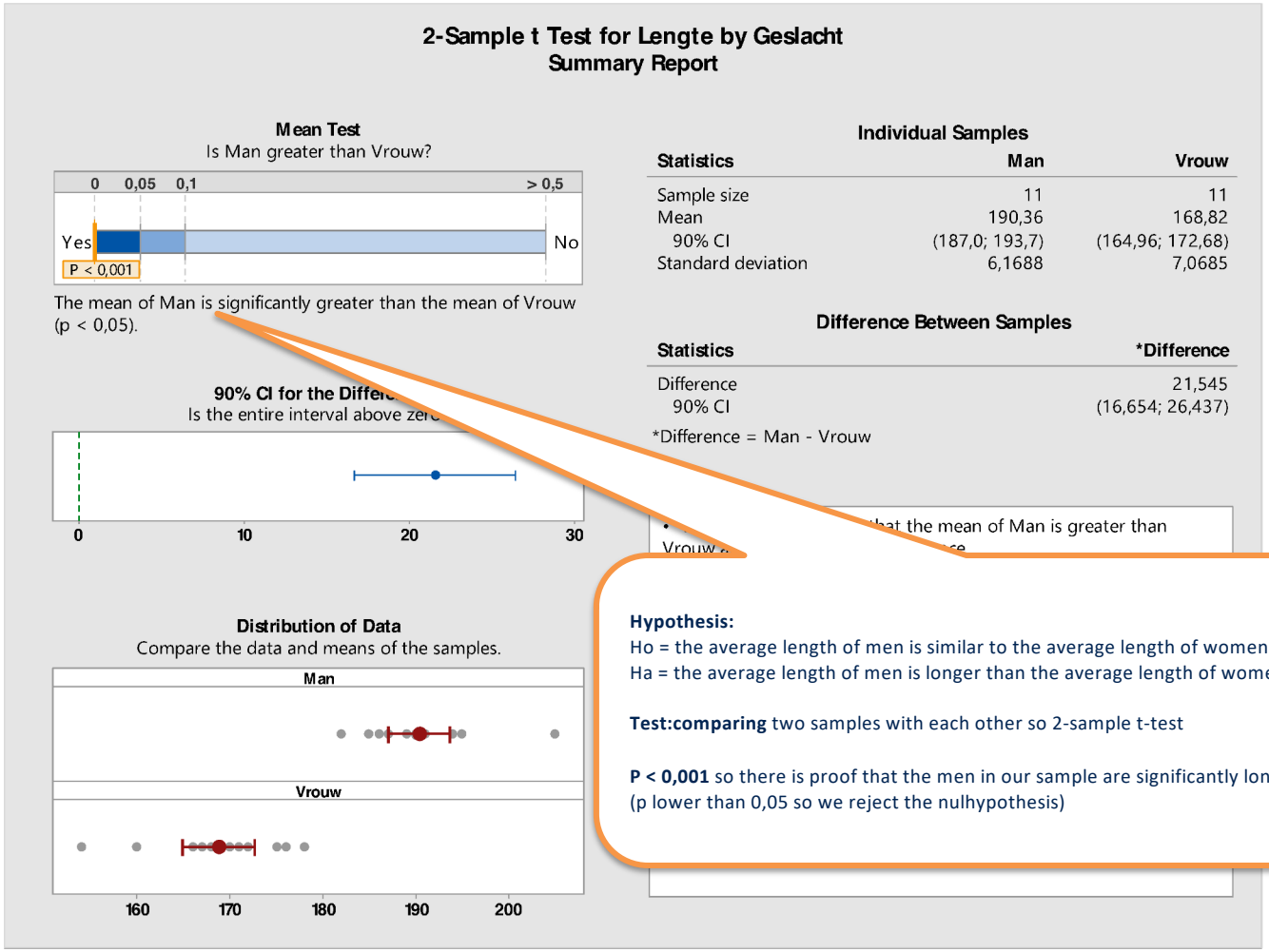
Slimmer werken, blije klanten

Elaboration: Two sample t-test

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

One-sided



Hypothesis:
Ho = the average length of men is similar to the average length of women
Ha = the average length of men is longer than the average length of women

Test:comparing two samples with each other so 2-sample t-test

P < 0,001 so there is proof that the men in our sample are significantly longer than de women.
(p lower than 0,05 so we reject the nulhypothesis)

Slimmer werken, blije klanten

Elaboration: Two sample t-test (via menu)

Two-Sample T-Test and CI: Length; Gender

```
Two-sample T for Length

Gender     N     Mean   StDev   SE Mean
Man                11   190,36    6,17       1,9
Woman      11   168,82    7,07       2,1

Difference = μ (Man) - μ (Woman)
Estimate for difference:  21,55
95% CI for difference:  (15,62; 27,47)
T-Test of difference = 0 (vs ≠): T-Value = 7,62  P-Value = 0,000  DF = 19
```

Output in Session window of Minitab

Two-Sample T-Test and CI: Length; Gender

```
Two-sample T for Length

Gender    N     Mean   StDev   SE Mean
Man       11   190,36    6,17       1,9
Woman     11   168,82    7,07       2,1

Difference = μ (Man) - μ (Woman)
Estimate for difference:  21,55
95% lower bound for difference:  16,65
T-Test of difference = 0 (vs >): T-Value = 7,62  P-Value = 0,000  DF = 19
```

You can select 'one-sided' or 'two-sided' via options

Slimmer werken, blije klanten

Paired t-test

Via Stat > Basic Statistics > Paired t-test



When?

- Comparing averages of the same group at different moments in time

Example:

- Is there a difference in average weight of test subjects before and after the use of diet pills
- Is the revenue for a group of organisations larger in January than in December?

ANOVA

Via Stat > ANOVA

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

When?

- Tests whether the averages of several groups are equal or not (with 3 or more groups)

Example:

  - Comparing departments, shops, countries, sales-teams etc.

Slimmer werken, blije klanten

Summary: plan for graphic analysis

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

- **Step 1:** Visual inspection of data:
  - What do I see? Which process does the data respresent?
  - Which information do I see in the different columns?
  - Do I see outlying or missing values?
- **Step 2:** Make a 'Graphical Summary' in Minitab
- **Step 3:** Check if there is a normal distribution of the data

---

- **Step 4:** What does the process say: make a control chart
- **Step 5:** Process capability analysis
- **Step 6:** Set hypothesis
- **Step 7:** Run the appropriate tests and draw conclusions

Slimmer werken, blije klanten

Minitab

- Introduction Minitab
  - Introduction
  - Menu

- Analysis
  - Graphic analysis
  - Yield calculation
  - Hypothesis testing

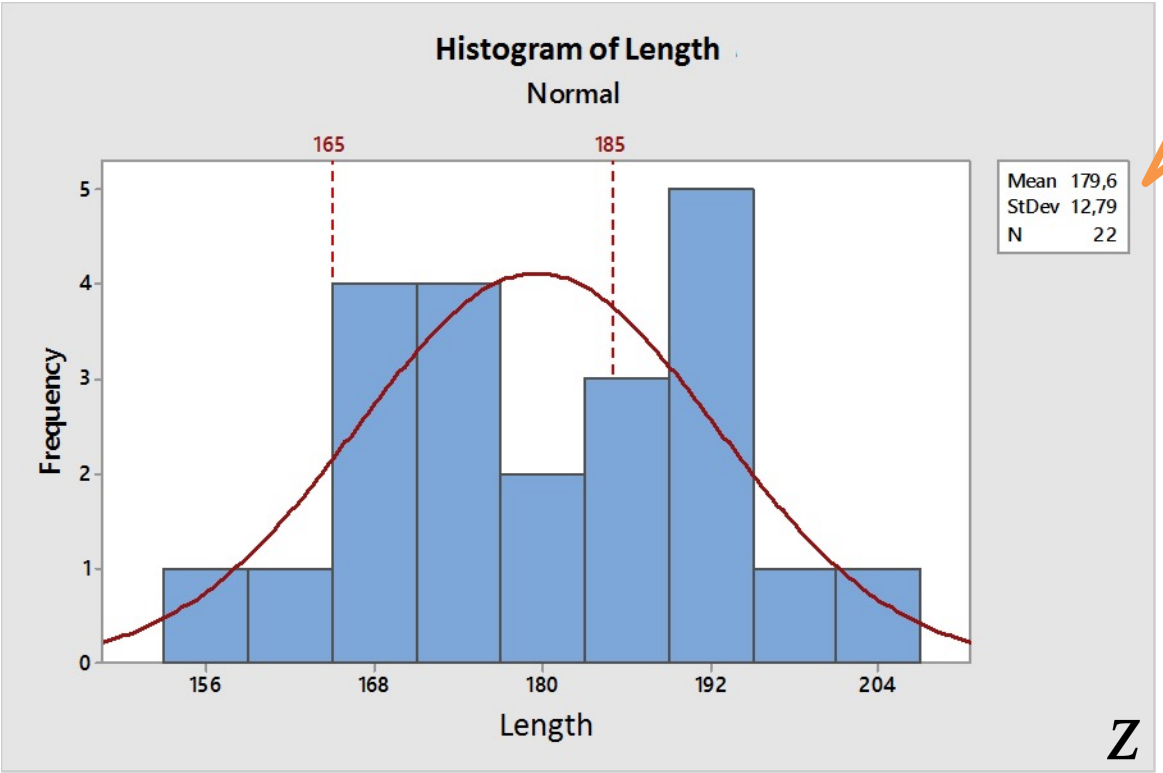
- Extra
  - Practice questions
  - Z-tables

bureau tromp
LEAN & SIX SIGMA

Slimmer werken,
blije klanten

Exercise: Calculate Yield

Question: What percentage of the population is larger than 1m85?



Mean	179,6
St Dev	12,79
N	22

$$z = \frac{(X - \mu)}{\sigma}$$

Slimmer werken,
blije klanten

Calculate Yield z-value

Calculate the z-value based on the following formula:

$$z = \frac{(X - \mu)}{\sigma}$$

In which:

- X: The specification limit for yield
- μ: The mean
- σ: The standard deviation

Look up the z-value > This allows conversion to %.

- A negative z-value indicates that the limit lays on the left side of the mean.
- A positive z-value indicates that the limit lays on the right side of the mean.

Slimmer werken,
blije klanten

Elaboration: Calculate Yield

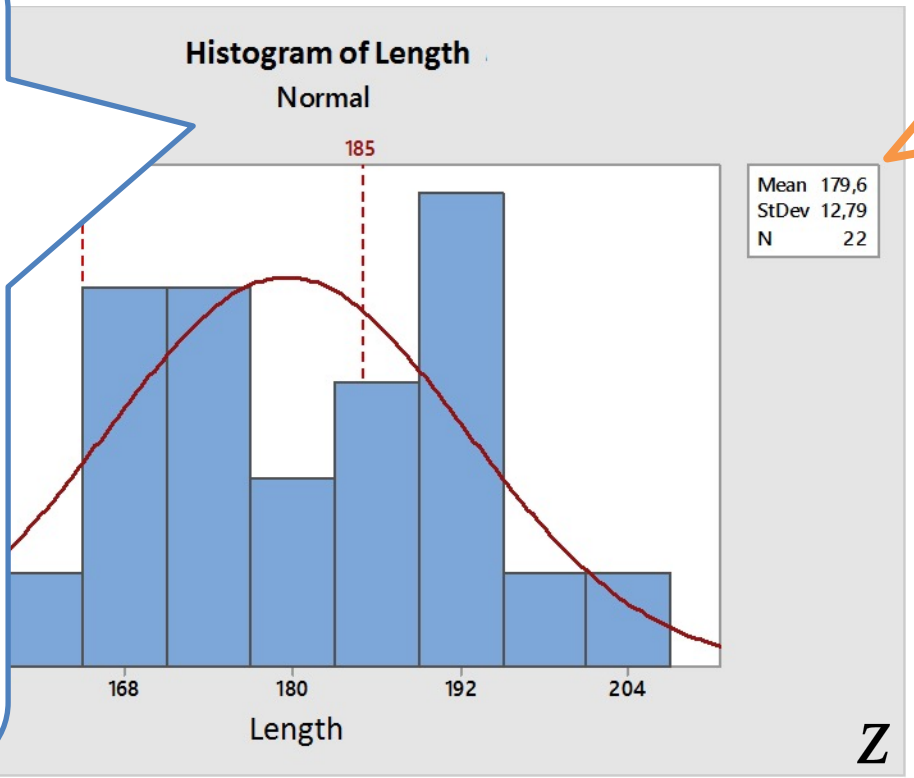
Question: what percentage of the population is larger than 1m85?

Answer:
- X = 185 cm
- μ = 179,6 cm
- σ = 12,79 cm

Z-value = 0,42

According to the z-value table this is 0,6628; as to say 66,28% is shorter than 1m85

100% - 66,28% =
33,72%
is longer than 1m85!



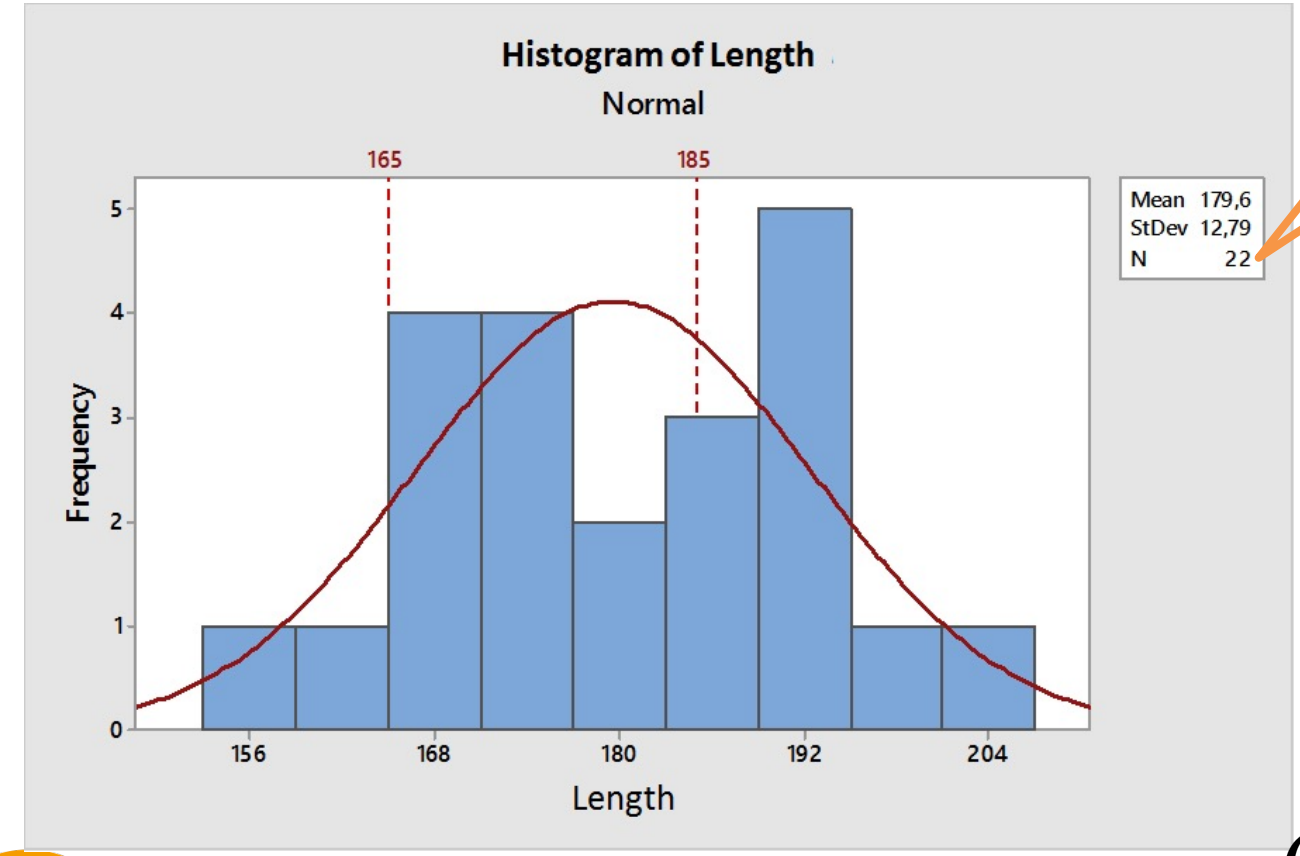
Mean 179,6
St Dev 12,79
N 22

$$z = \frac{(X - \mu)}{\sigma}$$

Slimmer werken, blije klanten

Exercise: Calculate Yield

Question: What percentage of the population is between 1m65 and 1m85?



