



V Creating World Class products

IV Creating capable processes

III Creating stable & efficient processes

II Creating a Continuous Improvement culture

I Creating a solid foundation

LEAN SIX SIGMA



MISSION

**We EMPOWER people
and organisations to
'BE MORE'**

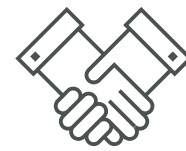




dare@harrybakertraining.com



<https://www.linkedin.com/in/dare-ariyo/>



HELLO & WELCOME!

In this course, I will be your instructor to facilitate and guide your learning Scrum and to get you ready both for real life and certification Exams

Dare Ariyo
Trainer/Consultant

Experience

Worked at Harrybaker for over 12 year and involved in almost everything within Harrybaker – From Finance, to project, to sales and marketing

Certifications

PRINCE2, Scrum Essential and AgilePM (Agile Business Consortium / APMG), Lean Six Sigma

Organization; Sector; Role; Location; LSS experience;
Objectives for this course; Interesting stuff about U

GETTING THE BEST OUT

- Listen actively
- Duration: Days/times & Breaks
- Taking questions – ask any time
- My video and writing on the whiteboard
- Connection Issues
- Training Slides, Homework & Recording
- Identity Confirmation
- Group chat???
- Survey at the end of each weekend for feedback

+2348028391360

Dare Ariyo, Training, Education, Trainer, Lagos, Yes LSS Exp,
10 years, To facilitate conversation, I can cook

“70/20/10 MODEL, THE CORNERSTONE OF LEARNING AND DEVELOPMENT”

Session 1: 8:30 – 10:15 am

Break 1: 10:15 – 10:30 am — 15 mins

Session 2: 10:30 – 12:15pm

Break 2: 12:15 – 12:45pm — 30 mins

Session 3: 12:45 – 14:30

Break 3: 14:30 – 14:45pm — 15 mins

Session 4: 14:45 – 16:30

Active Listening

Reflecting

- Repeat the gist of the message
- Verify your understanding of the message

Attending

- Lean slightly toward the speaker
- Stay at eye-level
- Maintain eye contact without staring

Following

- Respond with non-verbal gesture or verbal response
- Ask questions
- Allow speaker a moment to collect their thoughts

70/20/10 MODEL

- **70%** 🌱 — Learning through **hands-on experience**: doing the job, solving problems, facing challenges.
- **20%** 🤝 — Learning through **social interaction**: coaching, mentoring, and feedback from others.
- **10%** 📚 — Learning through **formal education**: courses, workshops, reading



INTRODUCTION

SCHEME
Owner



EXAM
institute



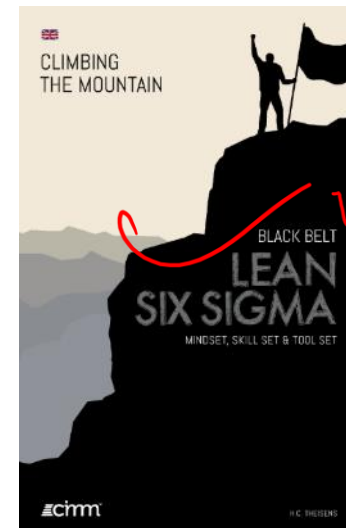
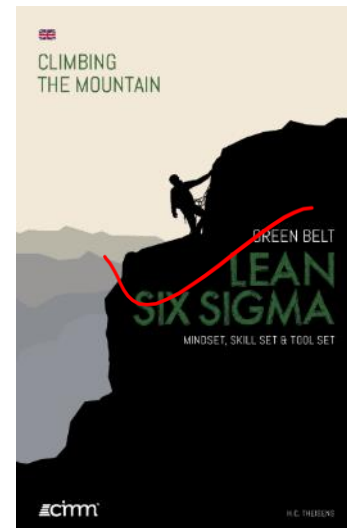
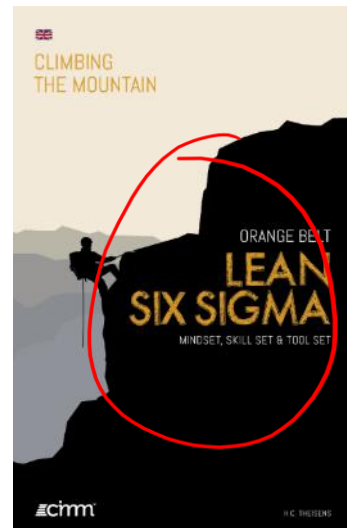
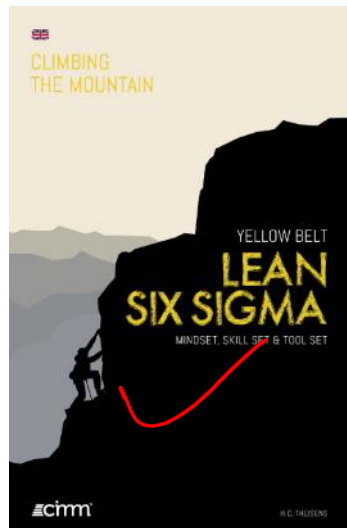
ATO
Acc. Training Org.



INTRODUCTION

This training uses the following reference materials

- Reference books: 'Climbing the Mountain | Mindset, Skill set and Toolset'
- Exercise books: 'Climbing the Mountain | Exercise book'
- Optional: eLearning portal
- Theisens, H.C.; LSSA 2021



INTRODUCTION

LSSA skill sets

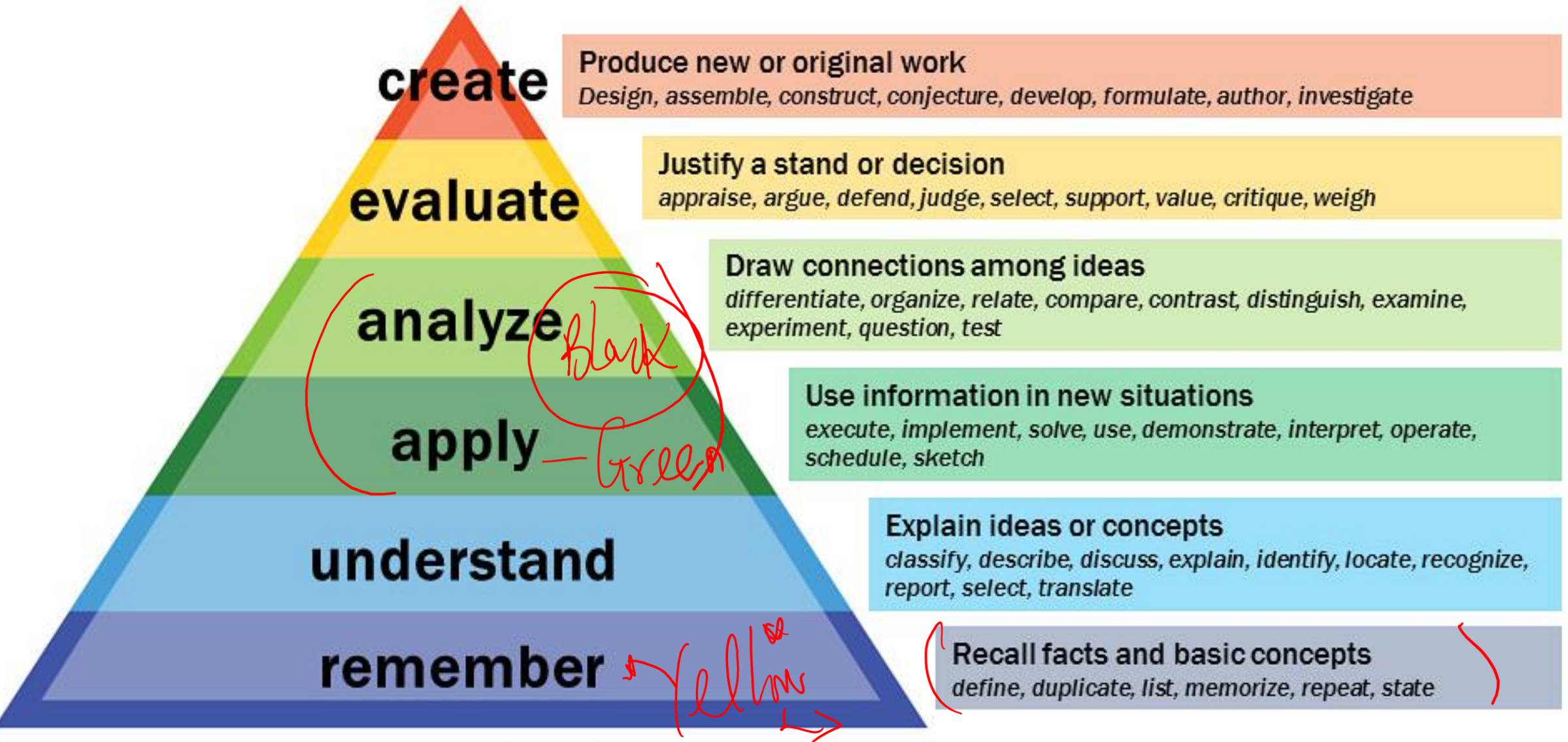
- Version 3.2
- March 2021



Remember	Understand	Apply	Analyze	Evaluate	Create
Recall	Describe Follow Identify Interpret Participate Understand	Apply Assure Assess Calculate Convert Define Demonstrate Differentiate Divide Eliminate Empower Encourage Facilitate Implement Motivate Organize Plan Prepare Present Promote Propagate Review Select Standardize Support Use	Analyze Construct Deploy Design Develop Distinguish Evaluate Lead Manage Translate	-	-



Bloom's Taxonomy



INTRODUCTION

LSSA Syllabus: Structure

- Unit (U)
The syllabus is presented by syllabus areas; each called a 'Unit'. The chapters in the book 'Climbing the Mountain' reflect the 'Units' described in this syllabus.
- Learning Element (E)
Each 'Unit' consists of a number of 'Elements'. The paragraphs in each chapter of the book 'Climbing the Mountain' reflect the 'Elements' in this syllabus.
- Performance Criteria (PC)
Each 'Element' consists of a number of 'Performance Criteria' and each 'Performance Criteria' has an explanation. These describe the tools, techniques and competencies that are required.
- Bloom level
A 'Cognitive Level' has been assigned to each 'Performance Criteria'- description according to Bloom's Taxonomy. This defines at which level the Belt is expected to apply the respective tool, technique or skill.



INTRODUCTION

LSSA Syllabus: Bloom Levels

- Level I – Remember
Recall or recognize terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc.
- Level II – Understand
Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.
- Level III – Apply
Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc.
- Level IV – Analyze
Break down information into its constituent parts and recognize their relationship to one another and how they are organized; identify sublevel factors or salient data from a complex scenario.








INTRODUCTION

Sample Exam paper

- As part of the training a sample exam paper is provided to candidates with answers.
- This can be used by the candidates to prepare for the Lean Six Sigma Black Belt exam.