Mean 179,6
StDev 12,79
N 22

$$z = \frac{(X - \mu)}{\sigma}$$

Slimmer werken, blije klanten

Elaboration: Calculate Yield

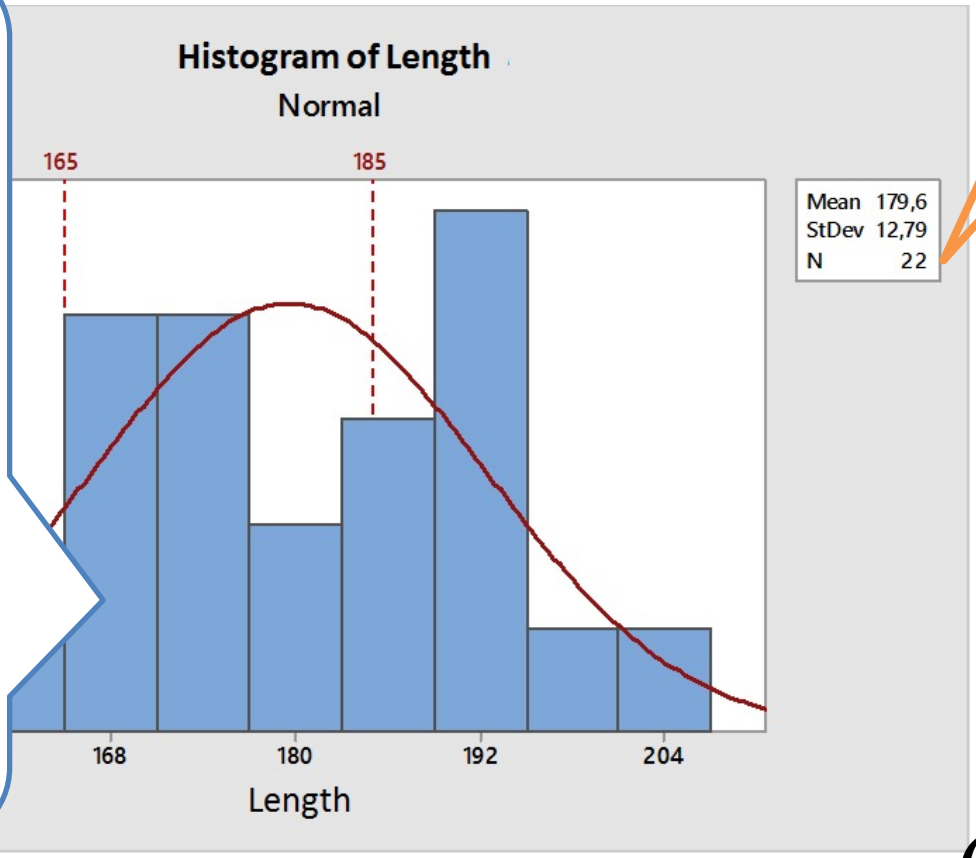
Question: What percentage of the population is between 1m65 and 1m85?

Answer:
Z-value of 165 cm:
- X = 165 cm
- μ = 179,6 cm
- σ = 12,79 cm

Z-value = -1,14 (beware, negative so left of the average)

According to the z-value table this is -0,8729; as to say **12,71%** *(1,0 – 0,8729 = 0,1271)*

Yield (185) – Yield (165)=
66,28 – 12,71 =
53,57%



Mean 179,6
StDev 12,79
N 22

$$z = \frac{(X - \mu)}{\sigma}$$

Slimmer werken, blije klanten

Extra exercises

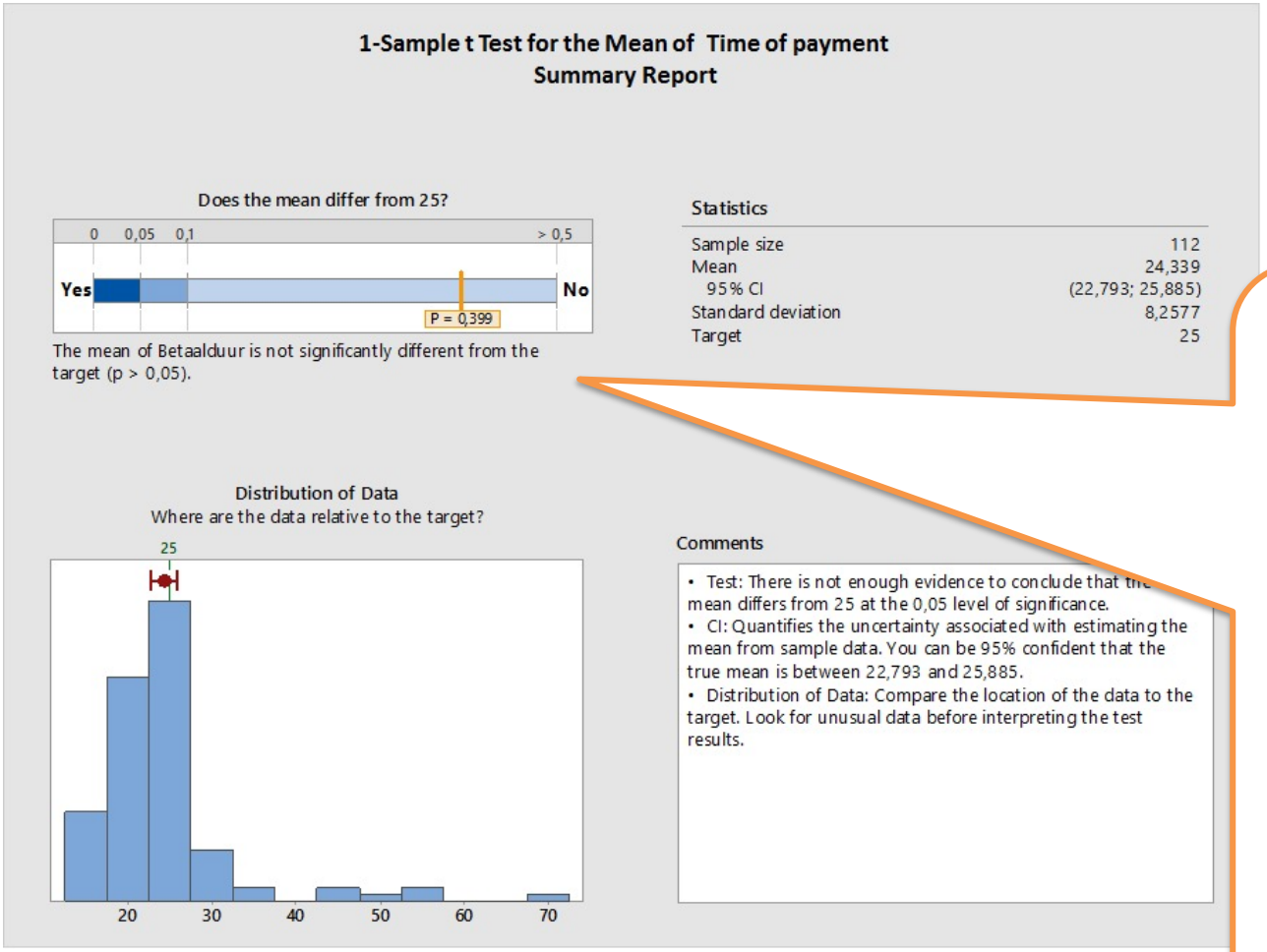
Open the Excel file (tab facturen) and test in Minitab:

1. Whether the average deviates significantly from the national average of 25 days
2. Whether the digital invoices deviate from postal invoices in the matter of time until payment
3. Is there a type of invoice that has a different mean regarding time until payment than the other types?

The results can be found in the following slides. You can of course always practice with other data.

Slimmer werken, blije klanten

Elaboration: Question 1



Hypothesis:
Ho = the average time until payment of invoices in our sample is similar to the national average of 25 days

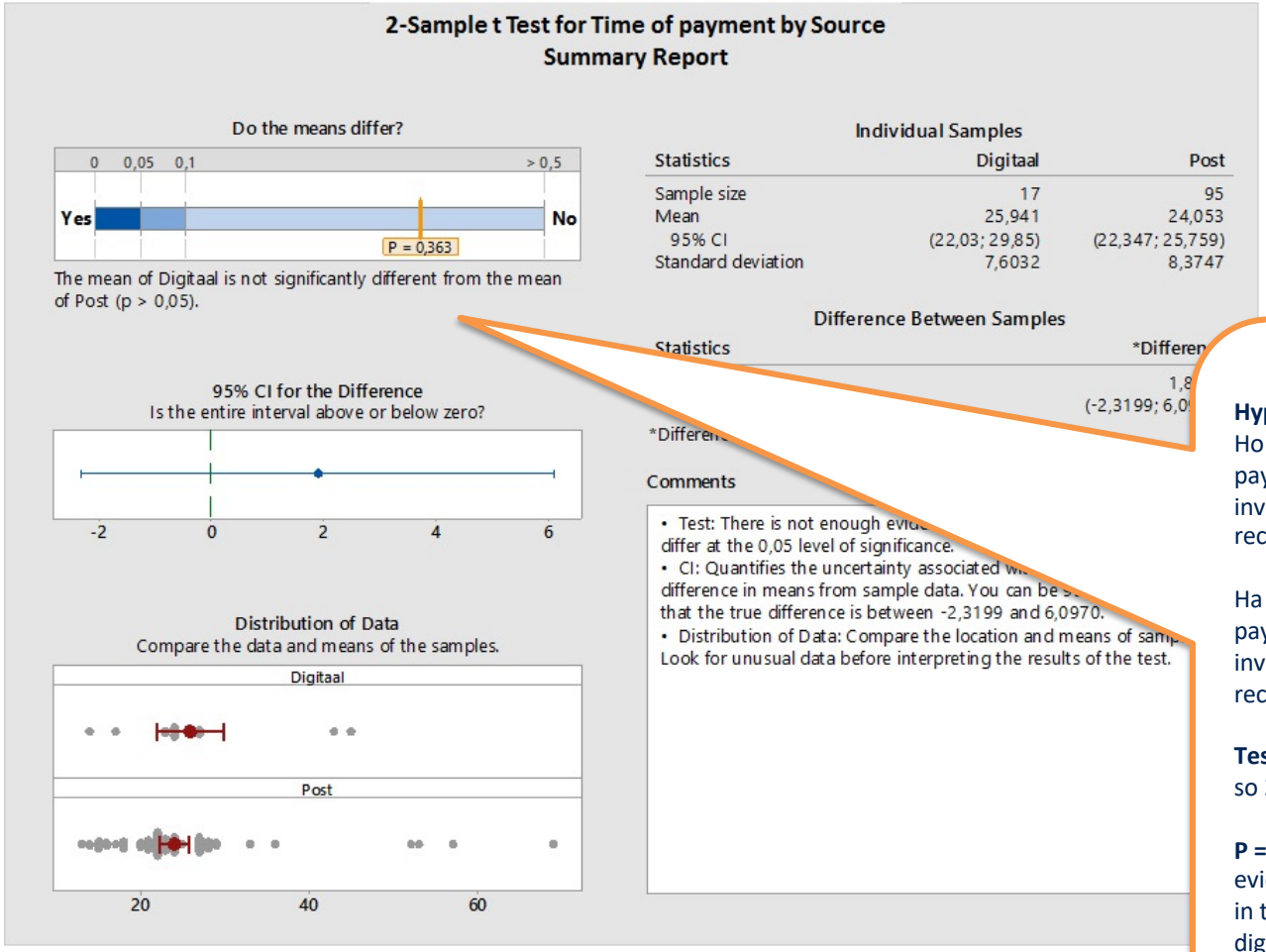
Ha = the average time until payment of invoices in our sample is different from the national average of 25 days

Test: One sample with data so 1-sample t-test

P = 0,399 so there is no evidence that our invoices are paid faster than the national average of 25 (p not lower than 0,05 so we DON'T reject the nulhypothesis)

Slimmer werken, blije klanten

Elaboration: Question 2



Hypothesis:
Ho = The average time until payment of digitally received invoices is similar to invoice received by mail.

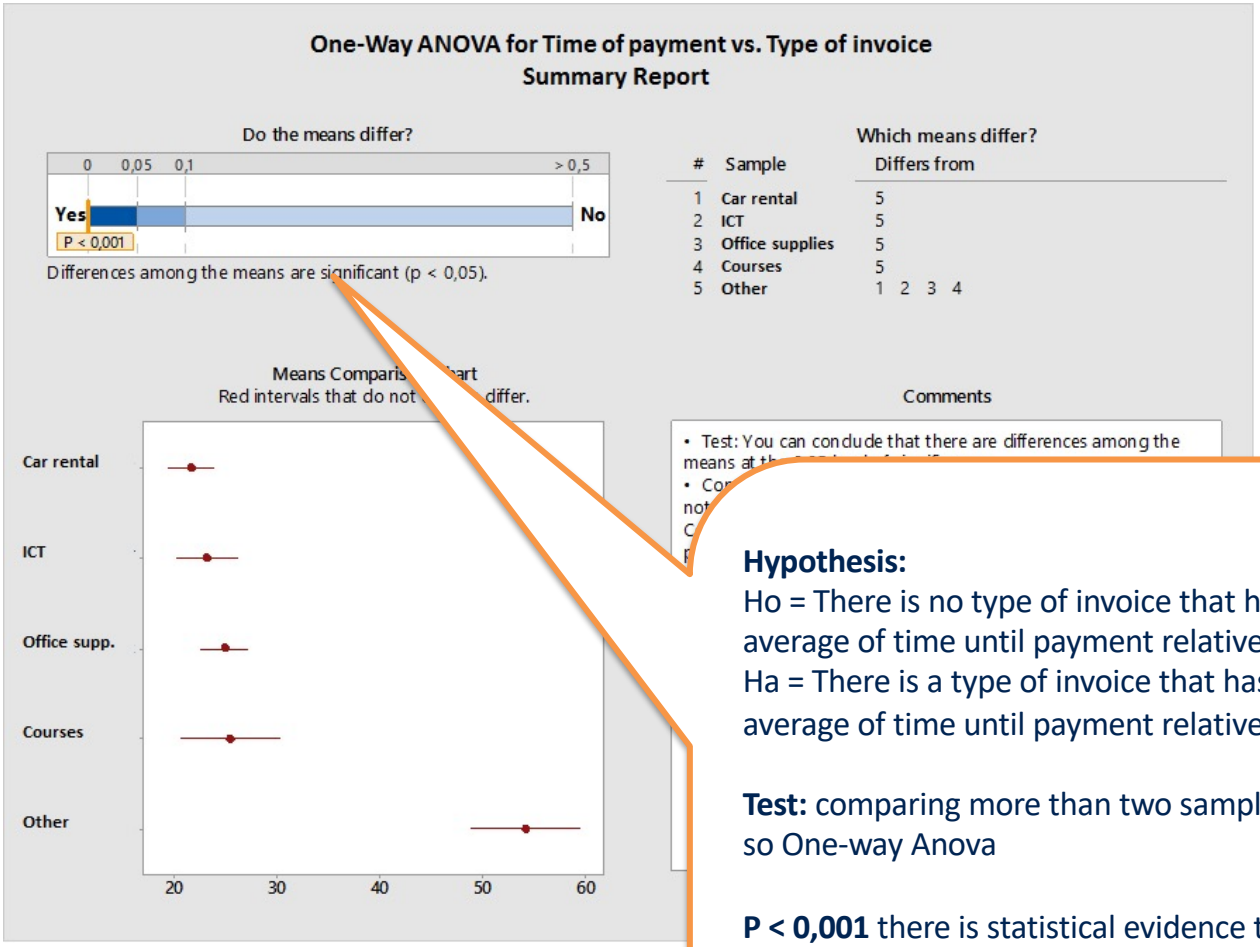
Ha = The average time until payment of digitally received invoices is different to invoices received by mail.

Test: two samples with each other so 2-sample t-test

P = 0,363 there is no statistical evidence that there is a difference in time until payment between digital invoices and invoices by mail (p NOT lower than 0,05 so we accept the nulhypothesis)

Slimmer werken, blije klanten

Elaboration: Question 3



Hypothesis:
Ho = There is no type of invoice that has a deviating average of time until payment relative to the other types.
Ha = There is a type of invoice that has a deviating average of time until payment relative to the other types.

Test: comparing more than two samples with each other so One-way Anova

P < 0,001 there is statistical evidence that there is a type of invoice with a different time until payment (p lower than 0,05 so we reject the null hypothesis). It is the type Other (Overig) that is different.

Slimmer werken,
blije klanten

Elaboration: Question 1 and 2 (via menu)

bureau tromp LEAN & SIX SIGMA

Question 1: One Sample t-test: Time until payment

Test of μ = 25 vs ≠ 25

Variable	N	Mean	StDev	SE Mean	95% CI	T	P
Time till payment	112	24,339	8,258	0,780	(22,793; 25,885)	-0,85	0,399

Question 2: Two Sample t-test and CI: Time until payment; Source

Source	N	Mean	StDev	SE Mean
Digital	17	25,94	7,60	1,8
Postal	95	24,05	8,37	0,86

Difference = μ (Digital) - μ (Postal)
Estimate for difference: 1,89
95% CI for difference: (-2,32; 6,10)
T-Test of difference = 0 (vs ≠): T-Value = 0,93 P-Value = 0,363 DF = 23

Slimmer werken, blije klanten

Elaboration: Question 3 (via menu)

Question 3: ANOVA Time until payment versus Type of invoice

```
Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Factor Information
Factor        Levels  Values
Type invoice       5  Car rental; ICT; Office supplies; Other; Courses

Analysis of Variance
Source         DF  Adj SS  Adj MS  F-Value  P-Value
Type invoice    4    2991  747,85    17,48    0,000
Error         107    4578   42,78
Total         111    7569

Model Summary
      S    R-sq  R-sq(adj)  R-sq(pred)
6,54083  39,52%     37,26%      33,75%

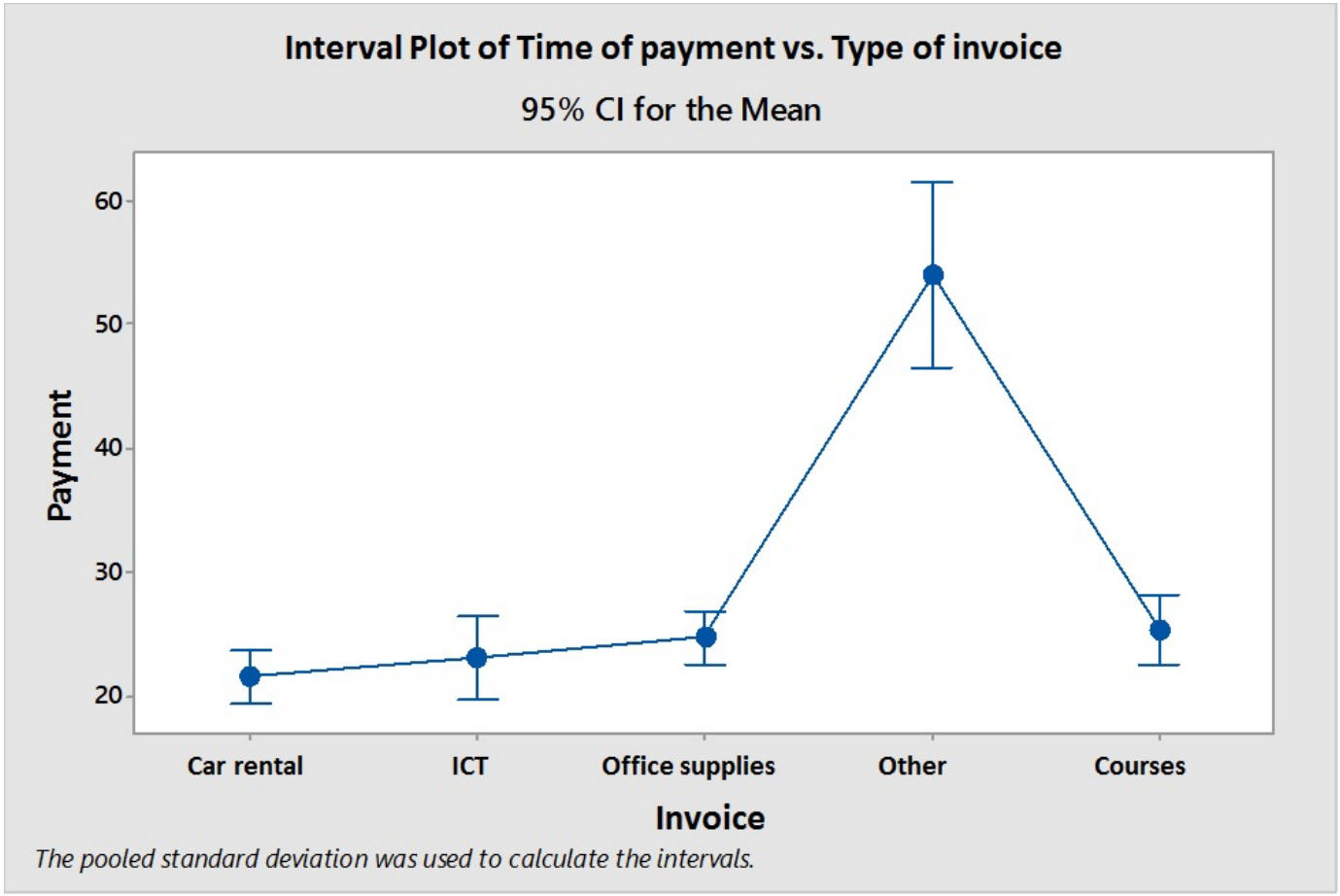
Means
Type invoice       N    Mean  StDev        95% CI
Car rental        39  21,564  5,404  (19,488; 23,640)
ICT               15   23,13   6,10  ( 19,79;  26,48)
Office supplies   35  24,800  4,517  (22,608; 26,992)
Other              3   54,00   2,65  ( 46,51;  61,49)
Courses           20   25,40  10,86   ( 22,50;  28,30)

Pooled StDev = 6,54083
```

Slimmer werken, blije klanten

Elaboration: question 3 (via menu)

Question 3: ANOVA



Slimmer werken, blije klanten

z-table

Standard Normal Probabilities

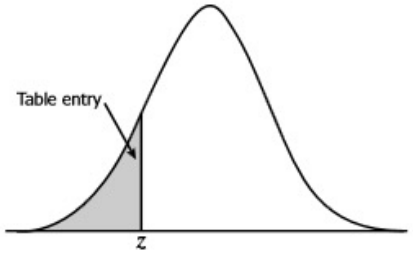


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
–3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
–3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
–3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
–3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
–3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
–2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
–2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
–2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
–2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
–2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
–2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
–2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
–2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
–2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
–2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
–1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
–1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
–1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
–1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
–1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
–1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
–1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
–1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
–1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
–1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
–0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
–0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
–0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
–0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
–0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
–0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
–0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
–0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
–0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
–0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

bureau tromp
LEAN & SIX SIGMA

Slimmer werken, blije klanten

z-table

Standard Normal Probabilities

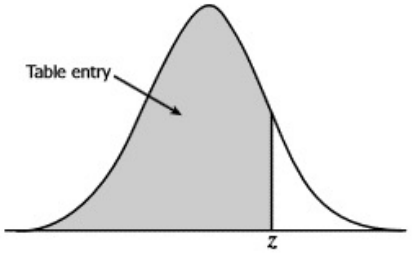


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

bureau tromp
LEAN & SIX SIGMA

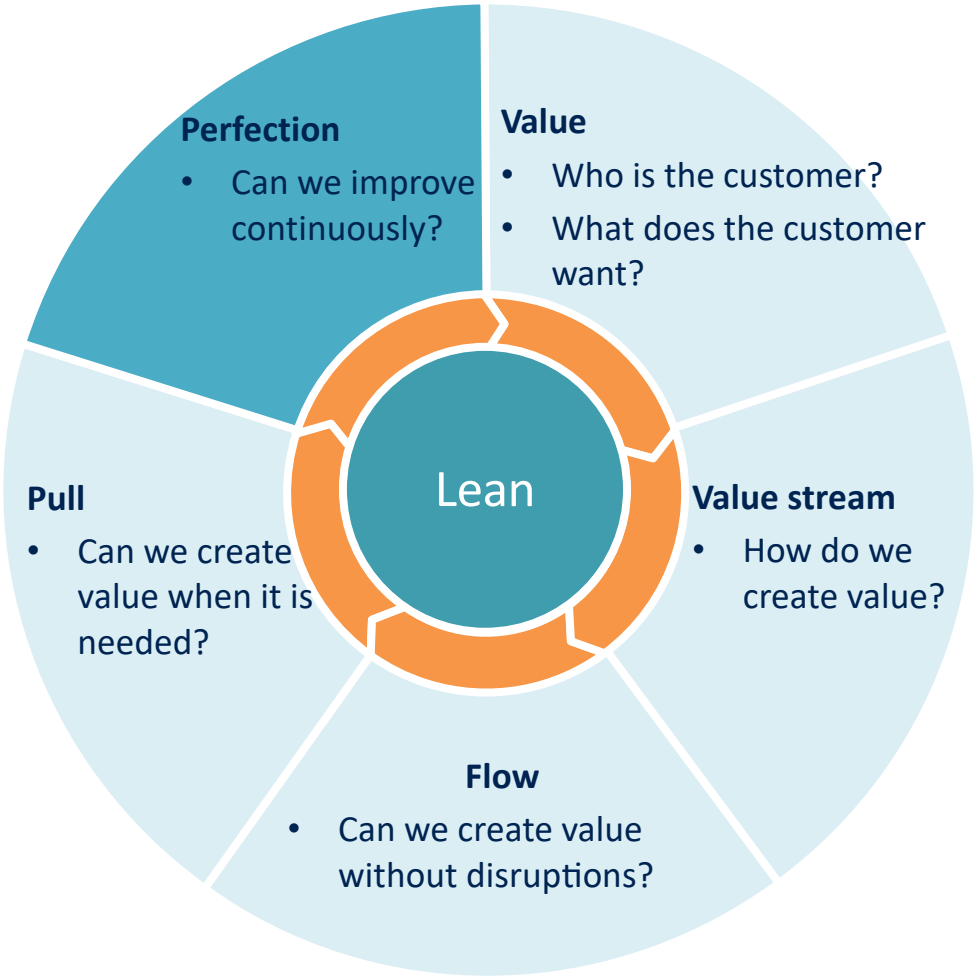
Slimmer werken, blije klanten

Schedule day 5

- Minitab
- 5th Principle Lean: Perfection
- Practice exam

Slimmer werken,
blije klanten

Principle 5: Perfection



Slimmer werken, blije klanten

5th Principle: Perfection



- The 5th principle: Perfection is about continuous improvements.
- Use the time you save to talk to clients and suppliers about their (new) demands
- Organise a (meeting)structure wherein continuous improvement is part of daily activities

Instruments and techniques:

- 5S
- Daystart
- Kaizen-event

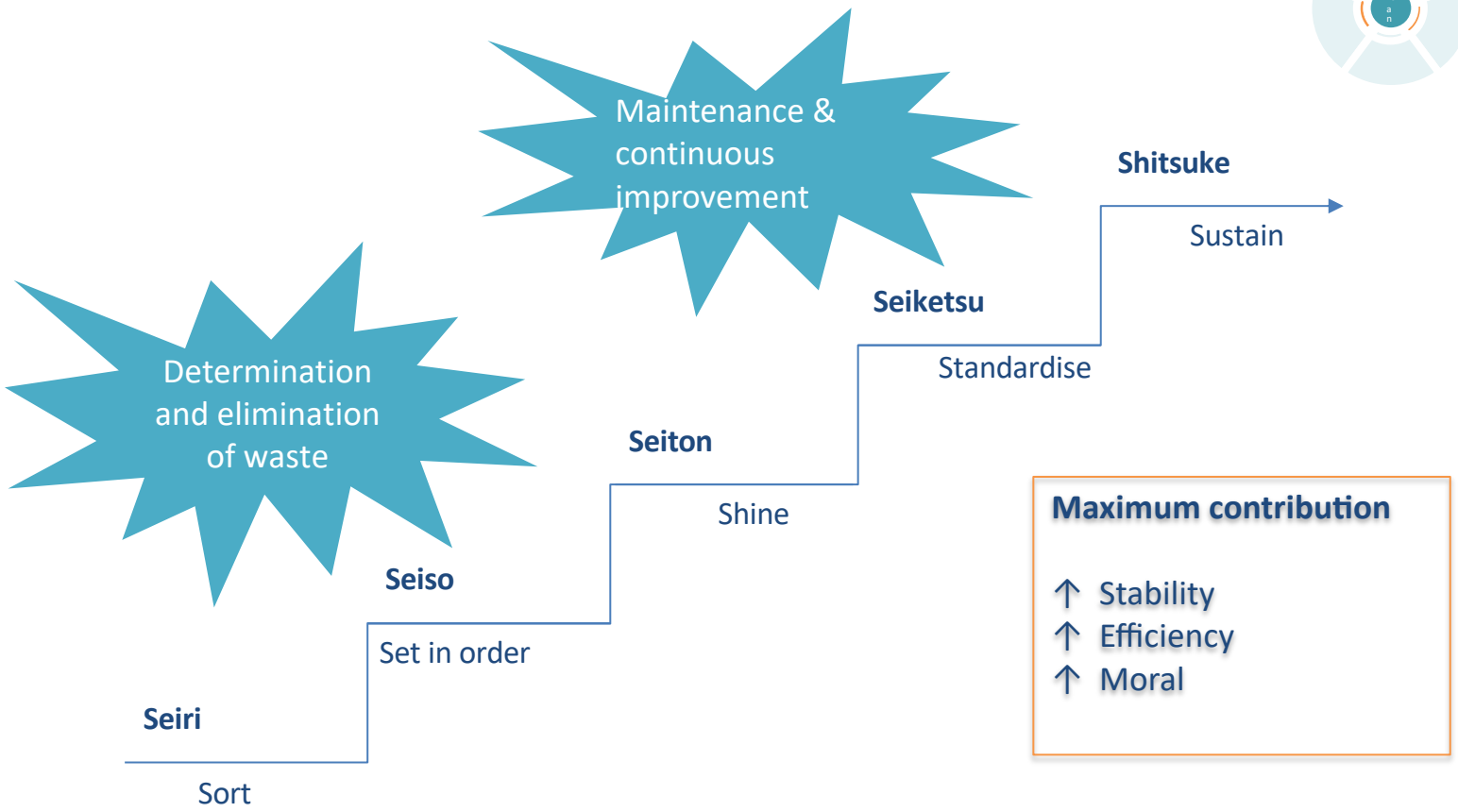
Slimmer werken,
blije klanten

5S



Slimmer werken, blije klanten

5S



Slimmer werken, blije klanten

5S: Sort

bureau tromp
LEAN & SIX SIGMA

Sort:

- Throw away everything that is not essential for the process



Slimmer werken,
blije klanten

5S: Set in order

Set in order:

- Give all materials a fixed place



Slimmer werken, blije klanten

5S: Shine

Shine:

- Elimination of sources that cause interruptions and waste
- Agreements about cleaning
- Divide responsibilities



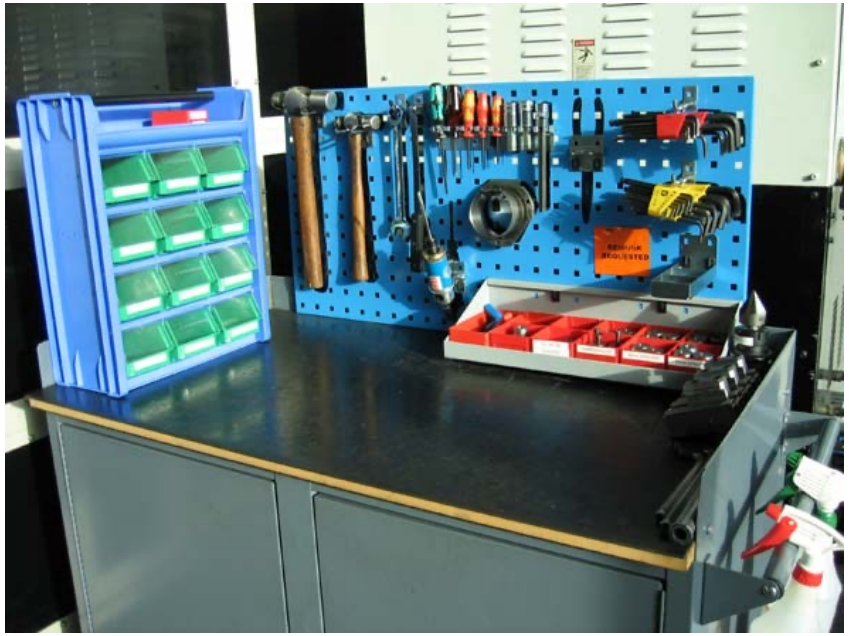
Slimmer werken,
blije klanten

5S: Standardise

Standarise:

- Communicate about agreements.

  Everybody knows it, so everybody does it
- Visual tools to detect deviations



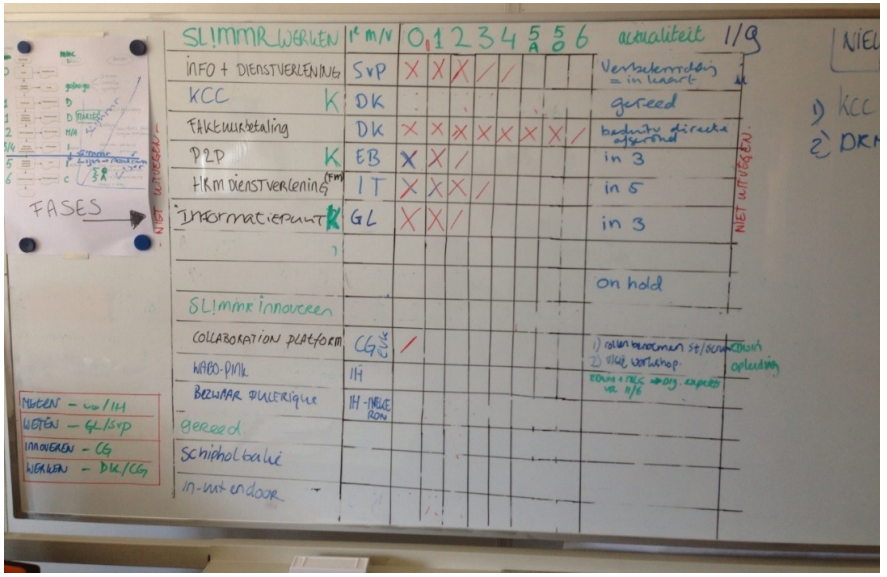


Slimmer werken,
blije klanten

5S: Sustain

Sustain:

- Securing the first 4S’s
- Audits, checklists
- Communication
- Adjust / address



Slimmer werken, blije klanten

Example: 5S

Example Royal Air Force



Before

After



Slimmer werken,
blije klanten

5S: the 6th S?

bureau tromp
LEAN & SIX SIGMA

Often forgotten: 6th S (Safety)



Slimmer werken,
blije klanten

Daystart

"Every day a little bit better"

- Stand-up meetings
- Improving with use 'common sense' and little financial means
- Use of an improvement board



Slimmer werken,
blije klanten

Kaizen

There are two types of Kaizen:

- Gemba Kaizen: ‘Change to do better on the workplace’
- Kaikaku Kaizen: ‘Radical change to do better’ (4 weeks)



Notice, Kaiaku =
‘Change for the worse’

Slimmer werken,
blije klanten

Gemba Kaizen

Improving with common sense and little financial aid
(innovation = contrary)

Focuses on

- Housekeeping (5S)
- Waste
- Standardisation

Fill in by

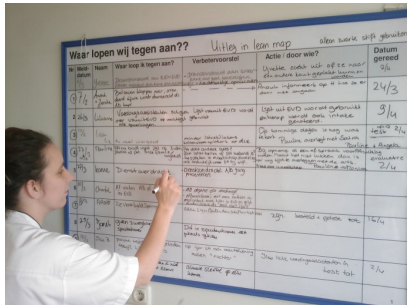
- Meeting structure
- Visual management
- Improvement boards
- Process performance

Slimmer werken,
blije klanten

Example: Gemba Kaizen

- Toyota: Andon (‘lamp’) for status process
  - Pull a cord to shut the process down in case of problems
  - Fix them with available employees
  - Hospital: improvement board







Slimmer werken, blije klanten

Kaikaku Kaizen

Is used when continuous improvement (day start, improvement board is not enough):

- Focus group frees up time
- Solutions directly implemented
- Remaining points <20 days

Basis of a Kaizen event: Kaizen circle and A3 Management

Is used when quick results are needed and the scope of the problem is clear

Slimmer werken,
blije klanten

Schedule day 5

- Minitab
- 5th Principle Lean: Perfection
- Practice exam

Slimmer werken,
blije klanten

End of day 5

Tomorrow:

- Six Sigma
  - Improve phase
  - Control phase
- Change management
- Exam
- Questions?

Slimmer werken,
blije klanten

bureau tromp

LEAN &
SIX SIGMA

Green Belt training

Lean Six Sigma

Slimmer werken,
blije klanten

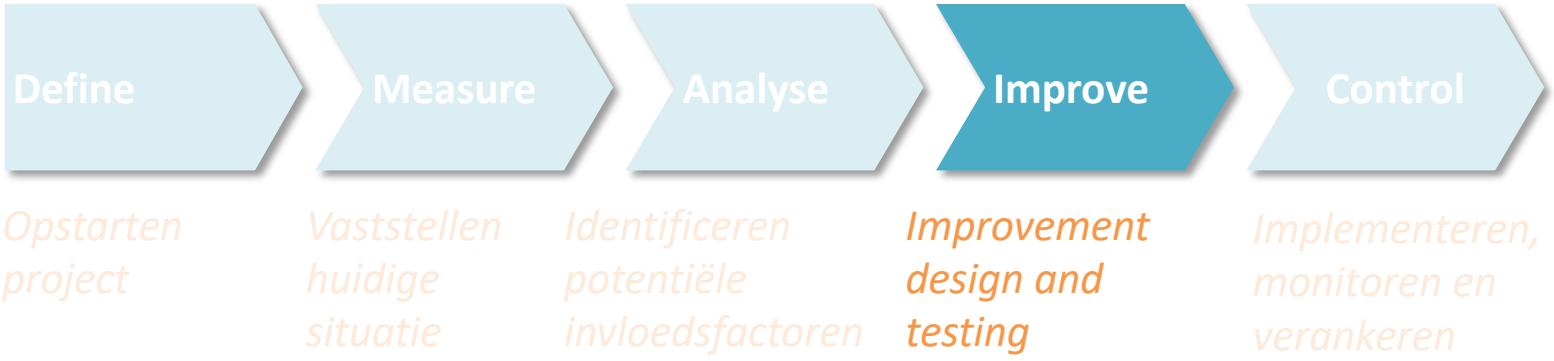
Day 6

Schedule day 6

- Improve phase
- Control phase
- Change management
- Exam

Slimmer werken,
blije klanten

Six Sigma structure | IMPROVE



Result:

- Improvement design

Slimmer werken, blije klanten

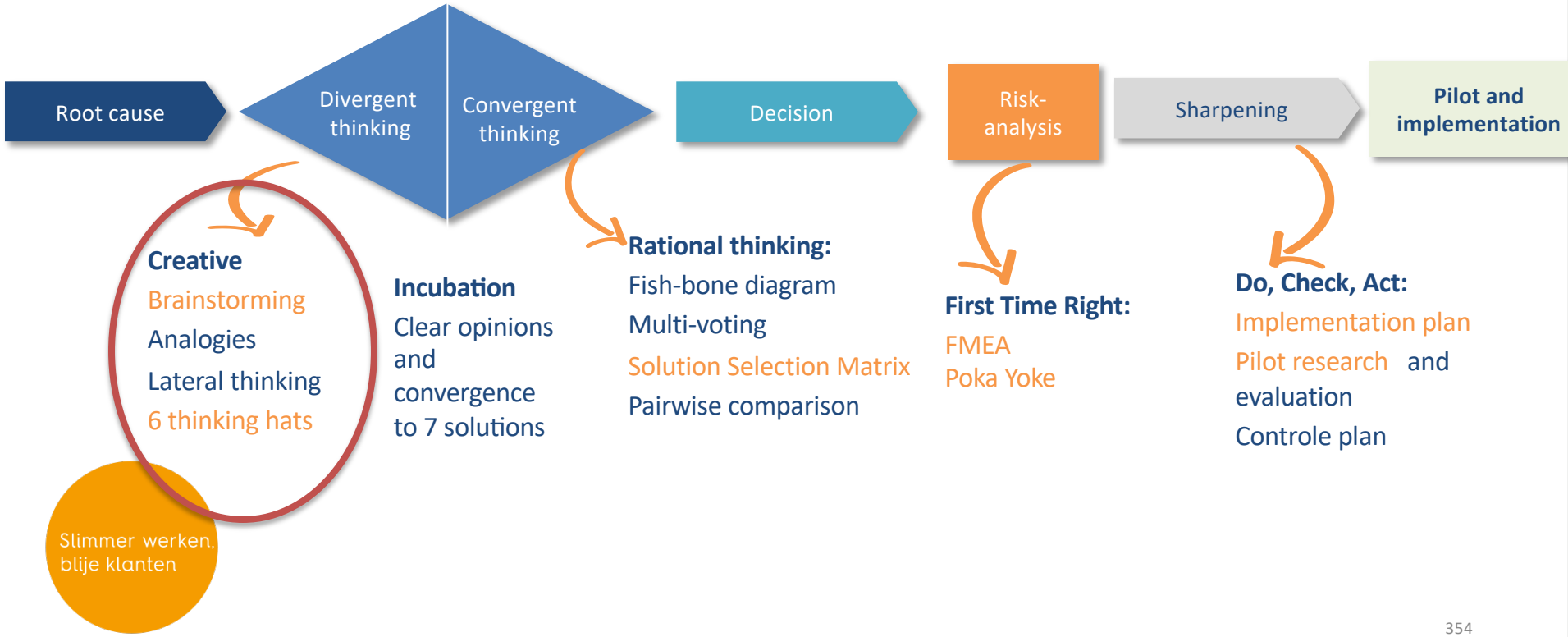
Improvement design

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Determining the right factors of influence

- In the Analysis phase we have determined the root causes for a couple factors of influence.
- These factors of influence are the starting point of the improve phase, where we try to find a suitable solution



Brainstorming

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Guidelines:

1. Clear formulation of the goal
2. Give everybody enough time (couple of minutes) to think
3. Collect ideas
    - Everything is right, no discussion about or critics on ideas
    - Build further on the ideas of others
    - Collection can take place in different ways (for example post-its)
4. Use techniques to energise brainstorm sessions
5. Wind up with
    - Enumeration of all ideas
    - Bundling of all ideas that are similar
    - Formulating clear next steps

For example: Analogies, random words, reverse brainstorm

Slimmer werken,
blije klanten

Brainstorming

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Do's	Don'ts
Keep it short (explaining the idea)	Be critical to ideas
Give participants time to think	Rate the ideas immediately
Build on existing ideas	Already nominate a project leader in the brainstrom session
Organise, categorise and evaluate only at the end of the session	Write down the incoming ideas only fragmentary
Aim for quality	

Slimmer werken,
blije klanten

Mindmapping







- Writing Well
  - Attitude
    - Ego
      - Confidence
      - Self-esteem
      - Individuality
    - Writing for self
    - Self Discipline
      - Tools=words
      - Learn by writing
        - Write, write, write, write
      - Craft learned by application
      - Re-writing
        - More color
        - Every change nearer
        - Seeing improvement
    - Sincerity
  - Good English
    - Good Models
      - Read
      - Need Mentors
    - Listen to what you write
      - Read aloud
      - Clarity
      - Direction
      - Change sentence
    - Take care to say it write
  - Information
    - Trust material
    - Present it
    - Leave reader decide
  - Narrative
    - Love to be told a story
    - Most interesting
    - Will hold on to point
    - Keep it human
    - Quotations keeps it alive
      - Subjects kept alive
      - Learn to interview
  - 1. Clarity
    - Purpose=understanding
    - Usage of words
      - Good English
    - Fall in love w/ active verbs
      - momentum
      - picture, who did what
    - Passive verbs
      - loses clarity
      - stops flow
      - must add passive noun
    - Nouns
      - Good
        - simple
        - help
        - fundamental
      - Bad
        - ion
        - intervention
        - killer nouns
        - concept nouns
  - 2. Simplicity
    - Clutter
    - Virtue of writing
    - Most admired
  - 3. Brevity
    - Most easy way
    - Short better than long
      - Air around words
    - Adverbs
    - Adjectives
    - Learn to cut
    - Linear structure
      - Break sentences apart
      - No sentence to short
  - 4. Humanity
    - Be natural
    - Be yourself
    - Style=you=personality
    - Reader comes on trip with you
      - Identify with author

Slimmer werken, blije klanten

Thinking hats

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

‘6 thinking hats’



- Look at a problem or question from different perspectives
- By ‘putting on’ different hats you can see problems from a different, possible better, view!
- The six hats are different and eah represent a certain vision you can take on when looking at a problem.