LSSA EXAMS (THEORETICAL + PRACTICAL)

					
	LSS YB	LSS OB	Lean GB	LSS GB	LSS BB
LSSA <small>lean six sigma academy</small>					
Theory exam					
Nr of questions	50	50	40	60	60
Language	NED/ENG	NED/ENG	NED/ENG	NED/ENG	NED/ENG
Pass mark	32	32	25	38	38
Pass mark	64%	64%	63%	63%	63%
Duration	60 min	120 min	120 min	180 min	180 min
Books	Open book	Open book	Open book	Open book	Open book
Tools	-	Calculator	Calculator	Minitab	Minitab
Practical assessment					
	-	-	1 project level III (or higher)	1 project level III (or higher)	1 x level III + 1 x level IV (or higher)



ORG. MODEL

Mission, Vision and Values

PROFIT Or LOSS

Strategy

Day to Day

Change

Operations/BAU

Portfolio

Programme

Projects

Product/Deliverable

Procurement

Sales Dept.

Marketing Dept.

Finance Dept.

IT Dept.

HR Dept.

Logistics Dept.

Etc Dept.

Products

Services



- Process Management

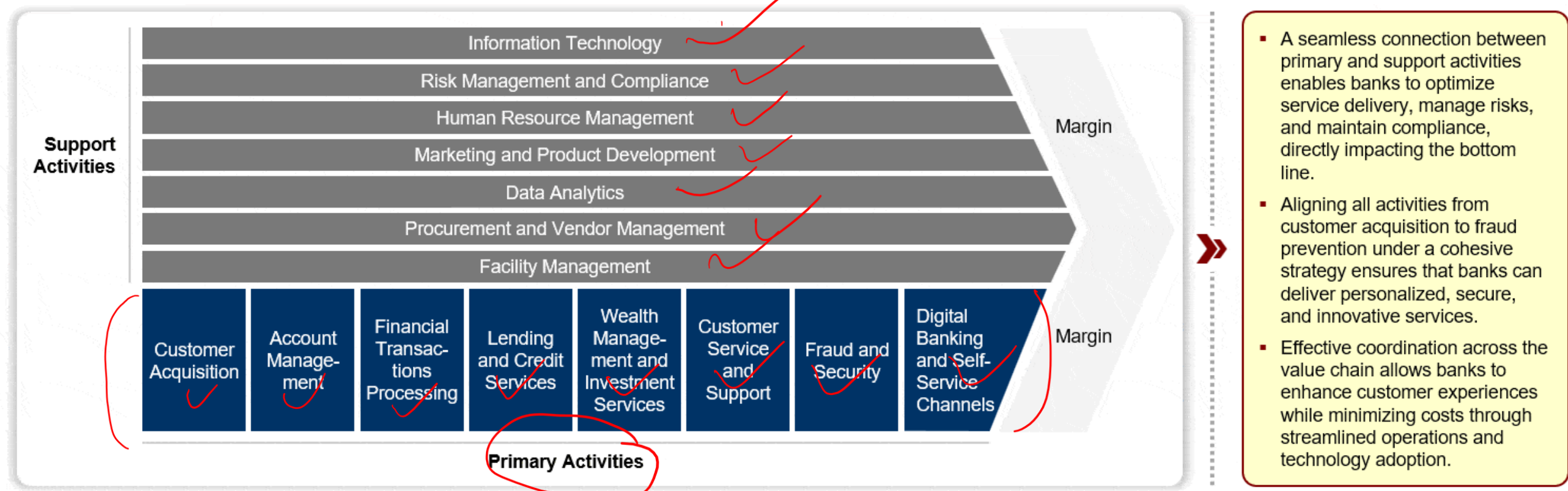
- Do you have your processes clearly mapped?



The Retail Banking Value Chain is defined by 8 primary activities and 7 support activities

Retail Banking Value Chain – Overview

Each of these activities is critical to the smooth operation and success of a Retail and Commercial Bank—and excellence in each area can lead to Competitive Advantages in a highly competitive market.



The Retail Banking Value Chain integrates customer-facing services with robust back-end processes, driving both customer satisfaction and operational efficiency.

Source: LearnPPT Consulting analysis

Service

Physical Vs. Transactional Processes

- Physical processes transform raw materials into finished goods through standardized sequences.
- Transactional processes handle ~~electronic data~~ with flexible, decision-driven steps.
- Physical processes involve large specialized teams; transactional use fewer empowered actors.
- Flow in physical processes is predictable; transactional processes include loops and rework.
- Measurement in physical processes is continuous; transactional uses discrete daily metrics.
- Physical processes focus on defects and downtime; transactional target waiting and communication gaps.
- Physical processes occur on factory floors; transactional across offices and geographic sites.
- Inventory in physical processes is visible; transactional inventory is often hidden electronically.
- Physical processes require planned changeovers; transactional need fast adaptability for exceptions.



Physical

- Manufacturing vs. Customer Service processes



Physical processes (Manufacturing)

Assembling, connecting
Forming, machining
Chemical processing
Joining, finishing
Testing (e.g. inspection, laboratories)
Groceries, shops, restaurants, etc.
Distribution, transportation & logistics
Construction

Transactional processes (Service)

Strategic planning process
New product development & IT development
Financial transactions
(e.g. billing, invoicing, banking, insurance)
Request for quotation
Customer service
Complaint management
Planning process & order entry process



U2 – POLICY DEVELOPMENT AND DEPLOYMENT

E1 – POLICY DEVELOPMENT



VISION & TRUE NORTH

Revenue and Cost

Value strategies according to Treacy and Wiersema

focuses on offering a unique service or product to the market

focuses on continuously offering superior products and services

Revenue

Revenue

Cost

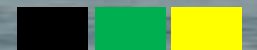


focuses on an optimal production process based on the expectations of the customer, without errors, on time and in a cost-efficient manner

VISION & TRUE NORTH



The True North works as a compass proving a guide to take an organization from the current condition to where it wants to be



UNDERSTANDING TRUE NORTH IN LEAN SIX SIGMA THINKING

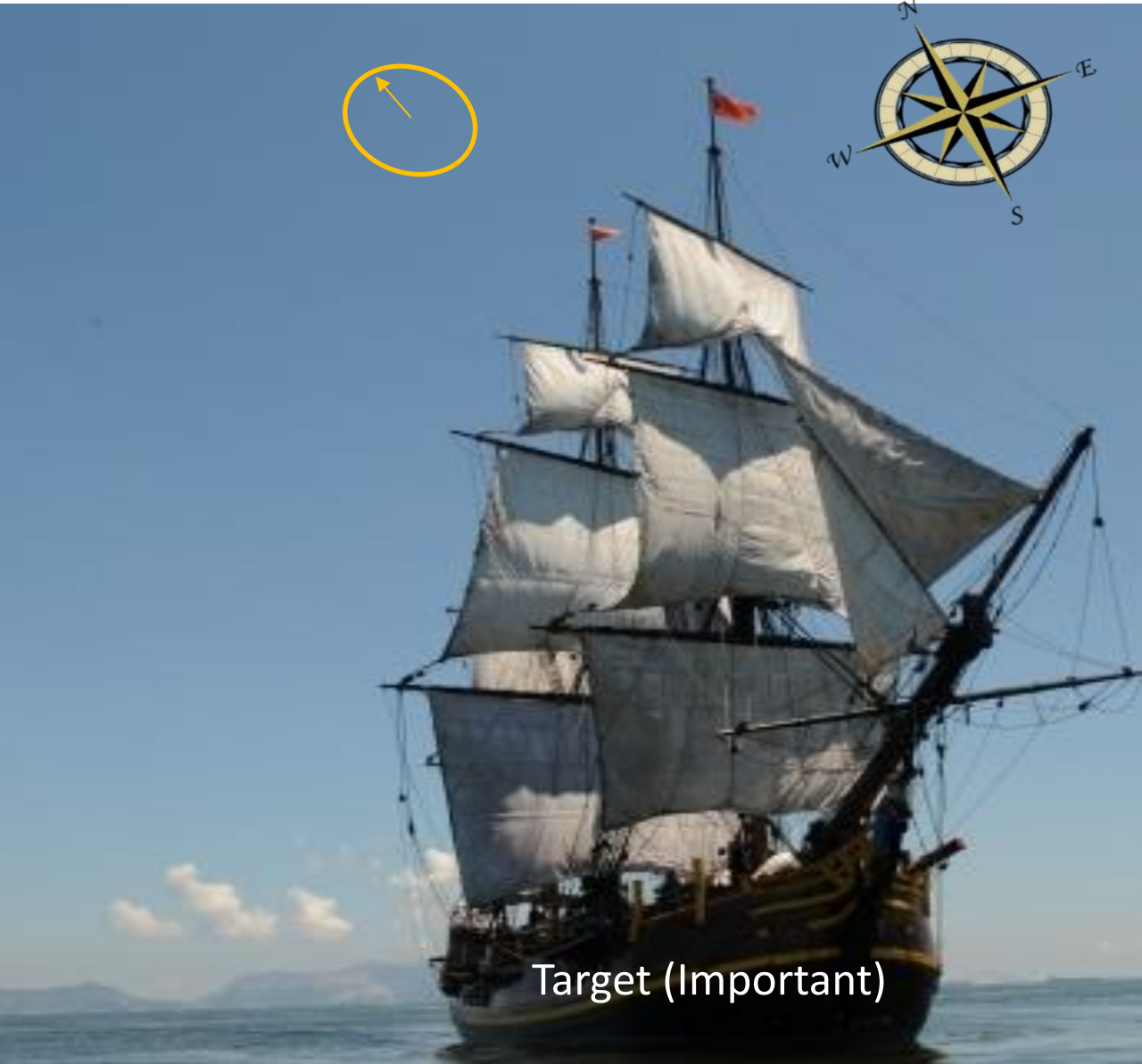
True North is the organization's guiding vision—a compass pointing toward an ideal state rather than a reachable endpoint.

It defines what we should strive for, not merely what we can do today, and fuels daily continuous improvement across every level.

Like a sailor tacking against the wind, we make constant small and breakthrough course corrections to stay aligned with our True North.

True North is a concise guiding statement that blends vision, mission, and values, serving as a decision-making filter and aligning all efforts toward strategic objectives.