Slimmer werken,
blije klanten

Example: Thinking hats

COLOURED HAT	THINK OF	DETAILED DESCRIPTION
	***White paper***	The white hat is about data and information. It is used to record information that is currently available and to identify further information that may be needed.
	***Fire and warmth***	The red hat is associated with feelings, intuition, and emotion. The red hat allows people to put forward feelings without justification or prejudice.
	***Sunshine***	The yellow hat is for a positive view of things. It looks for benefits in a situation. This hat encourages a positive view even in people who are always critical.
	***A stern judge***	The black hat relates to caution. It is used for critical judgement. Sometimes it is easy to overuse the black hat.
	***Vegetation and rich growth***	The green hat is for creative thinking and generating new ideas. This is your creative thinking cap.
	***The sky and overview***	The blue hat is about process control. It is used for thinking about thinking. The blue hat asks for summaries, conclusions and decisions.

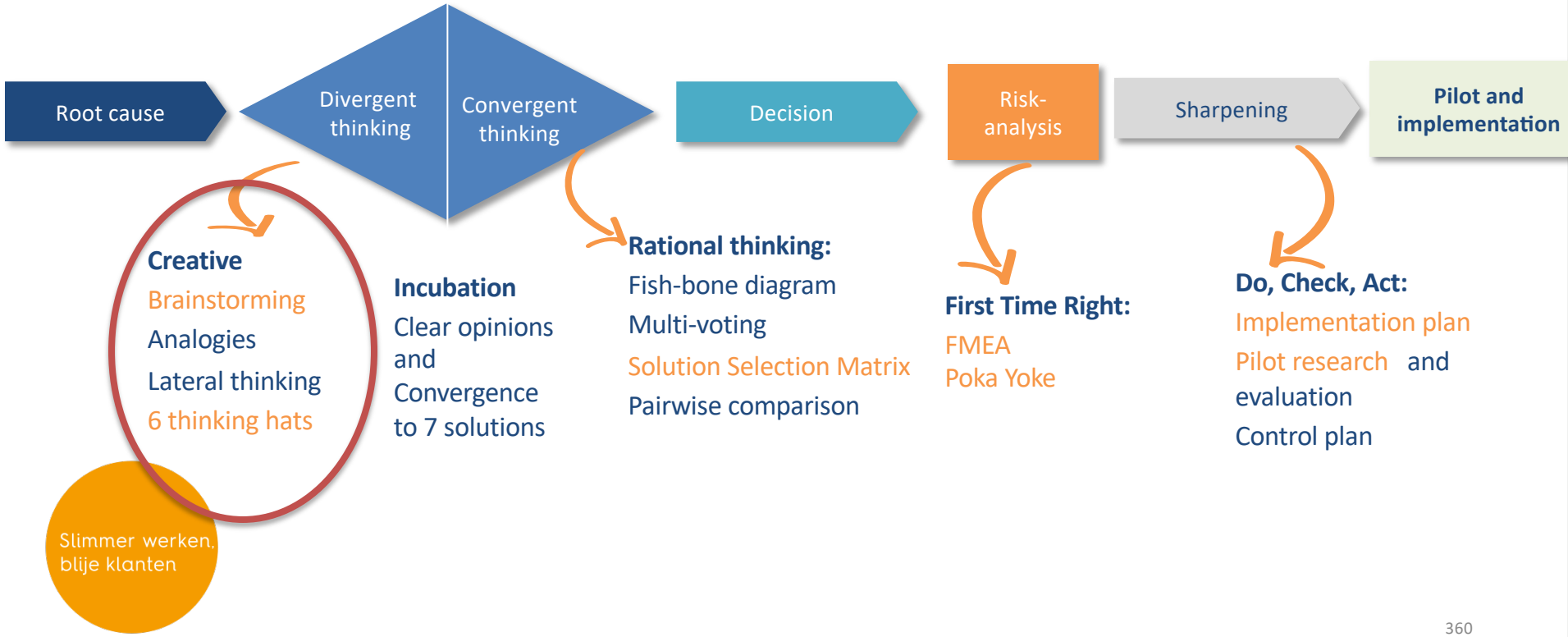
Improvement design

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Determine the right factors of influence

- In the Analysis phase we have determined the root causes for a couple factors of influence.
- These factors of influence are the starting point of the improve phase, where we try to find a suitable solution



Selection matrix

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Solution selection matrix

Method to compare alternatives based on criteria and the importance of these criteria.

- **Step 1:** Make a list with ‘wish’ criteria
- **Step 2:** Give rankings (1-10) to the list of ‘wish’ criteria
- **Step 3:** Compare the possible solutions based on the criteria you set (score 1-10)
- **Step 4:** Calculate the total score (ranking x score)

Slimmer werken,
blije klanten

Example: Selection matrix

Critical factors	Weight	Stay	Job A	Job B
Match my passion	20	7	9	8
Compensation &benefit	30	7	7	8
Quality time with family	25	8	9	6
Sustainability	15	7	6	9
Career progression	10	8	7	8
TOTAL SCORE	**100**	**735**	**775**	**765**

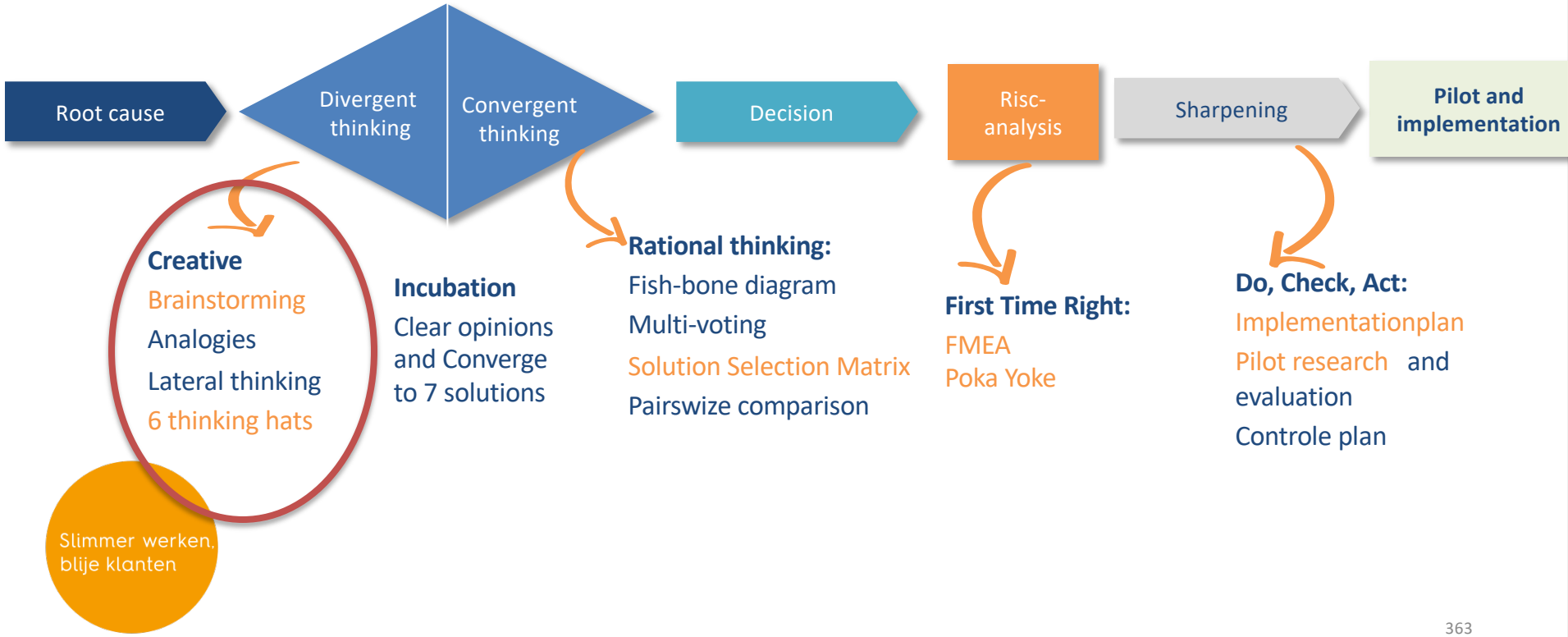
Improvement design

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Determine the right factors of influence

- In the Analysis phase we have determined the root causes for a couple factors of influence.
- These factors of influence are the starting point of the improve phase, where we try to find a suitable solution



FMEA

bureau tromp
LEAN & SIX SIGMA



Failure Mode and Effect Analysis (FMEA)

FMEA researches the consequence of a possible product or process failure in order to take constructive or process measures beforehand. This is to prevent the chance of happening or lowering the impact on the outcome.

Goal:

- Recognition of causes and finding possible weak spots
- Setting priority for further analysis
- Calculate the risks for the customer/ organisation
- Defining of measures to limit the risks.

Slimmer werken,
blije klanten

FMEA

An important element of FMEA is analysing three characteristic mistakes:

- Severity (1-10)
- Frequency of occurrence (1-10)
- Likelihood of detection

The 'failure modes' will be scored on each aspect on a scale of 1 to 10. The outcome is called ‘Risk Priority Number’ .

RPN = (Severity) x (Frequency of occurrence) x (Likelihood of detection)

RPN > 120? Take action!

Slimmer werken,
blije klanten

FMEA

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Severity how severe are the defects?

Occurence how often does the defect occur?

Detection How fast are defects detected?

RPN Prioritising based on scores

PRODUCT FAILURE MODE & EFFECT ANALYSIS

RPN

Date: 5-11-2013

No.	Name of part or process step	Failure mode	S	Cause	O	Effect	D	TR	Action	Responsible
1	Lighting	No power to lamp	2	Faulty wiring	2	No light	9	36	Check wiring	
		Lamp broken	4	Burning hours used	4	No light	9	144	Replace lamp	
		Wiring faulty	4	Unclear instruction	4	No light	9	144	Rewire	
2	Sitting object	Couch breaks when sitting down	1	Production fault	2	Product broken	9	18	Control during /after production	
		Couch damages clothing	2	Subpar finish	3	Clothing ripped	7	42	Check before placement	
		Stays wet long	2	Bad design	2	Not able to sit	8	32	Attention design	
		People try moving it	2	Vandalism	3	Not possible	4	24		
3	Lamp post	Falls over	1	Vandalism	3	Falls over	9	27		
		Cage at top damaged	2	Vandalism	2	Falls off	8	32	Reattach cage	
		Cage at top damaged	2	Vandalism	2	Cage/bulb broken	8	32	Repair cage	

Slimmer werken, blije klanten

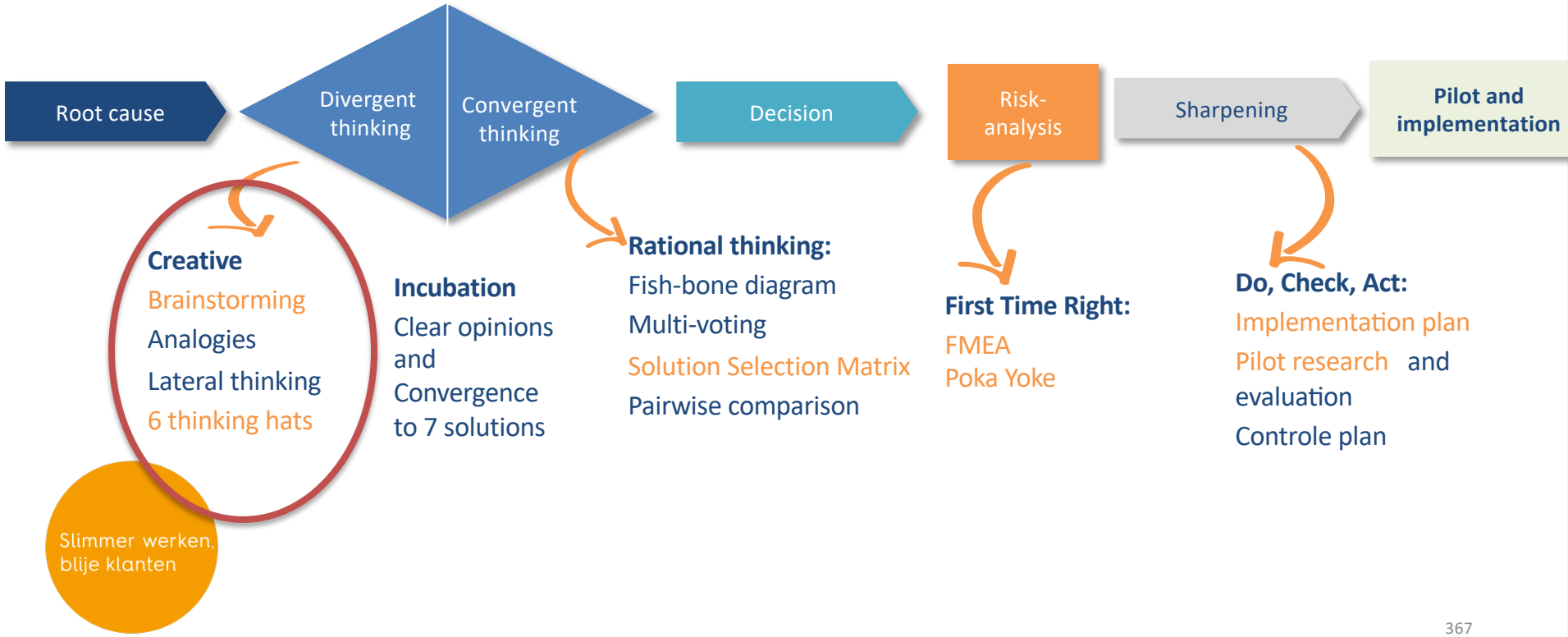
Improvement design

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Determine the right factors of influence

- In the Analysis phase we have determined the root causes for a couple factors of influence.
- These factors of influence are the starting point of the improve phase, where we try to find a suitable solution



Poka Yoke

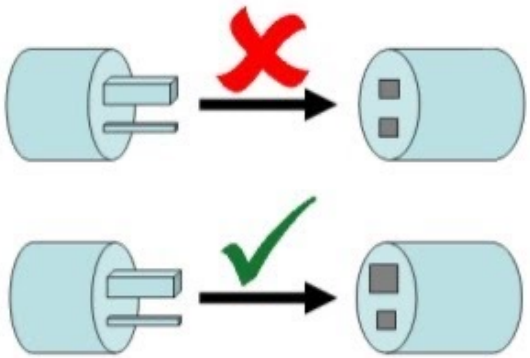
Striving to ‘not make any possible mistake’ (failsafe)

18

Poka Yoke – Mistake Proofing

A poka-yoke is any mechanism in a lean manufacturing process that helps an equipment operator avoid (yokeru) mistakes (poka).

Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur



USB Cable

Laptop Charger

Poka Yoke

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Method to design a process or product in a way that it is almost impossible to make mistakes.









Slimmer werken,
blije klanten

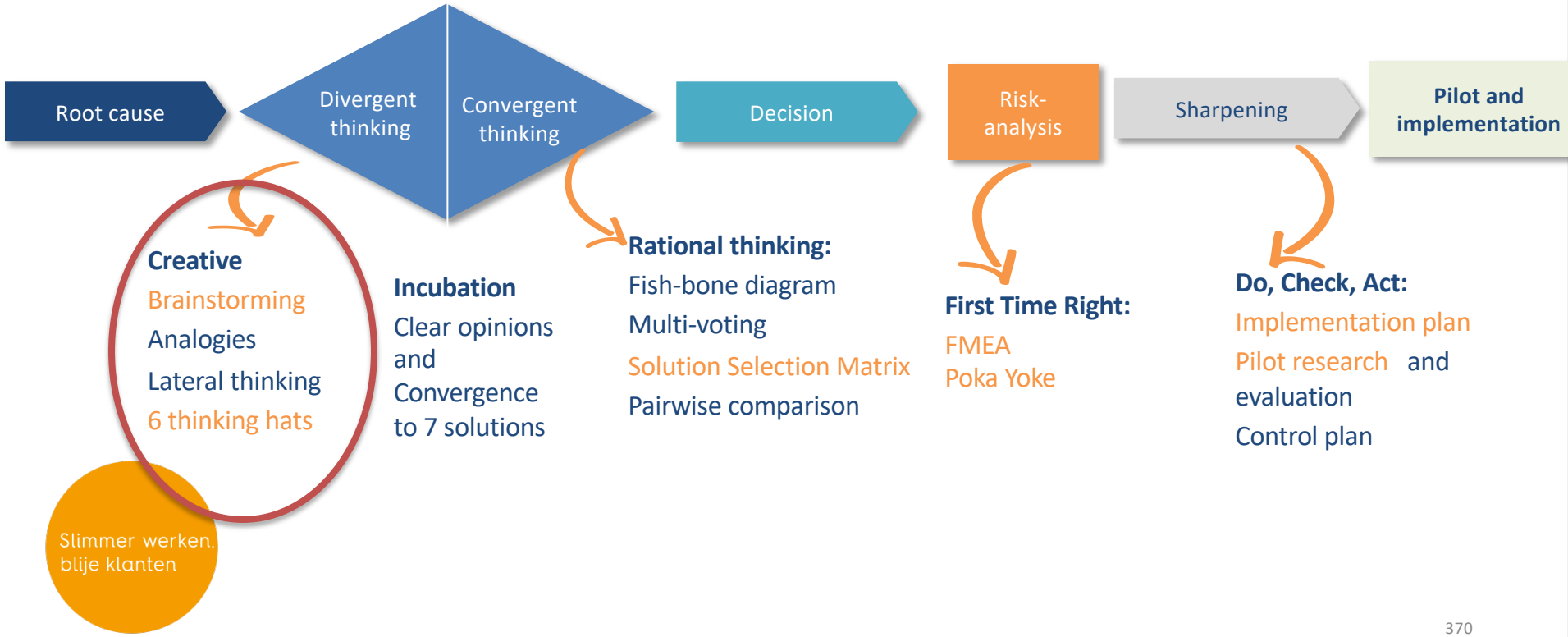
Improvement design

bureau tromp LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Determine the right factors of influence

- In the Analysis phase we have determined the root causes for a couple factors of influence.
- These factors of influence are the starting point of the improve phase, where we try to find a suitable solution



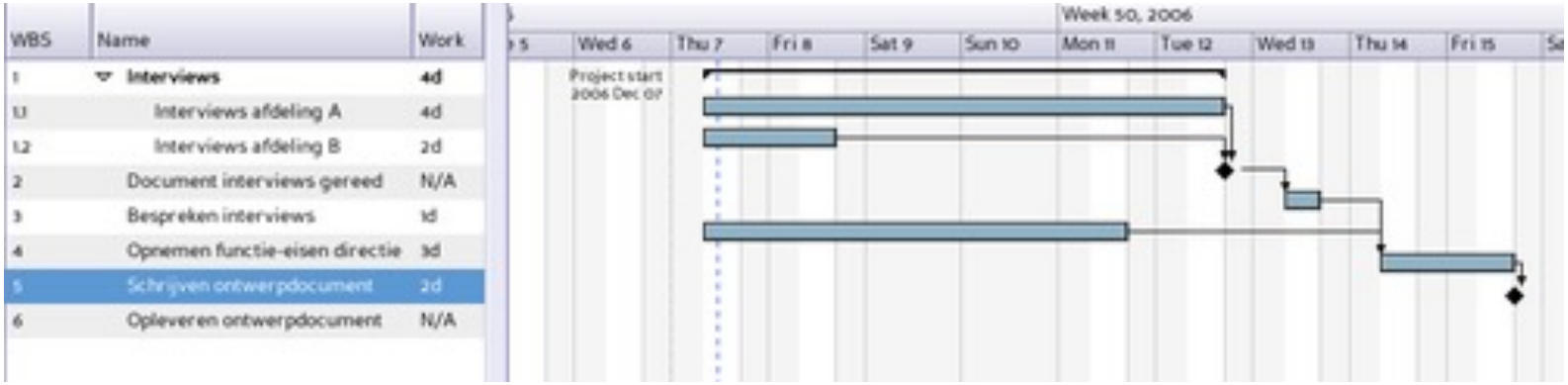
Implementation plan

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Determination and visualisation of all activities, responsibilities and data that are relevant for a succesfull implementation

- Often on 1 A4 (Looks like a Project Charter)
- Simply written
- Clears tasks, responsibility
- Planning
- Most important risks
- Plan for mitigating the risks



WBS	Name	Work
1	Interviews	4d
1.1	Interviews afdeling A	4d
1.2	Interviews afdeling B	2d
2	Document interviews gereed	N/A
3	Bespreken interviews	1d
4	Opnemen functie-eisen directie	3d
5	Schrijven ontwerpdocument	2d
6	Opleveren ontwerpdocument	N/A

Slimmer werken,
blije klanten

Example: Implementation plan

Background & Target

The SC can be reached by phone several ways, but 88% of the total calls stem from the 342/350 and 470 line.

In the current situation there is a priority distinction in regard to answering line 470. Customers who contact the SC through the 470 line (ABN AMRO) will from now be put on hold and be the next in line to be helped by SC. As the current preferential treatment has a few important consequences:

- The current waiting time on the 470 line (11 sec) is a lot shorter than the waiting time on the 350 line (51 sec).
- An increase of waiting time on the 470 line has a very big influence on waiting time on the 350 line.
- The waiting time and order in which customers are helped at the SC is unpredictable, because calls to the 470 line are directly placed at the top of the waiting list. (The KKV made it obligatory for insurance companies to offer information to calling customers while they are on hold until they get to speak to a call centre employee).

Improval proposition & implementation

Given the influence of the preferential treatment for the 470 line on the waiting time for the other lines, in combination of not being able to predict this waiting time, the improval proposition is cancelled. The 470 line will get the same approach as other SC customers – ''All calls are equal''.

The current waiting times on the 470 line will increase from 11 seconds to 38 seconds (ceteris paribus). Consequently, the cancellation of the preferential treatment will make the waiting time for the 350 line less dependant on the amount of calls on the 470 line. The current waiting time (exclusive tape) will drop from 38 to 12 seconds (ceteris paribus). The waiting times for all lines will be spread leaving the chance for excess significantly smaller comparing to the current situation.

The switch can easily be implemented by technical . To test if dropping the preferential treatment provides the desired results, there will be a pilot on 2 February. A seperate plan of approach has been created for this pilot.

Approach & Planning

1.	Forming concept plan of approach pilot 470-line	wk 4
	• Date from/till	
	• Stakeholders (hitch on IT)	
	• Possible consequences	
	• Extra capacity	
	• Mapping contingecy plan	
2.	Approval pilot	wk 4
3.	Execution pilot	wk 5
4.	Analysing pilot results	wk 5
5.	Coordinate analysis with team managers	wk 5
6.	Organise controls	wk 6
7.	Implement plan for improvement	wk 6

Business Case

Benefits

<u>Current sitation</u>

• Waiting time 350 line (from 342/350)	51 sec*
• Waiting time 470 line	11 sec
• Excess (+240 sec)	3% of total calls

<u>New situation</u>

• Waiting time 350 line (from 342/350))	38 sec*
• Waiting time 470 line	38 sec*
• Excess (+240 sec) (pilot results)	…

Costs

- No costs (concerns technical switch)

** Waiting times based on median*

Team composition

<Name>	In the lead for improval proposition
<Name>	Team manager
<Name>	Team member
<Name>	Team member
<Name>	Team member
<Name>	Team member
<Name>	Technical support
<Name>	Manager SC

Pilot

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

- A pilot is a small scale test of a suggested solution used to understand the effects of the solution better.
- By learning from a pilot study we can effectively implement the solution on a larger scale.

- **Step 1:** Make a plan to conduct a pilot
- **Step 2:** Make a plan for data collection
- **Step 3:** Communicate the plan and strategy
- **Step 4:** Train the personnel
- **Step 5:** Conduct the pilot and collect data according to the plan
- **Step 6:** Evaluate the effectiveness of the solution
- **Step 7:** Determine whether or not there are other (possible) cause-effect relations that can help reach the improvement goal
- **Step 8:** Evaluate the performance of the pilot as a whole

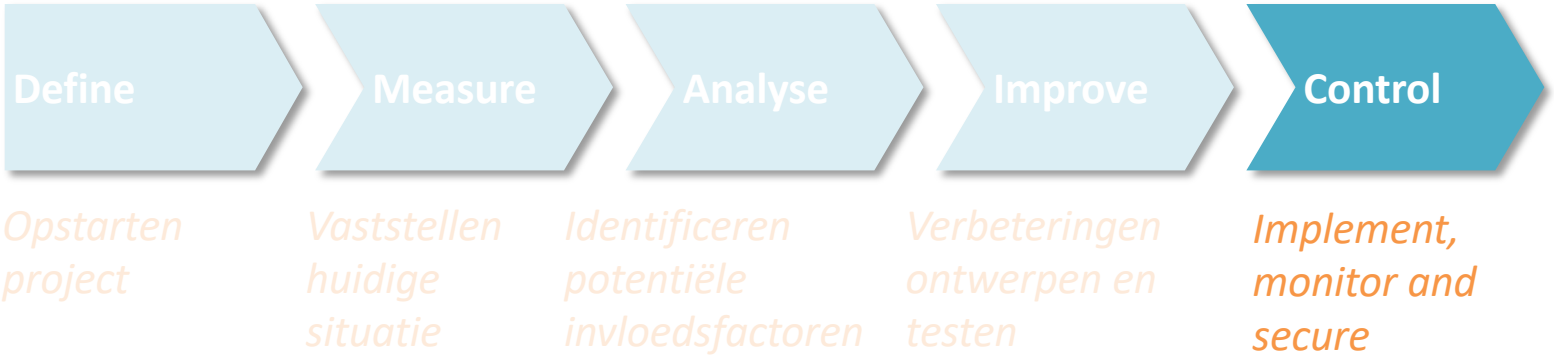
Slimmer werken, blije klanten

Schedule day 5

- Improve phase
- Control phase
- Change management
- Exam

Slimmer werken,
blije klanten

Six Sigma structure | CONTROL



Result:

- Control plan
- Statistical Process Control (SPC)
- Project documentation
- Finishing the project

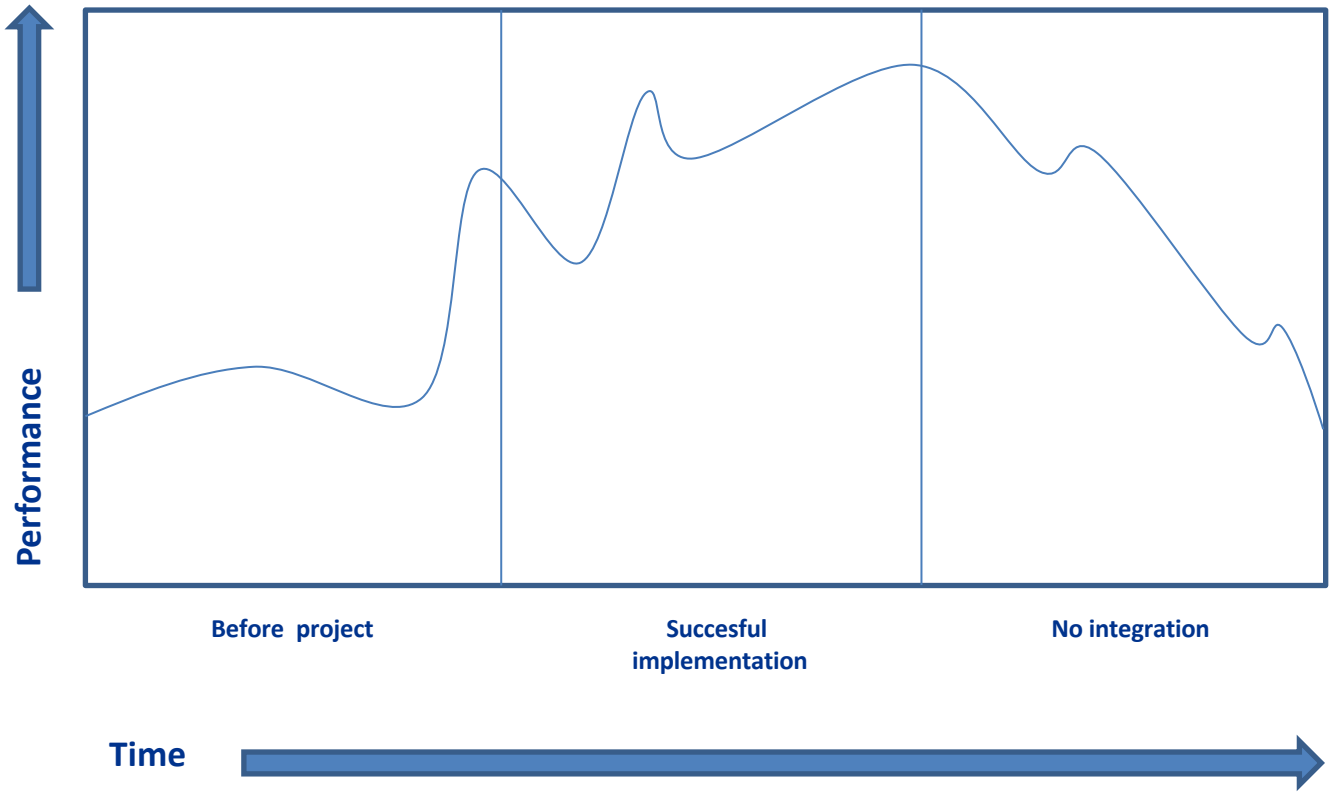
Slimmer werken, blije klanten

Control plan

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Why control?