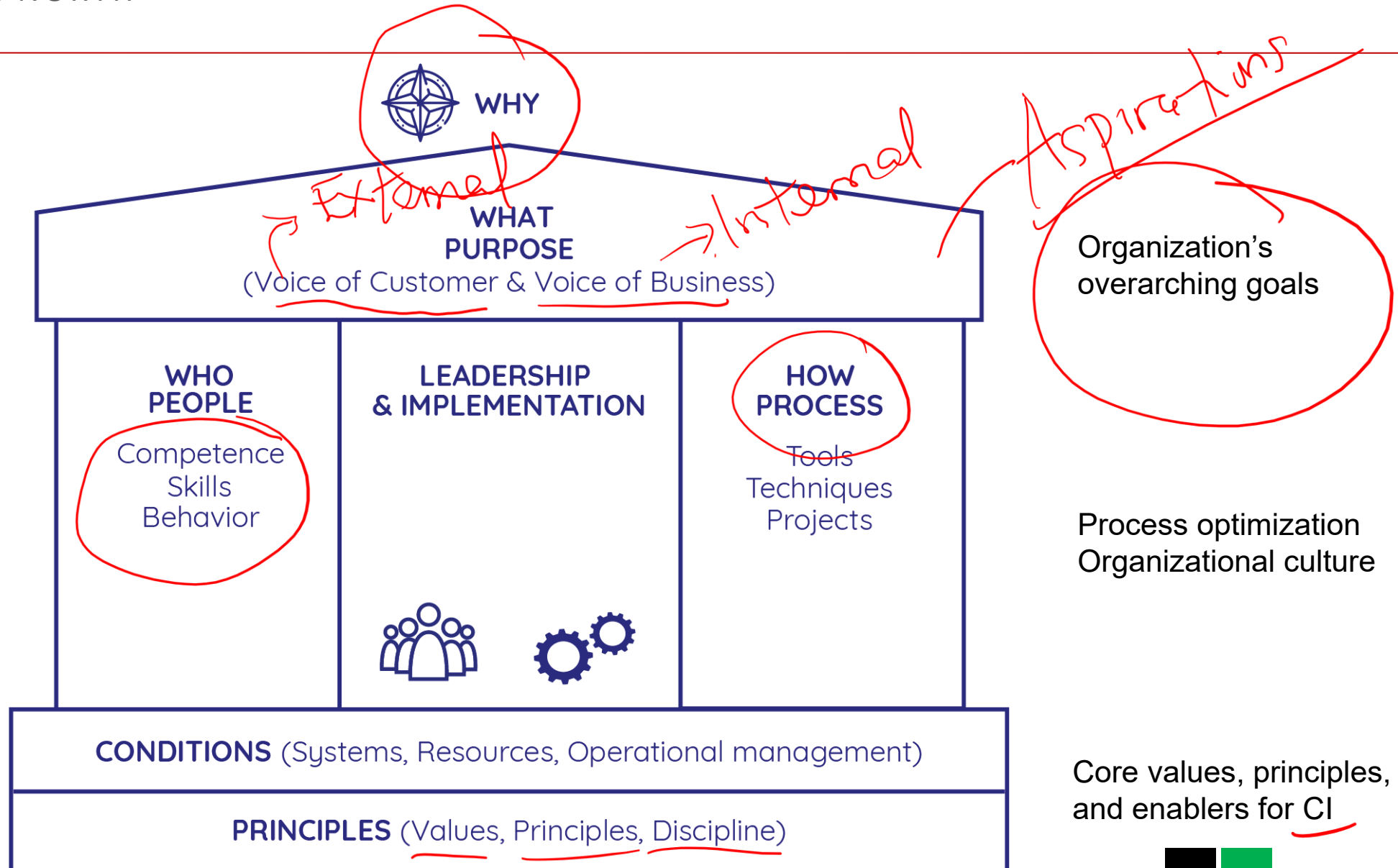


Target (Important)



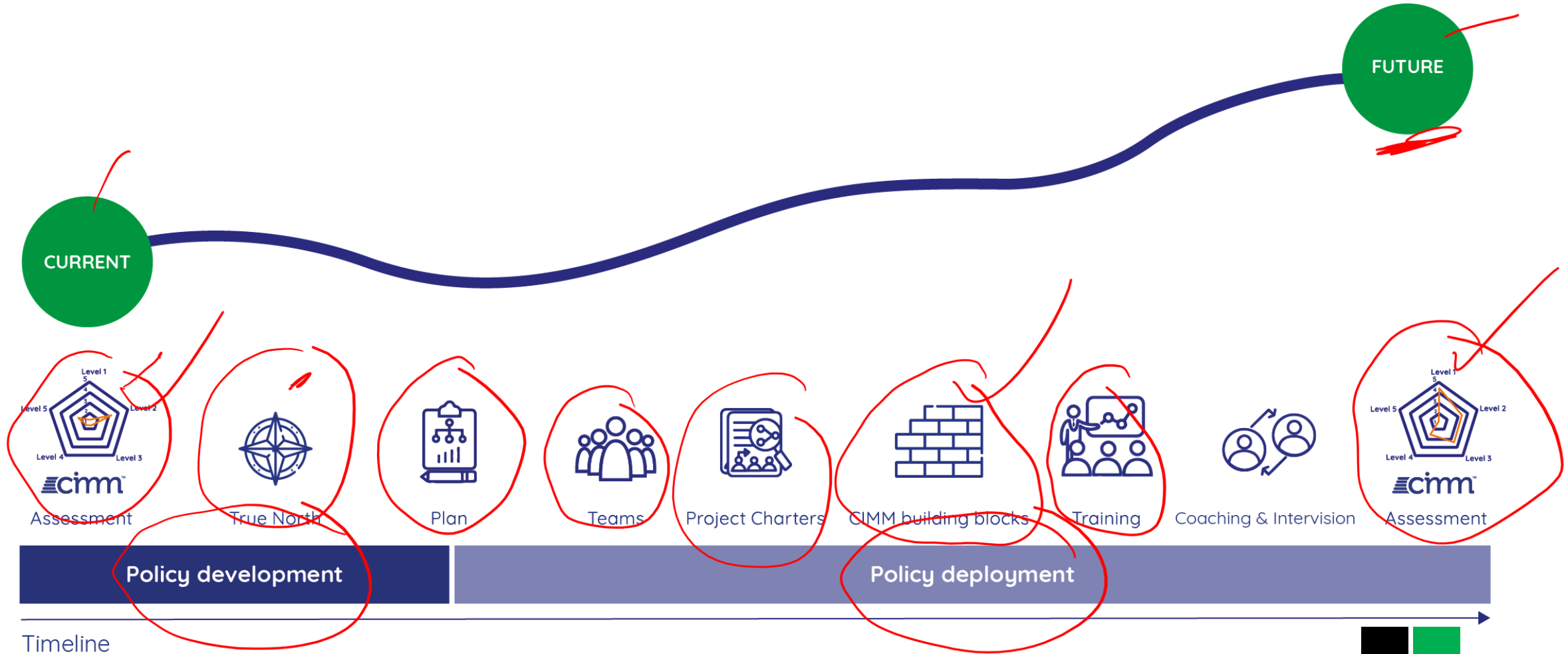
Whirlwind (Urgent)

VISION & TRUE NORTH



TRANSFORMATION ROADMAP

Transformation roadmap



TRANSFORMATION ROADMAP



PERFORMANCE AND FINANCIAL METRICS

Critical Success Factors (CSF)

- Define the areas that are important for the success of the organization.
- What needs to be done to become successful?
- Qualitative.

Key Performance Indicators (KPI)

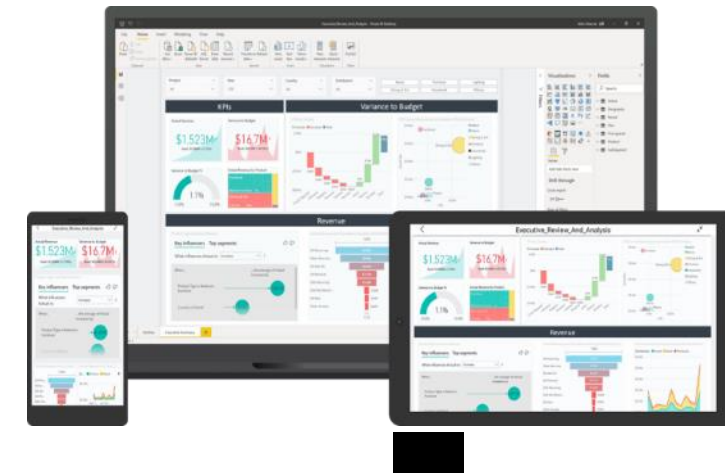
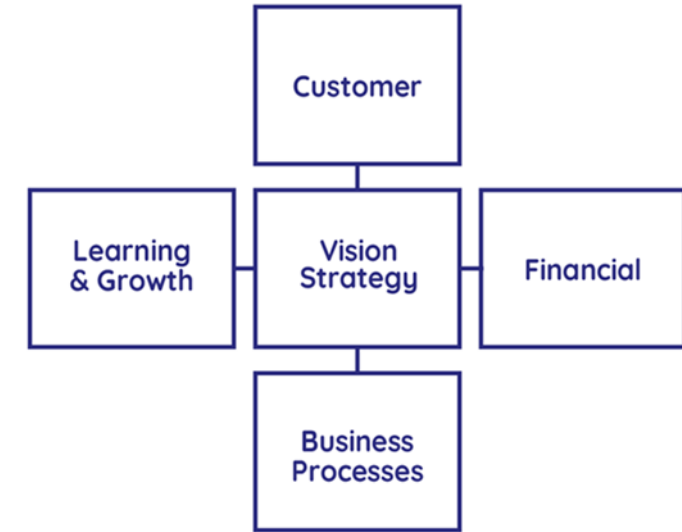
- Used to measure the result.
- How successful are we?
- Quantitative.



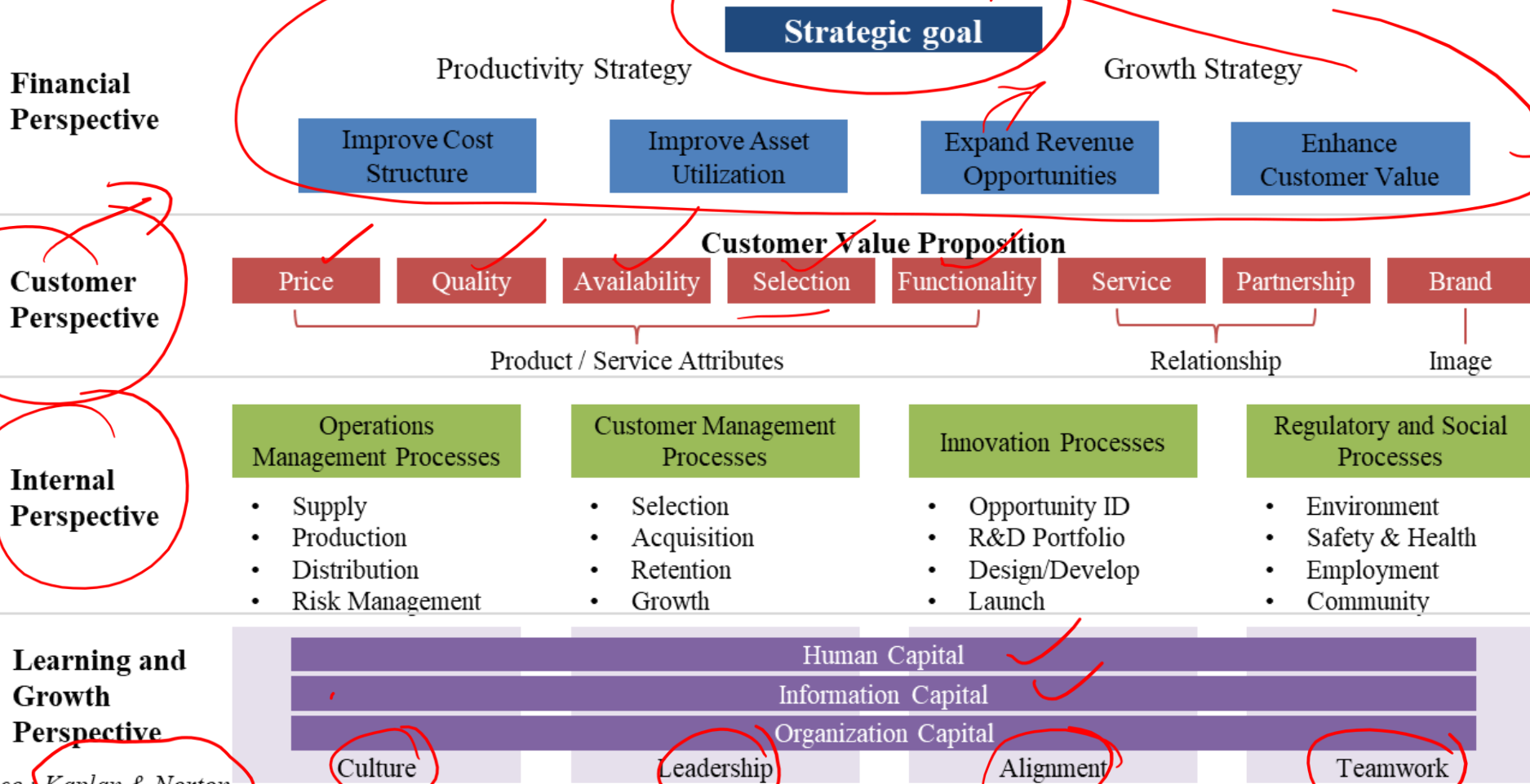
PERFORMANCE AND FINANCIAL METRICS

Balanced scorecard – four perspectives

1. Learning & Growth Perspective:
 Metrics referring to employee training and corporate cultural attitudes related to both individual and corporate self-improvement.
2. Business Process Perspective:
 Metrics referring to how well the business is running and whether its products and services conform to customer requirements.
3. Customer Perspective:
 Metrics referring to customer satisfaction, both external and internal.
4. Financial Perspective:
 Metrics referring to financial performance, but also to non-financial performance like risk assessment and cost-benefit data.



STRATEGY MAP



Source: Kaplan & Norton

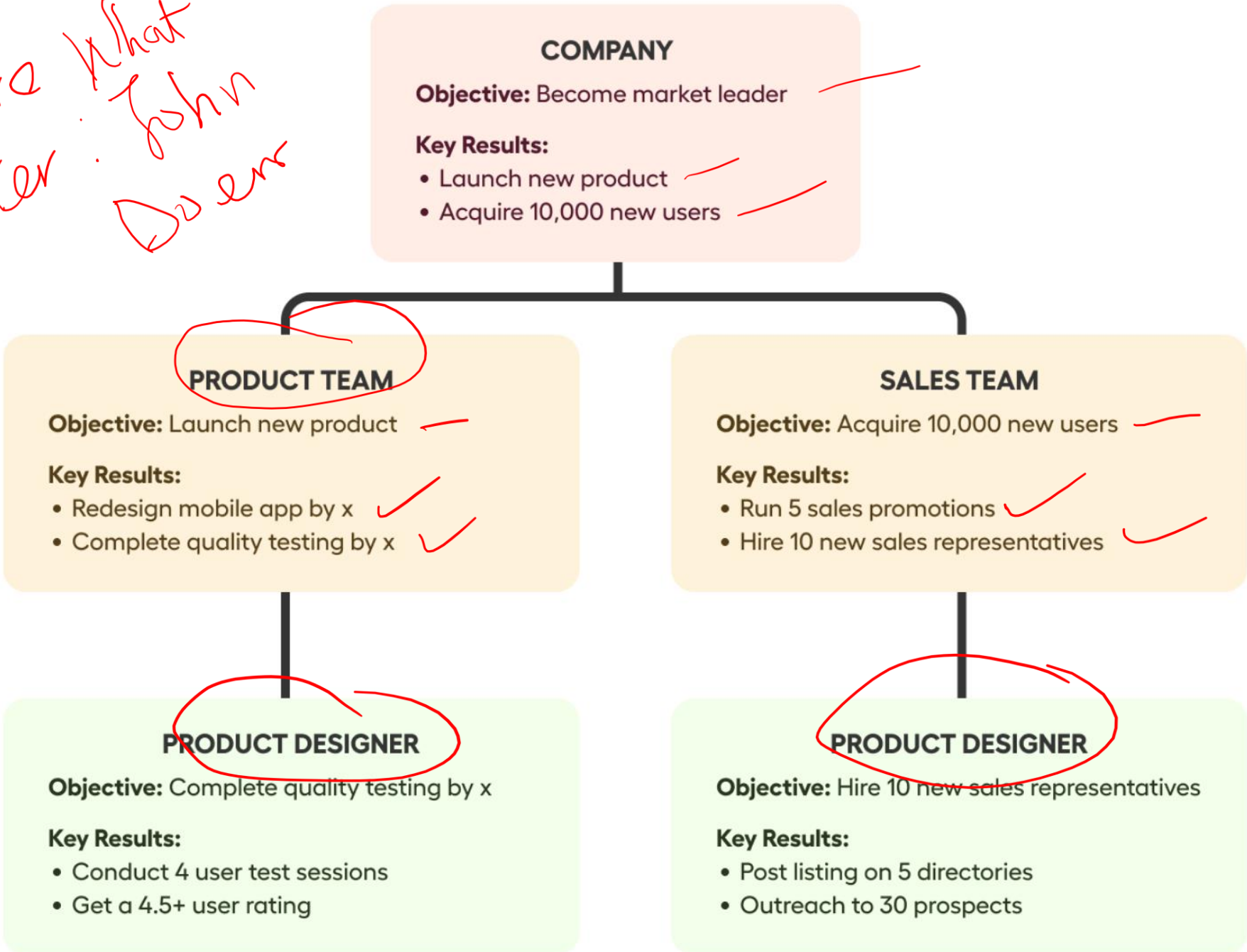
HOSHIN KANRI

Bowling chart

KPI		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD
🟢 Omzet	Target	€ 400,000	€ 500,000	€ 500,000	€ 500,000	€ 500,000	€ 500,000	€ 450,000	€ 500,000	€ 550,000	€ 550,000	€ 550,000	€ 500,000	€ 6,000,000
	Actual	€ 425,385	€ 495,105	€ 507,076										
🟡 Klantenklachten	Target	0	0	0	0	0	0	0	0	0	0	0	0	0
	Actual	0	0	1										
🔴 NPS score	Target	20	20	20	20	20	20	20	20	20	20	20	20	20
	Actual	15	12	15										
🟢 First Time Right %	Target	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
	Actual	92%	93%	89%										
🟢 On Time Delivery %	Target	90%	90%	90%	95%	95%	95%	95%	95%	95%	95%	95%	95%	94%
	Actual	88%	92%	92%										
🟡 SEO positie Google	Target	>50	>50	50	25	25	20	15	10	9	8	7	6	6
	Actual	112	78	52										
🔴 Projectvoortgangs-%	Target	20%	20%	20%	20%	20%	0%	0%	0%	0%	0%	0%	0%	100%
	Actual	0%	10%	10%										
🟢 Standup meetings	Target	8	8	8	8	8	8	8	8	8	8	8	8	96
	Actual	8	8	8										
🟢 Doorlooptijd orderintake	Target	20	20	20	20	15	15	5	5	5	5	5	5	5
	Actual	22	18	20										
🟢 Aantal YB's & GB's getraind	Target	0	0	10	2	0	0	0	10	0	0	0	0	22
	Actual	0	0	11										
🟡 Aantal Kaizen projecten	Target	0	0	0	2	2	2	2	2	2	2	2	2	18
	Actual	0	0	0										

Measure what matters. John Doe

*Redeal to cus
Chinitana Waffle*




U1 – WORLD CLASS

E1 – CONTINUOUS IMPROVEMENT



CONTINUOUS IMPROVEMENT HISTORY

A man in a dark suit stands with his back to the camera, hands on his hips, looking out over a vast cityscape under a cloudy sky. The city below is densely packed with buildings and a large body of water is visible on the right. A semi-transparent dark grey horizontal band is overlaid across the middle of the image, and a red oval highlights the text within it.

Develop and produce products and services
that are the best in the world

*Just In
Time,*

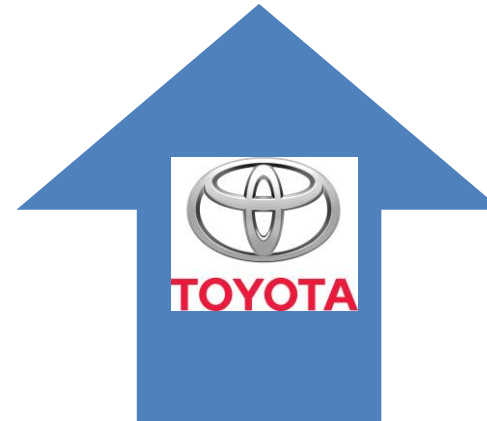


8000
cars/day

1952



2500
vehicles/13
years



1938

CONTINUOUS IMPROVEMENT HISTORY



History of production
Ford: assembly line (1900)

CONTINUOUS IMPROVEMENT HISTORY



History of Lean
Toyota: focus on elimination of Waste

CONTINUOUS IMPROVEMENT HISTORY



History of Six Sigma
Motorola: focus on reducing variation

CONTINUOUS IMPROVEMENT HISTORY

Historical overview

- 1900 – Ford Manufacturing line
- 1924 – Shewhart Statistical Process Control; Plan-Do-Check-Act
- 1935 – Fisher Design of Experiments (DOE)
- 1937 – J.M. Juran Pareto ('80/20 rule' & 'Vital few vs. Useful many')
- 1965 – Feigenbaum Cost of Quality (Quality Costs)
- 1979 – Ishikawa Continuous Improvement; Cause-Effect diagram
- 1980 – W.E. Deming SPC; Plan-Do-Check-Act
- 1980 – G. Taguchi Loss Function; Design of Experiments
- 1980 – Ohno & Shingo Elimination of Waste; Toyota TPS
- 1985 – Womack & Jones Lean Thinking
- 1986 – Masaaki Imai Kaizen; Just in Time; Customer Delight
- 1986 – Smith & Harry Six Sigma founders at Motorola / Six Sigma Academy (1994)
- 1987 – Harrington Cost of Poor Quality (COPQ)
- 1996 – Jack Welch General Electric (GE) incorporates Six Sigma
- 2000 LSS in service, finance, healthcare, IT etc.
- 2009 LSSA (Lean Six Sigma Academy)



CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES

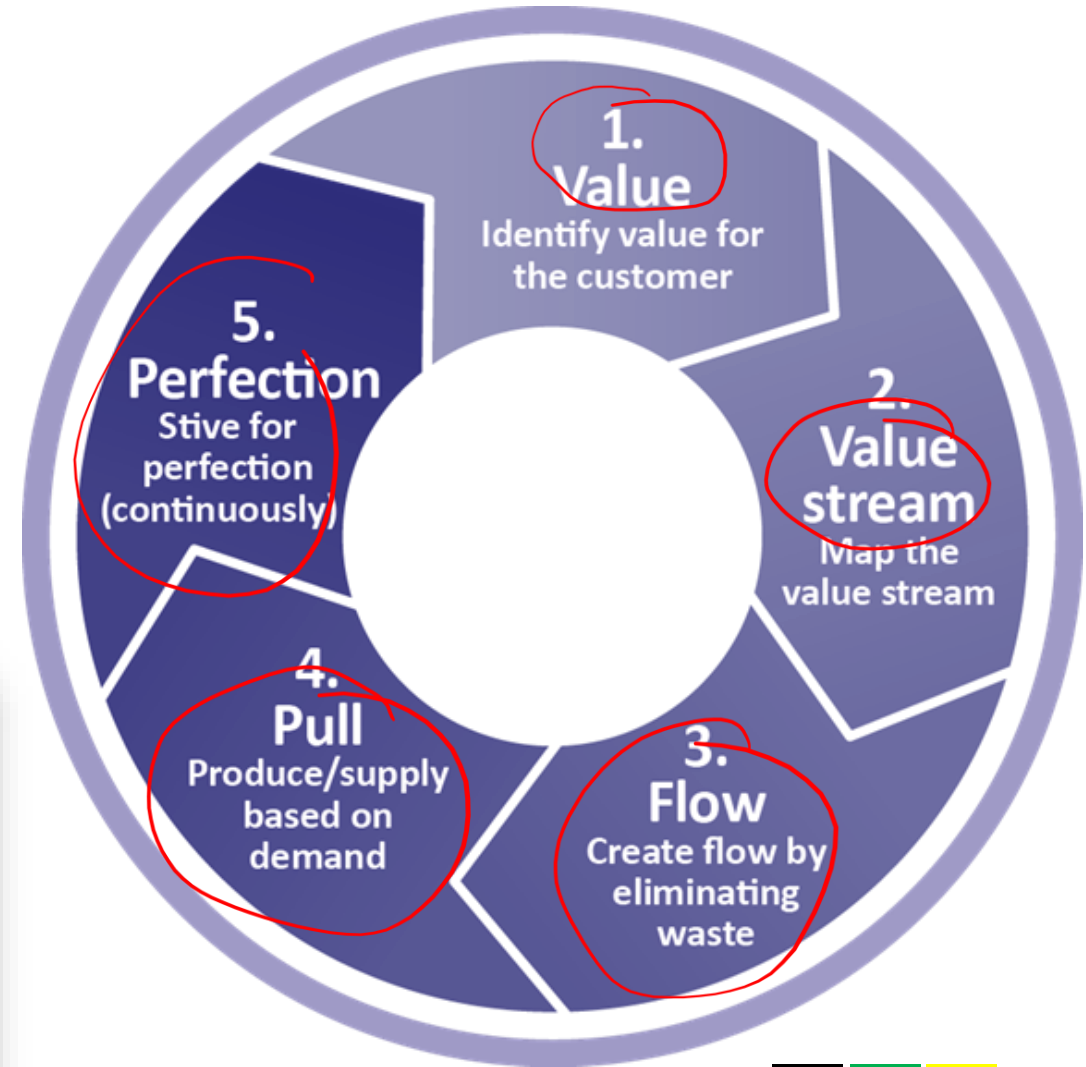
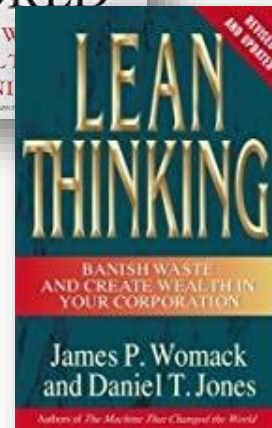
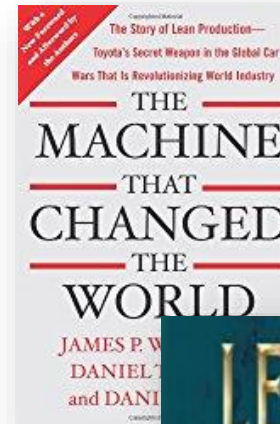
Lean Thinking



J.P. Womack



D.T. Jones



CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES

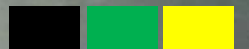


Principle 1 – Value
Determine what adds value to the customer

CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES



Principle 2 – Value stream
Map the value stream

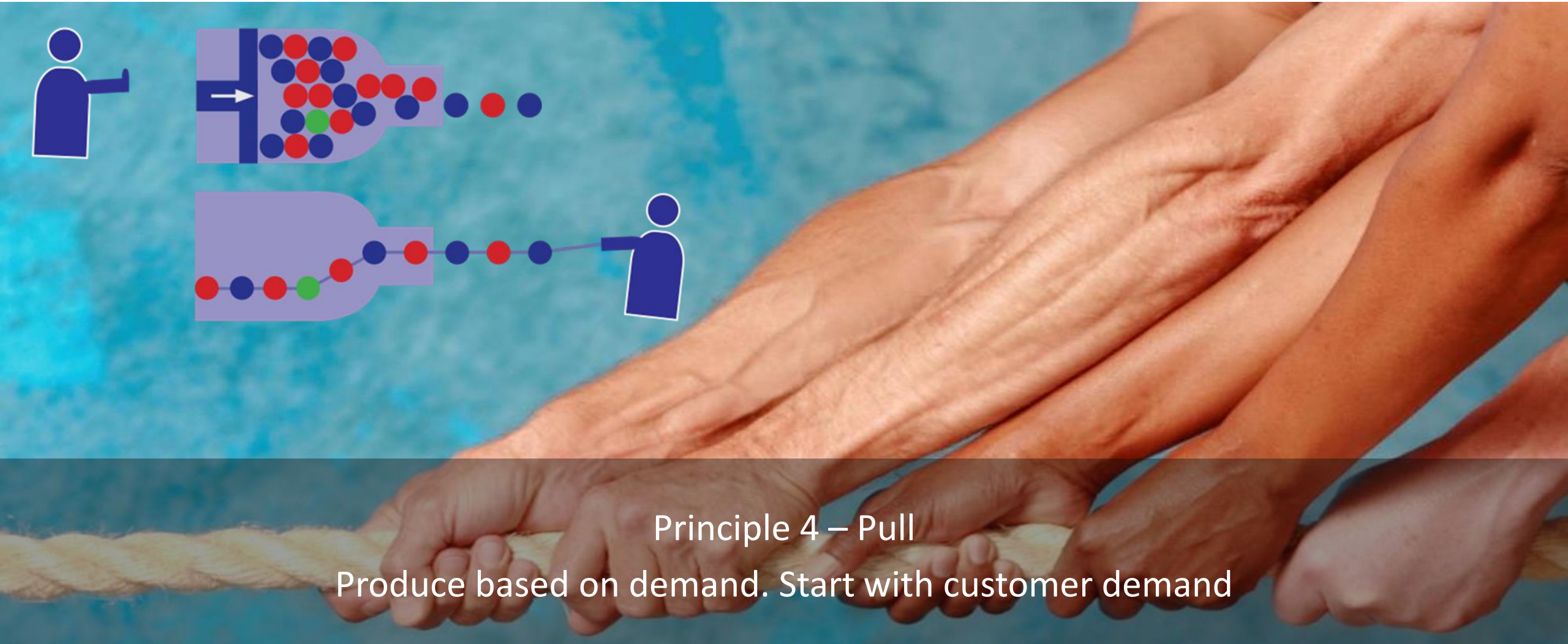
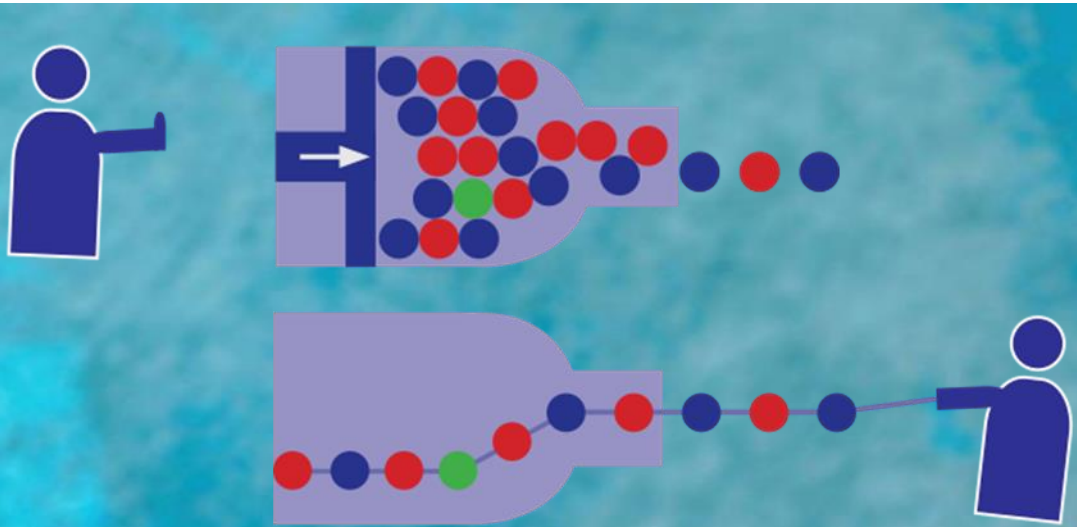


CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES



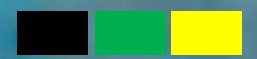
Principle 3 – Flow
Create a constant Flow by eliminating waste

CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES



Principle 4 – Pull

Produce based on demand. Start with customer demand



CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES



Principle 5 – Perfection (continuous improvement)
Continuously carry out improvement projects



CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES

The 4P model

Problem solving:

- 14. Become a learning organization through relentless reflection and Continuous Improvement.
- 13. Make decisions carefully by consensus, while thoroughly considering all options. Subsequently implement decisions rapidly.
- 12. Go see for yourself to thoroughly understand the situation.