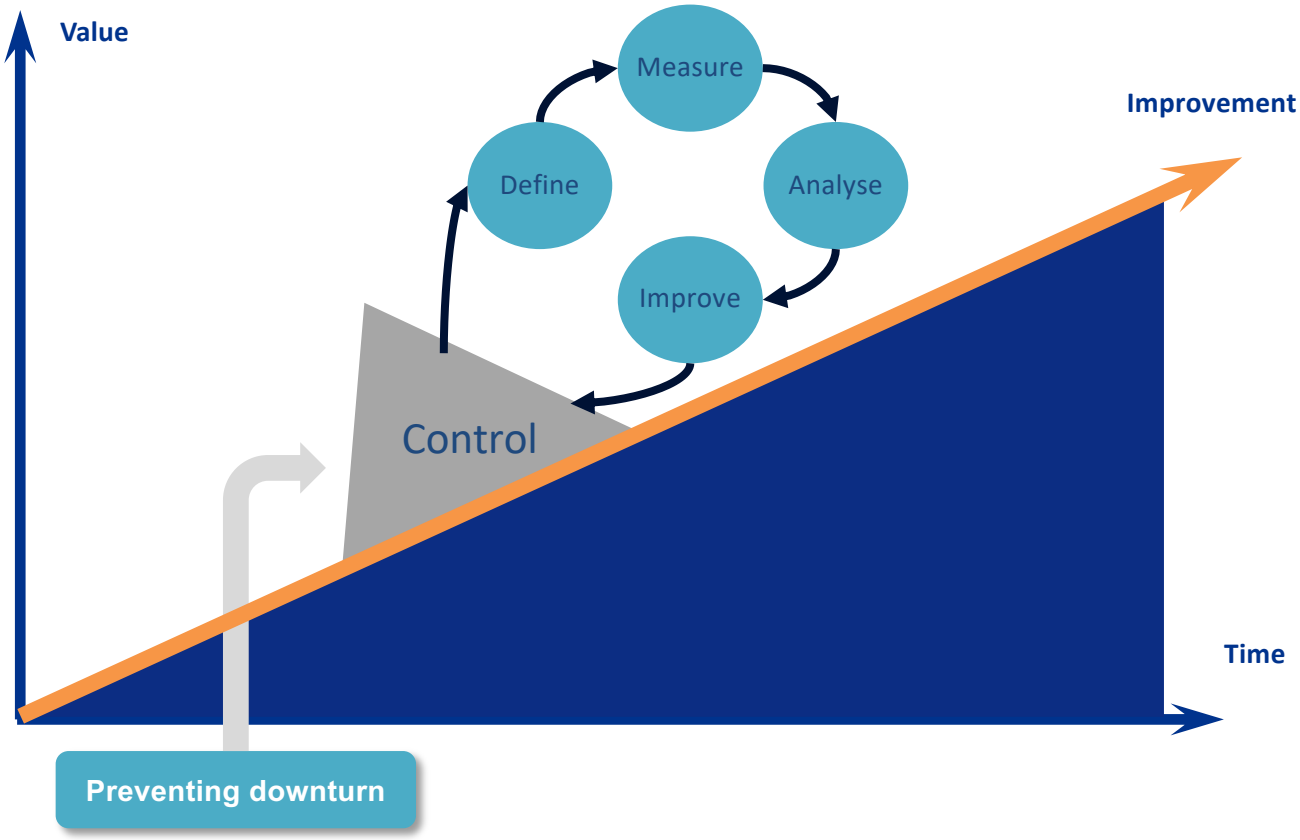
Slimmer werken, blije klanten

Control plan

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Why control?



Slimmer werken,
blije klanten

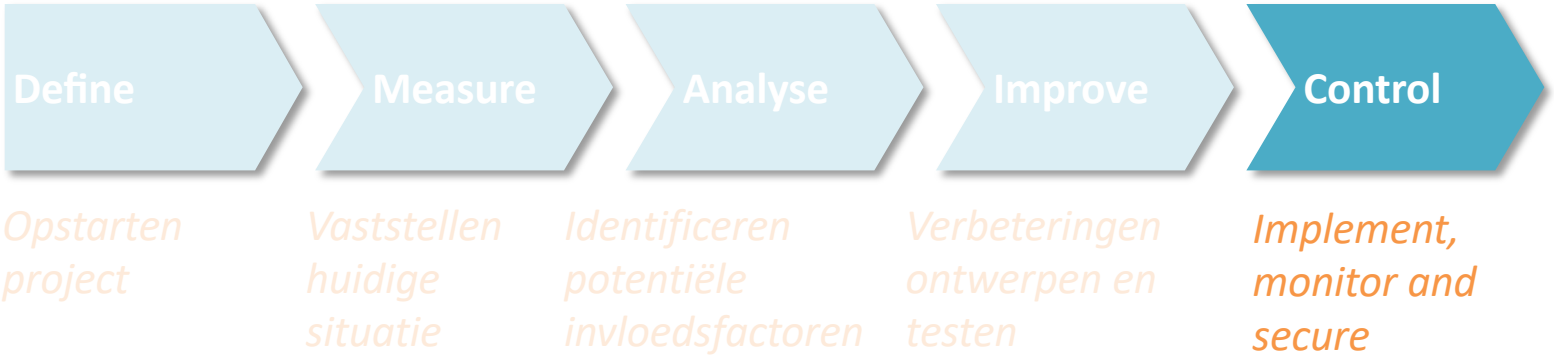
Control plan

The Control plan is an overview of all elements of the process we want to control and monitor. This is to prevent slipping back into old behaviour.

Of these elements we will mention:

- Responsibilty for conducting the control plan
- What are we going to control?
- Which X or Y are we talking about?
- Specifications of X or Y
- Which procedures do we have to control for this element?
- Plan for measure: what and how are we going to measure?
- Reaction plan: what actions are we going to undertake if we diverge too much from the specifications?

Six Sigma structuur | CONTROL



Result:

- Control plan
- Statistical Process Control (SPC)
- Project documentation
- Finishing the project

Slimmer werken, blije klanten

Statistical Process Control (SPC)

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Statistical Process Control

SPC is applied in order to monitor and control a process. After specifying the process limits, with the help of SPC, it can be established whether the process is under control.

Goal of SPC:

- Process monitoring: recognising and pursuing process distribution
- Discovering whether the process is stable and under control
- Identifying the usual and unusual causes
- Determining methods to manage the process



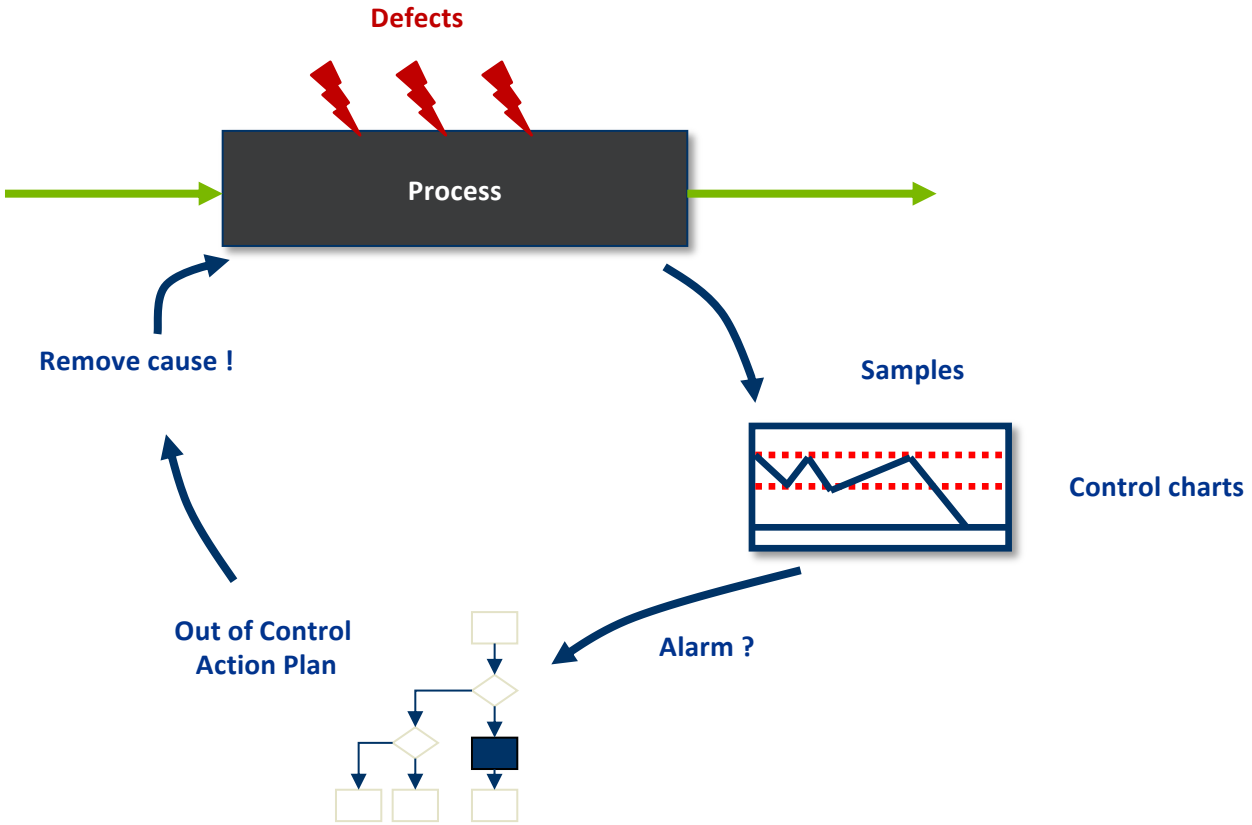
Slimmer werken,
blije klanten

Statistical Process Control (SPC)

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

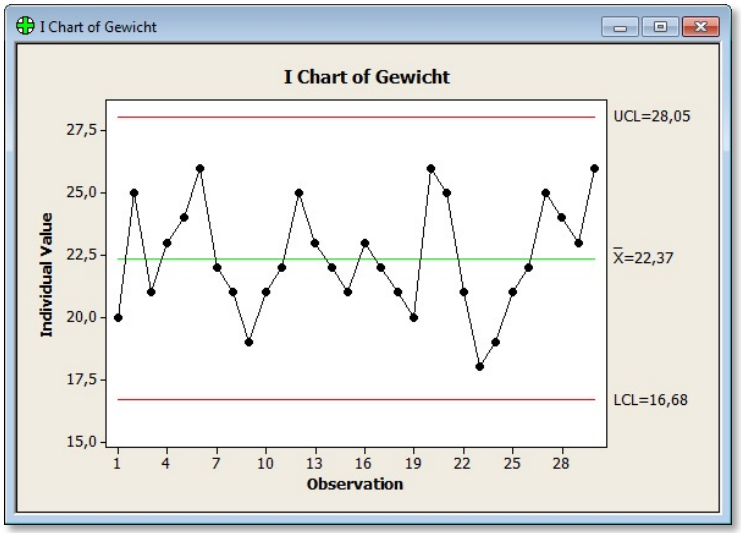
The course of SPC



Slimmer werken,
blije klanten

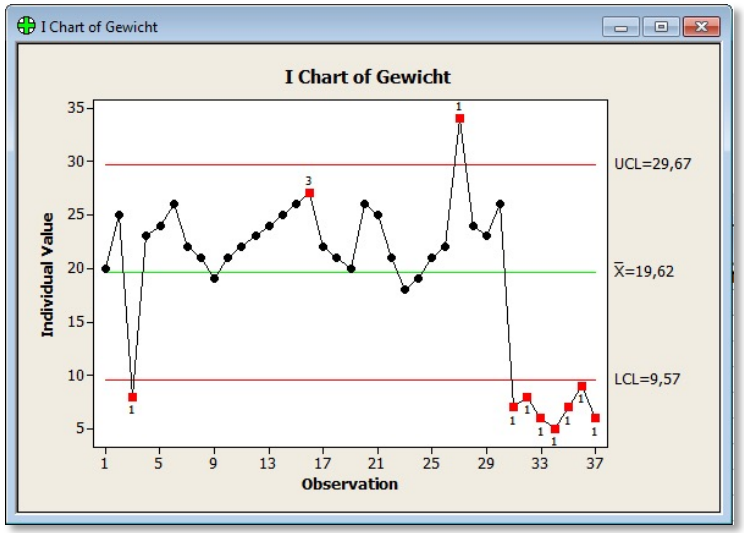
Statistical Process Control (SPC)

Use of control charts in the Control phase:



Process in control

No action



Process not in control

Action!

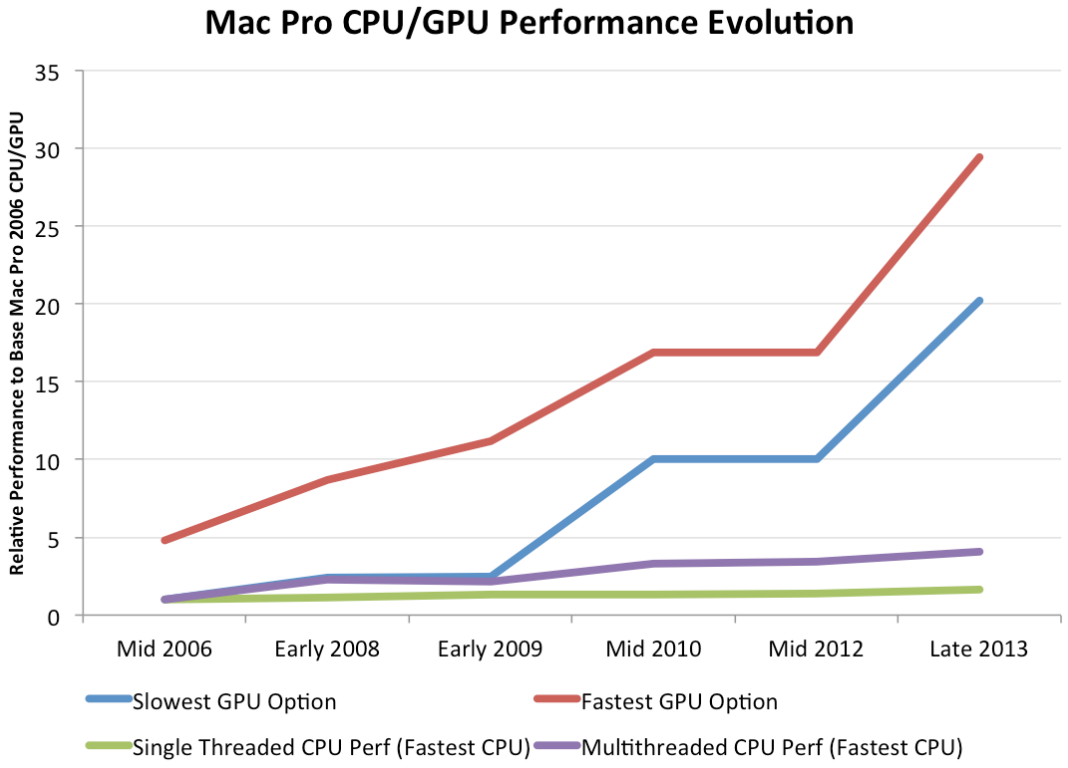
Slimmer werken,
blije klanten

Statistical Process Control (SPC)

bureau tromp
LEAN & SIX SIGMA

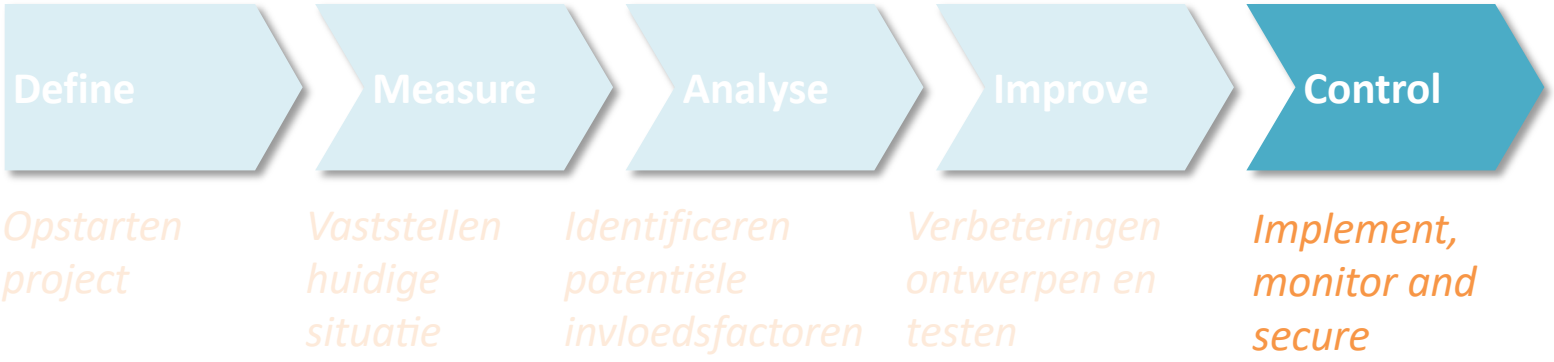
Define | Measure | Analyse | Improve | Control