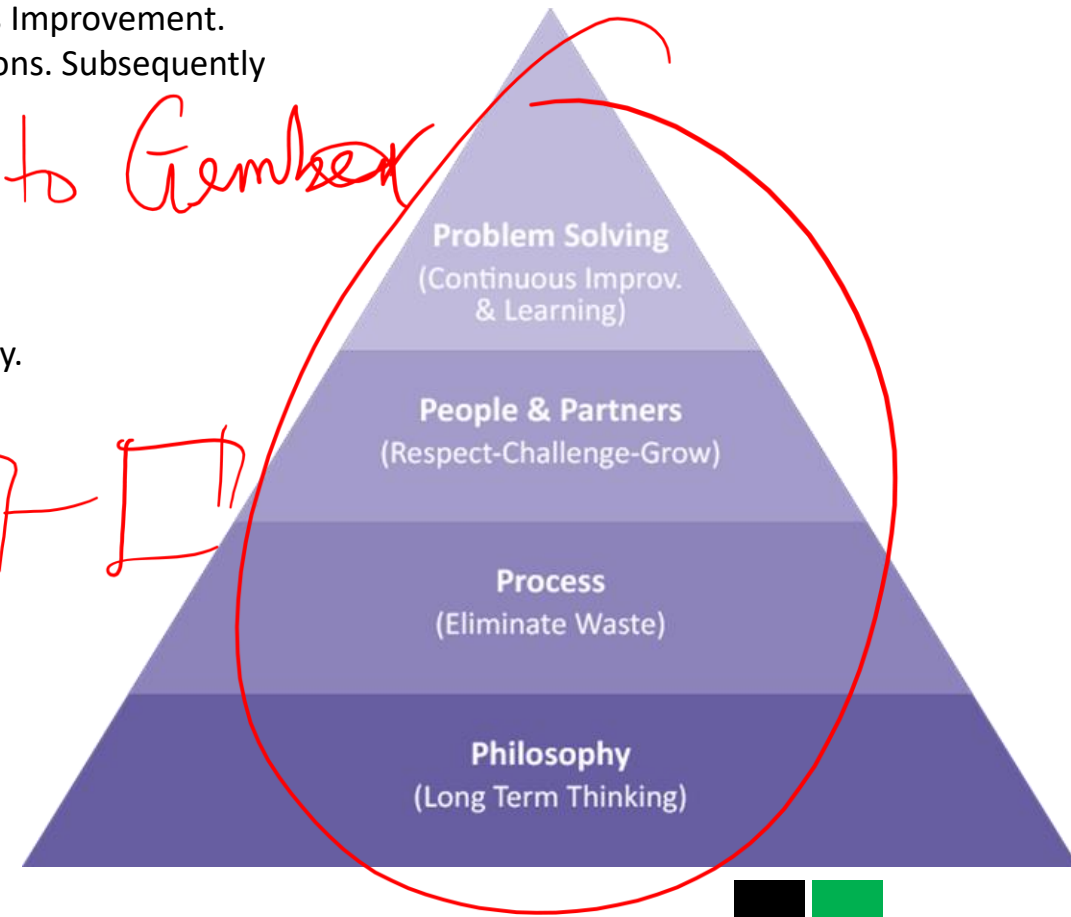
- Go to Gemba

People & Partners:

- 11. Challenge your suppliers and help them to improve.
- 10. Respect, develop and challenge your colleagues and teams.
- 09. Develop leaders who understand the processes and propagate the philosophy.

Process:

- 08. Use only reliable, thoroughly tested technology.
- 07. Avoid problems through visual control. ✓
- 06. Standardize tasks for Continuous Improvement. ✓
- 05. Stop when there is a quality problem. ✗
- 04. Level out the workload. ✓
- 03. Use Pull systems to avoid overproduction. ✓
- 02. Create a process flow so that problems become visible. ✓



Philosophy:

- 01. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.

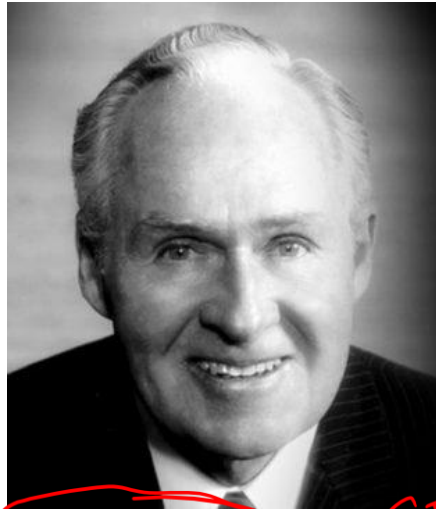
CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES



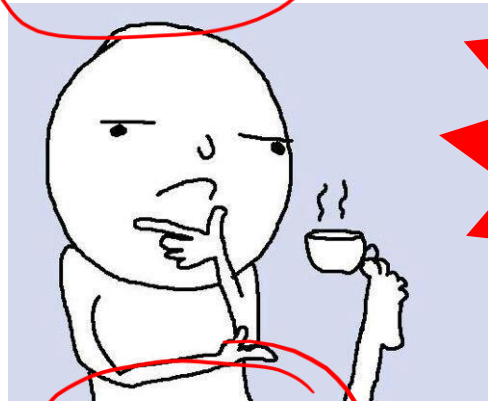
Values and principles of Six Sigma
Motorola: focus on reducing variation



MOTOROLA AND SIX SIGMA



Bob Galvin



Art Sundry

Bill Smith



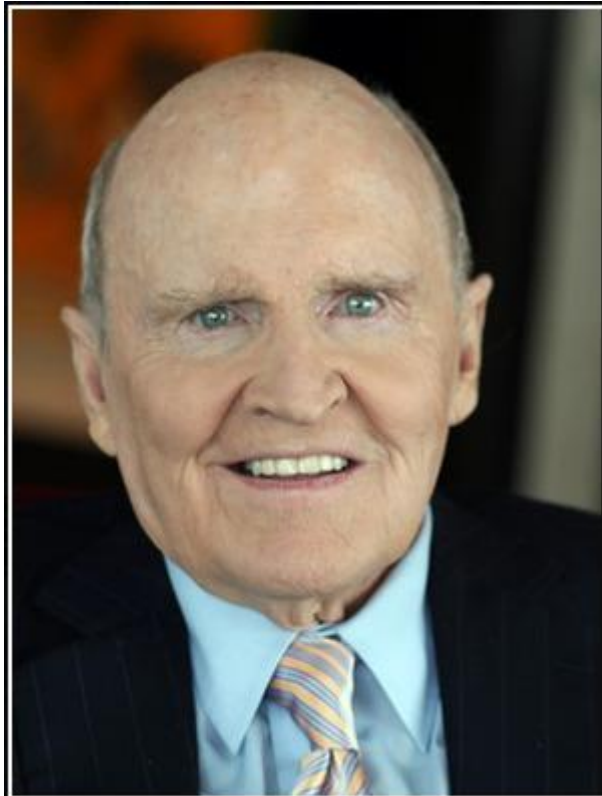
Mikel Harry



\$16b in
15
years



\$12b in
5 years



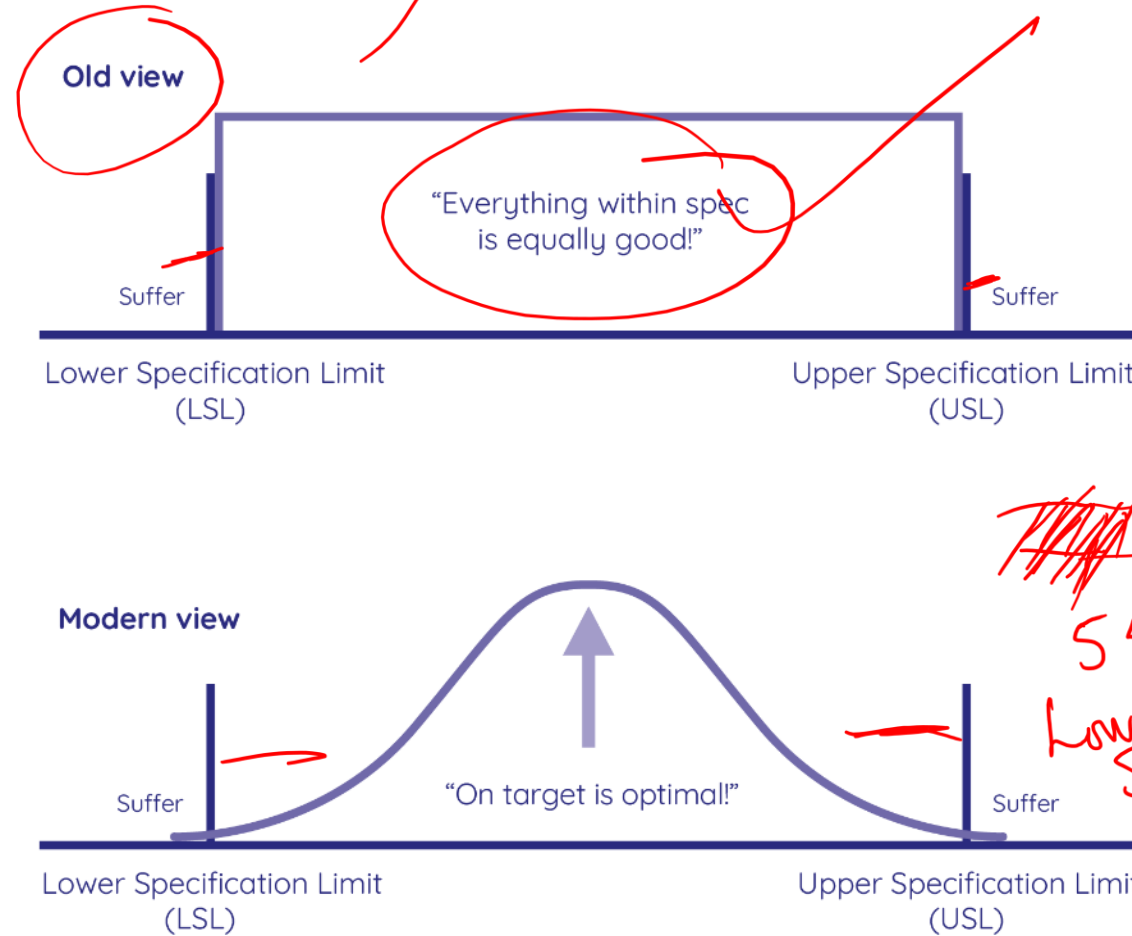
Six Sigma is a quality program that, when all is said and done, improves your customers' experience, lowers your costs, and builds better leaders.

Jack Welch

AZ QUOTES

CONTINUOUS IMPROVEMENT VALUES AND PRINCIPLES

Six Sigma – focus on reducing variation



VOC
VOB

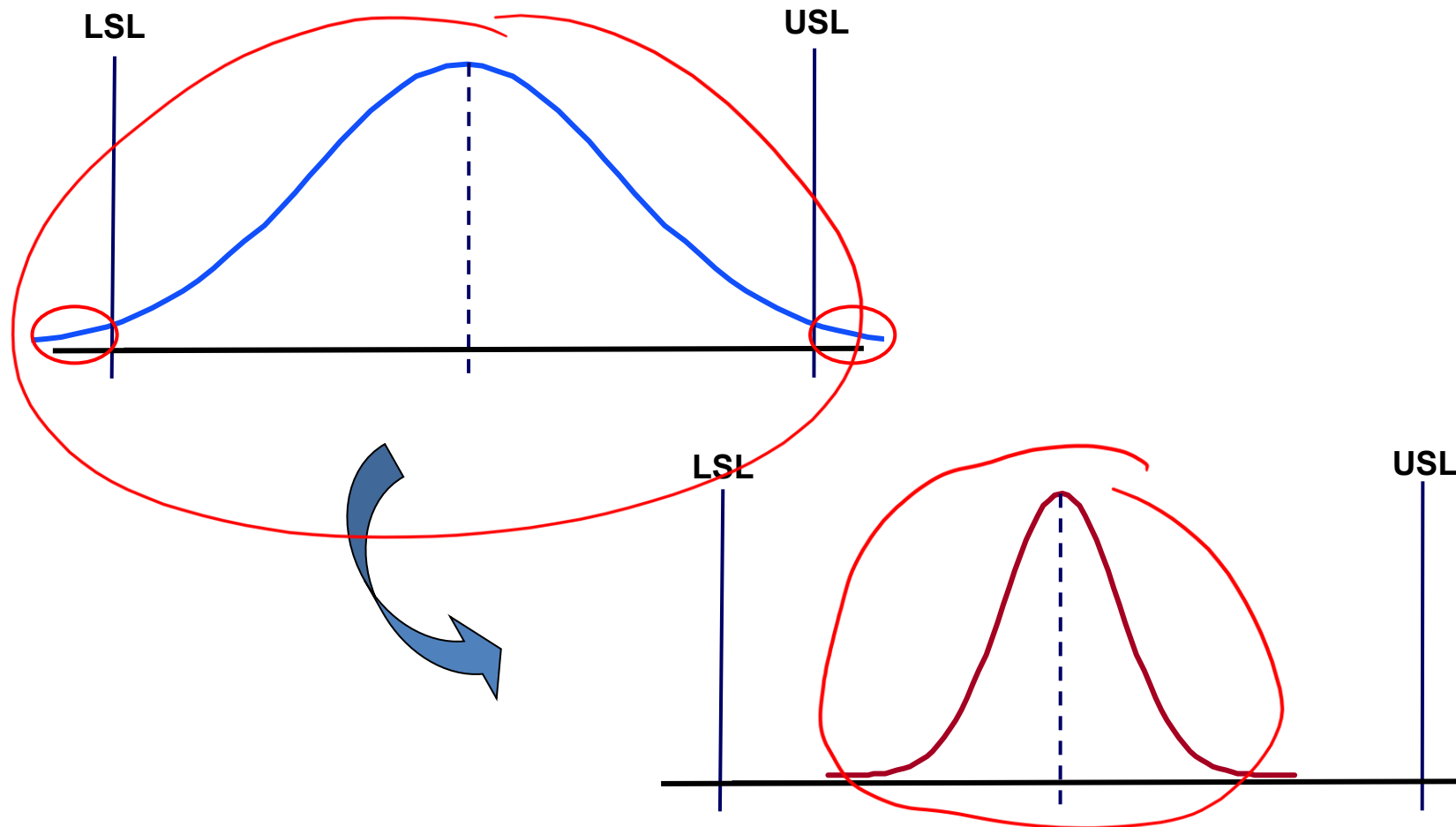
5σCL

Lower Specification Line

6σCL
USL



SIX SIGMA – FOCUS ON REDUCTION OF VARIATION



The 12 agile principles

1 Satisfy the **customer**



A circular gauge with a rainbow-colored arc and the word 'SATISFACTION' below it, with five smiley faces underneath.

2 Welcome **change**




An illustration of a woman and a man sitting at a desk with a laptop, looking at the screen.

3 Deliver **frequently**

Sprint 1	Sprint 2	Sprint 3	Sprint 4	Sprint 5
story	story	story	story	story
story	story	story	story	story
story	story	story	story	story

4 Work **together**



An illustration of a man and a woman sitting at a desk with laptops, working together.

5 Trust and **support**




An illustration of a group of people in a meeting, with one person standing and presenting.

6 Face-to-face **conversation**




An illustration of two people in conversation, with thought bubbles containing gears and a lightbulb.

7 Working **software**



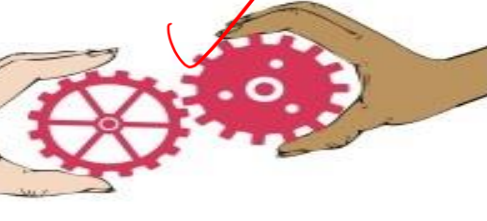
An illustration of three smiling laptop computers, each holding a red CD-ROM.

8 Sustainable **development**




A bar chart with the y-axis labeled 'ESTIMATE (POINTS)' and the x-axis labeled 'ITERATIONS'. There are four bars of varying heights.

9 Continuous **attention**



An illustration of two hands holding two interlocking red gears.

10 Maintain **simplicity**




A sign with the text 'Keep It Simple Stupid' and an arrow pointing to the right.

11 Self-organizing **teams**



An illustration of three people standing around a large puzzle piece.

12 Reflect and **adjust**



An illustration of a group of people in a huddle, looking at something on the ground.

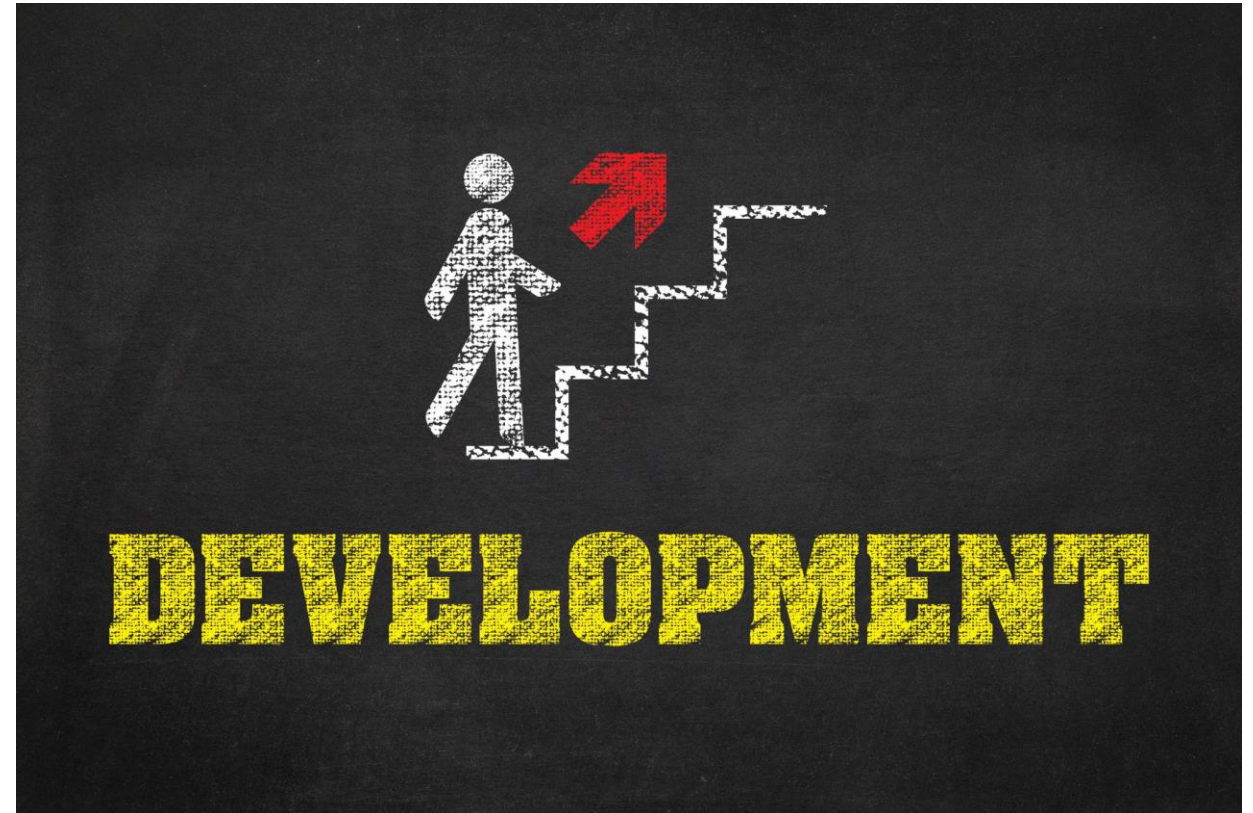
CUSTOMER SATISFACTION THROUGH EARLY AND CONTINUOUS DELIVERY

- Deliver valuable software to customers as early and often as possible.
- Frequent releases allow customers to benefit sooner and provide valuable feedback.
- Iterative improvements based on real user input enhance product relevance.



WELCOME CHANGING REQUIREMENTS, EVEN LATE IN DEVELOPMENT

- Be flexible and open to changes, even late in the project.
- Adapting to shifts in market and user needs keeps products relevant.
- Pivoting allows competitive advantage by responding quickly to industry changes.



DELIVER WORKING SOFTWARE FREQUENTLY

- Release usable software every few weeks or months.
- Short cycles reduce risk and enable quicker feedback.
- Frequent deliveries allow faster course correction and improvement.



BUSINESS PEOPLE AND DEVELOPERS MUST WORK TOGETHER DAILY

- Ensure constant collaboration between business and technical teams.
- Align goals, priorities, and expectations through daily communication.
- Facilitate quick decision-making and problem solving.