Visualisation of performance over time



Slimmer werken, blije klanten

Six Sigma structure | CONTROL



Result:

- Control plan
- Statistical Process Control (SPC)
- Project documentation
- Finishing the project

Slimmer werken, blije klanten

Project documentation

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Documentation

Capture the new situation with the help of the following instruments:

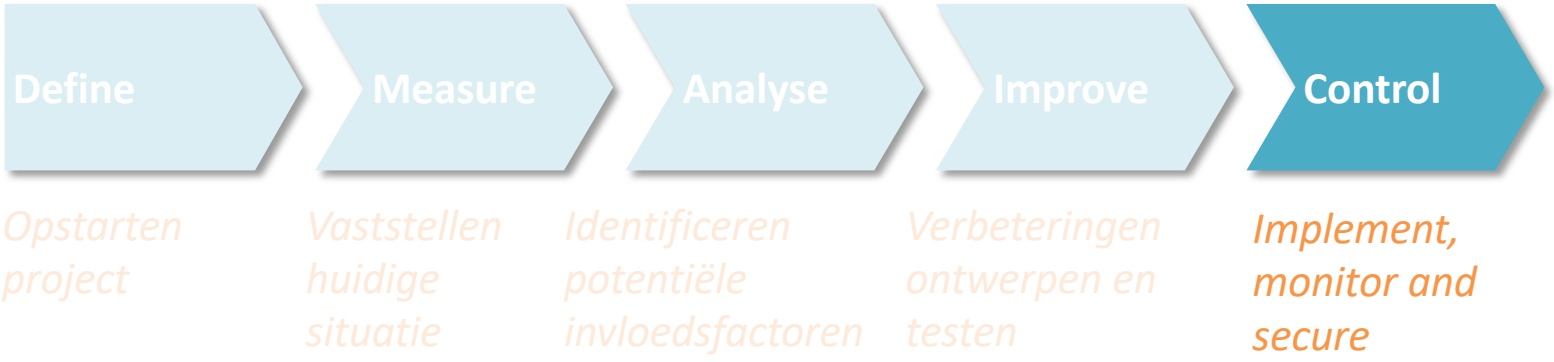
- SIPOC
- VSM current state
- VSM future state
- Work instructions
- Standard work (SOP)

- Communicate and make available to other teams and the organisation
- Generate a basis for further improvements in the organisation
- Secure results for future comparisons



Slimmer werken, blije klanten

Six Sigma structure | CONTROL



Result:

- Control plan
- Statistical Process Control (SPC)
- Project documentation
- Finishing the project

Slimmer werken, blije klanten

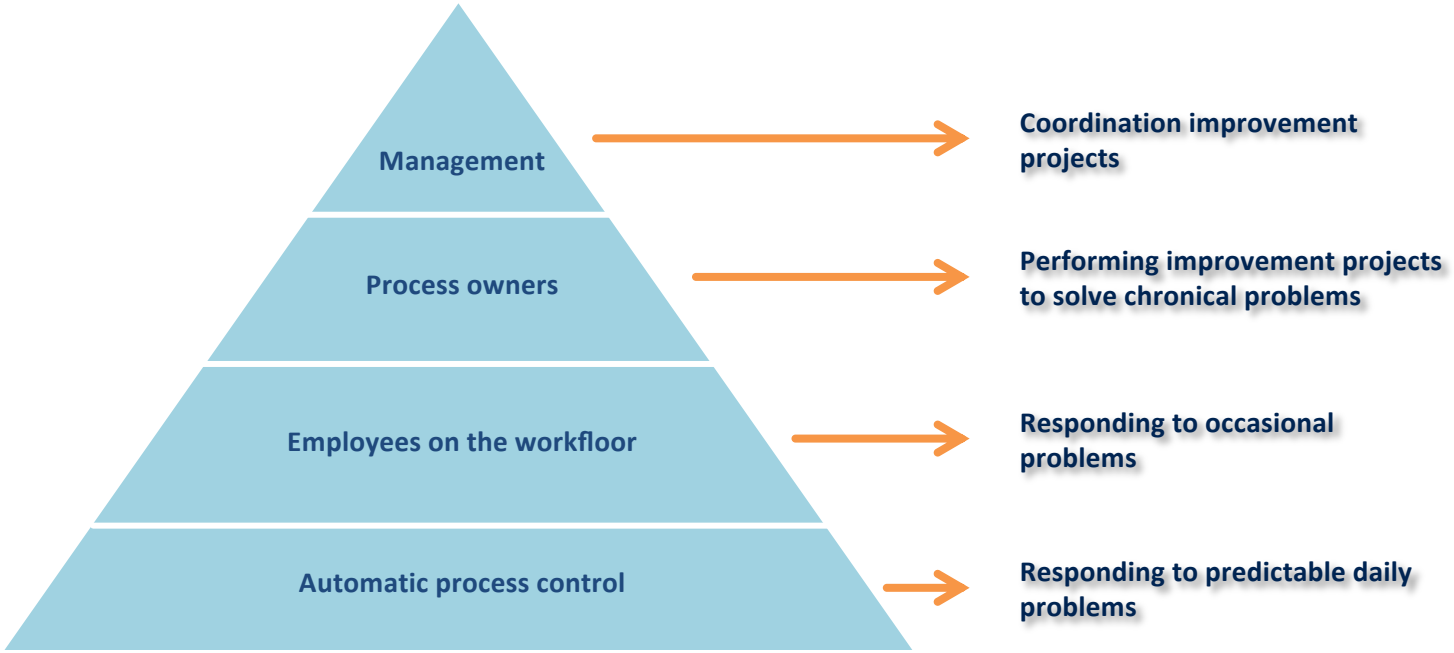
Finishing the project

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Roles and responsibilities

- Many organisations have difficulties with the balance between acute problem solving and structural improvement.
- Joseph Juran designed a model for organising both.



Slimmer werken, blije klanten

Finishing the project

The project can be finished when:

- The project is completely and correctly documented.
- The results are communicated to the relevant stakeholders in the organisation.
- The Green Belt is certain that feedback is received about the effectiveness of actions for improvement.
- The next steps (if applicable) are clear.
- The transfer of the project to the line organisation is secured.

Tip: Always evaluate the project with the project team in order to learn from it!

Finishing the project

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Financial results

- It is important to make the financial results of your project evident.
- Therefore, involve someone with financial insights into your project as soon as possible (accountant, controller).
- For the financial results; make an estimate of the resulting or expected savings of your process improvements.



Slimmer werken,
blije klanten

Finishing the project

bureau tromp LEAN & SIX SIGMA

Define Measure Analyse Improve Control

Financial results

	Period 1		Period 2	
Sales	$2,956,435		$3,500,000	
Procurement Costs	$271,992	9.2%	$346,500	9.9%
Conversion Costs	$1,921,683	65.0%	$2,317,000	66.2%
Distribution Costs	$206,950	7.0%	$241,500	6.9%
Support Costs	$37,842	1.3%	$35,700	1.0%
Total Costs	$2,438,468	82.5%	$2,940,700	84.0%
Margin	$517,967	17.5%	$559,300	16.0%
External Overheads	$167,068	5.7%	$197,785	5.7%
Change in Inventory	$242,428	8.2%	$98,681	2.8%
Earnings Before Tax	$593,327	20.1%	$460,196	13.1%

Plain English Income Statement

Slimmer werken, blije klanten

Finishing the project

bureau tromp
LEAN & SIX SIGMA

Define | Measure | Analyse | Improve | Control

Celebrate succes!



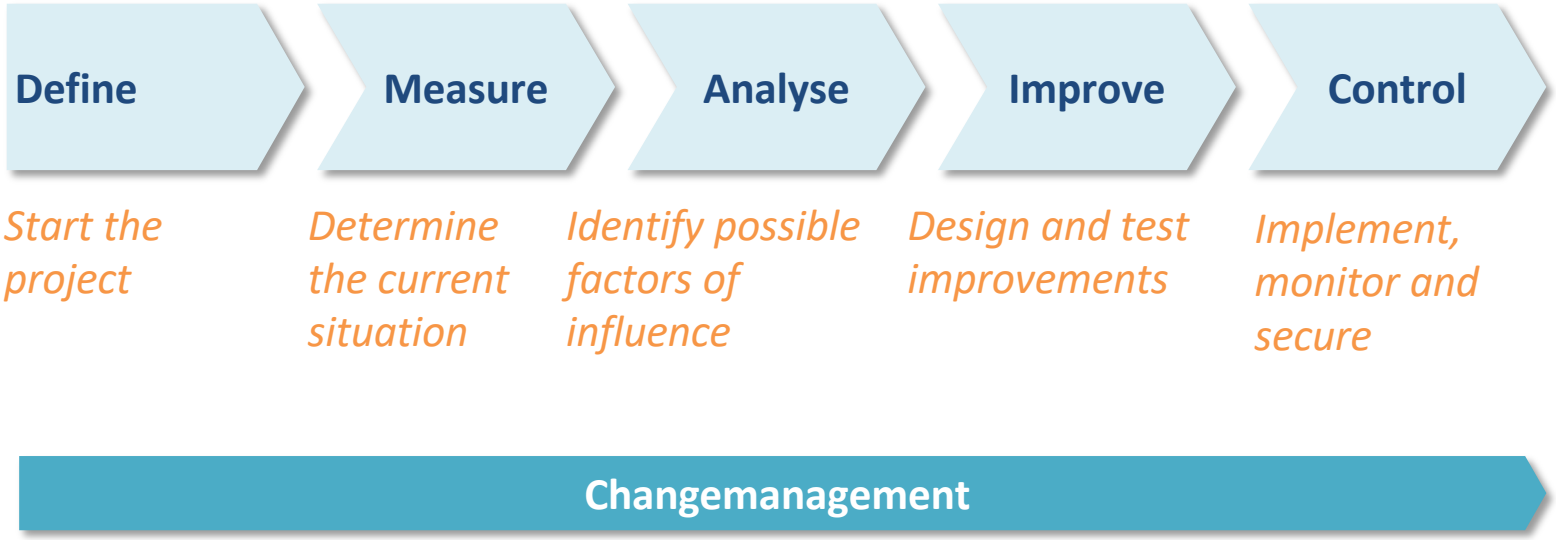
Slimmer werken,
blije klanten

Schedule day 5

- Improve phase
- Control phase
- Change management
- Exam

Slimmer werken,
blije klanten

Six Sigma structure | Change Management



Slimmer werken, blije klanten

Change management

bureau tromp
LEAN & SIX SIGMA

Different stadia of change

- Change management usually takes place in five stadia
- The further the organisation is with Lean, the faster the organisation can go through the different stadia.

- From your role as Green Belt you have to pay attention to the change aspects regarding ‘respect for people’. Sometimes this can be time-consuming, unclear or political, but when you don’t pay attention to it your project is doomed for failure in the long term!



Slimmer werken,
blije klanten

Phase 1: Recognition and acceptance

- Recognition is the first step of the phase, acceptance the last
- A critical first step is to demonstrate and make clear that change is necessary, even when the pain is not visible or sensible for everybody
- Recognition starts with letting go, which is not the easiest step for most people
- When the organisation recognises the supposition and accepts that change is necessary, you can move on to the next phase

Phase 2: Direction and planning

- After acceptance it is important to determine vision and direction on where the organisation is moving in the future.
- By drawing a vision for the future the organisation knows what the goal is. Involve everyone's ideas when creating this vision.
- By involving people with influence (proponents & opponents) from the entire organisation with the planning process, acceptance will grow.
- Give space for emotions, even if there is acceptance. Emotions always exist!

Phase 3: Forward

- When acceptance and direction is present, change can occur
- As projectleader it is important to know if people are following you, are staying behind or need extra attention
- Use three important communication tools to get everybody on board:
  - Clear expectations
  - Right communication
  - Right behaviour

Phase 4: Chaos



blije klanten

Phase 4: Chaos

- The first Lean-improvement and implementation is starting
- Change accounts for questions, uncertainties, fear… In short: Chaos
- Prevent the urge of going back to the old way of working
- Support of (middle) management is crucial in this phase

‘Chaos is a gateway to a new reality’

Slimmer werken,
blije klanten

Phase 5: Integration

- By acting consistently, communicating clearly and showing the right behaviour, the change will become visible and a part of the new organisation.
- Management will have to speak to, adress, or even fire, a small percentage that doesn't want to change.
- Lean is a continuous improvement and no goal in itself, it can take years before the organisation acts 'completely' like it.



Slimmer werken, blije klanten

Team development stadia (Tuckman)

bureau tromp
LEAN & SIX SIGMA

Forming
Team acquaints and establishes ground rules. Formalities are preserved and members are treated as strangers.



Storming
Members start to communicate their feelings but still view themselves as individuals rather than part of the team. They resist control by group leaders and show hostility.



Norming
People feel part of the team and realize that they can achieve work if they accept other viewpoints.



Performing
The team works in an open and trusting atmosphere where flexibility is the key and hierarchy is of little importance.



Adjourning
The team conducts an assessment of the year and implements a plan for transitioning roles and recognizing members' contributions.



Slimmer werken, blije klanten

Schedule day 6

- Improve phase
- Control phase
- Change management
- Exam

Slimmer werken,
blije klanten

Lean Six Sigma Yellow Belt certified!.. What's next?

bureau tromp
LEAN & SIX SIGMA

Theory:



Reality:



Slimmer werken,
blije klanten

Curious for more?

Reading tips