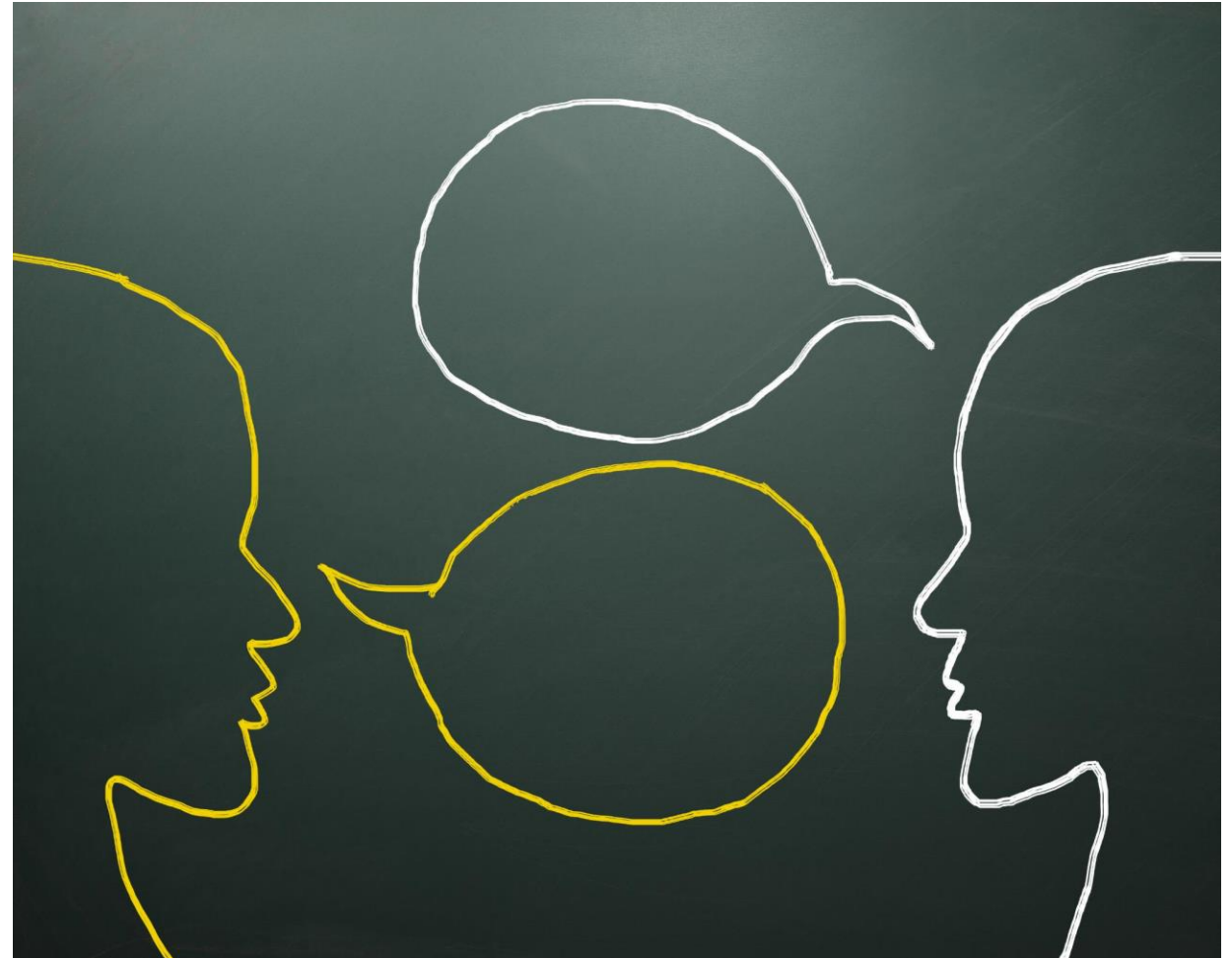
BUILD PROJECTS AROUND MOTIVATED INDIVIDUALS

- Empower passionate team members with trust and support.
- Motivated individuals take ownership and deliver better results.
- Allow autonomy in choosing tools and methods.



FACE-TO-FACE CONVERSATION IS MOST EFFECTIVE

- Direct communication is faster and clearer than emails or documents.
- Reduces misunderstandings and accelerates decision-making.
- Personal interaction fosters stronger team relationships.



WORKING SOFTWARE IS THE PRIMARY MEASURE OF PROGRESS

- Functioning software is more important than documentation or plans.
- Demonstrates real progress and delivers value.
- Focus efforts on producing usable features.



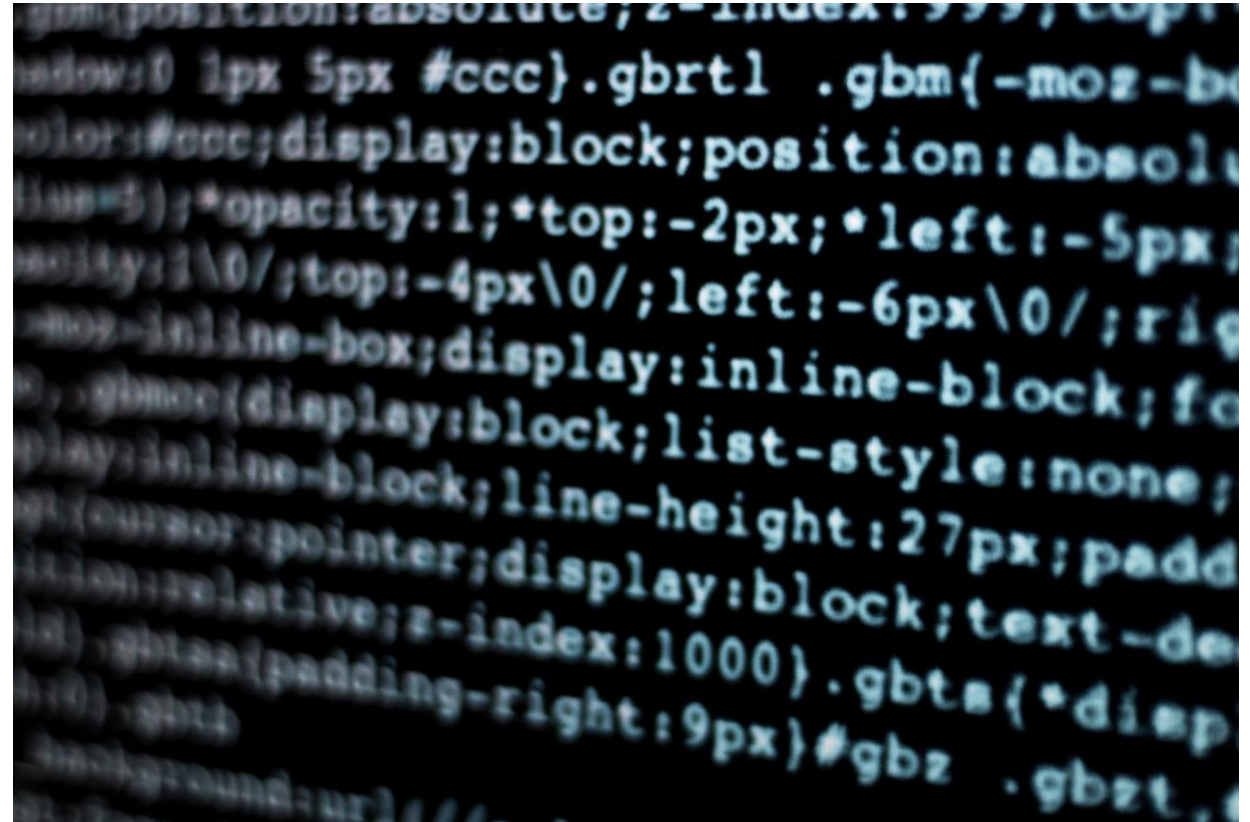
PROMOTE SUSTAINABLE DEVELOPMENT

- Maintain a pace that can be sustained long-term.
- Avoid burnout by planning realistic workloads.
- Sustainable work keeps teams productive over time.



CONTINUOUS ATTENTION TO TECHNICAL EXCELLENCE AND GOOD DESIGN

- Regularly improve code quality and architecture.
- Clean design makes software easier to maintain and scale.
- Refactor frequently to reduce complexity.



SIMPLICITY— MAXIMIZE WORK NOT DONE

- Focus only on essential features that deliver value.
- Avoid unnecessary complexity and wasted effort.
- Keep the product lean and efficient.

BEST DESIGNS EMERGE FROM SELF-ORGANIZING TEAMS

- Teams decide how to work and solve problems.
- Encourages creativity and ownership.
- Leads to better and more efficient solutions.

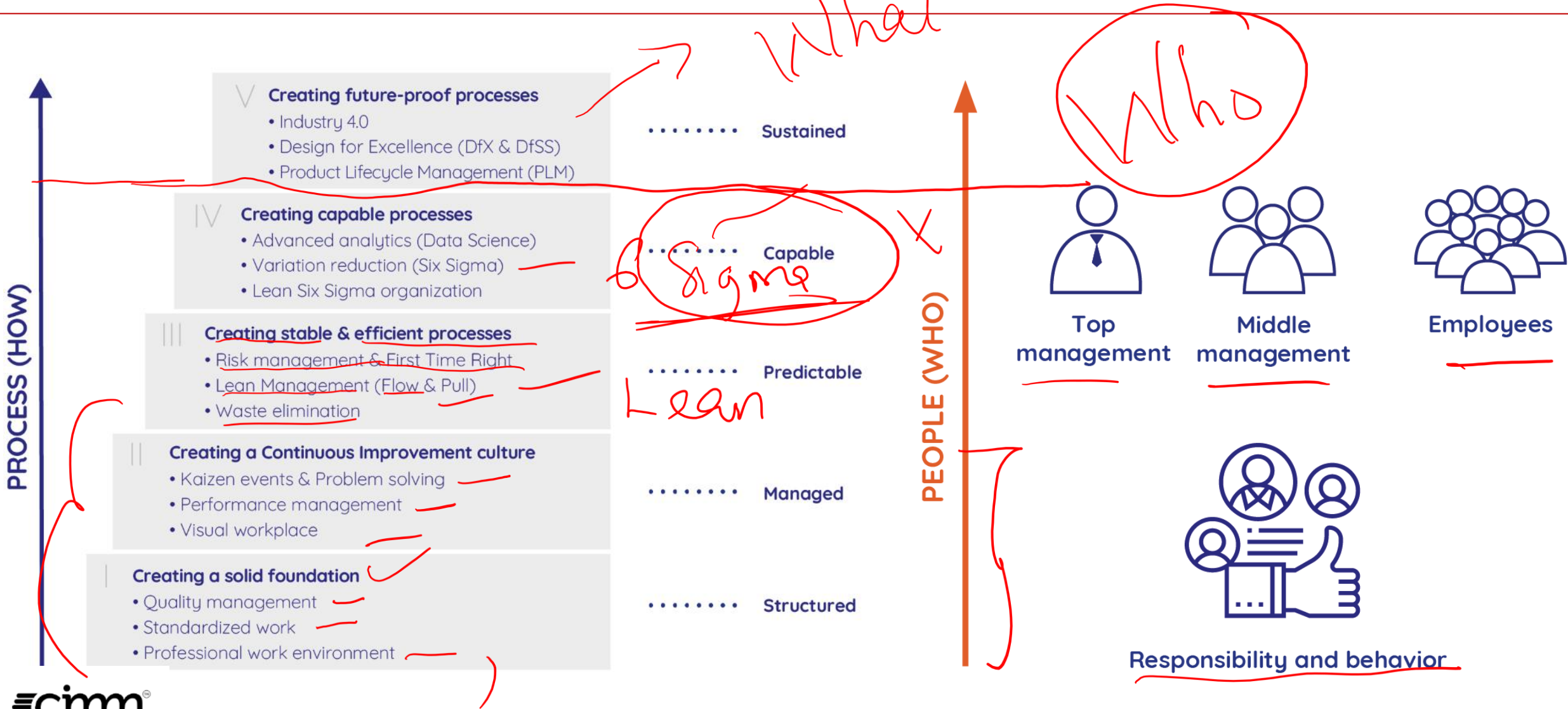


REGULAR REFLECTION AND ADJUSTMENT

- Teams frequently evaluate and improve their processes.
- Continuous improvement enhances performance and morale.
- Retrospectives identify successes and areas for change.



CONTINUOUS IMPROVEMENT MATURITY MODEL



CONTINUOUS IMPROVEMENT MATURITY MODEL

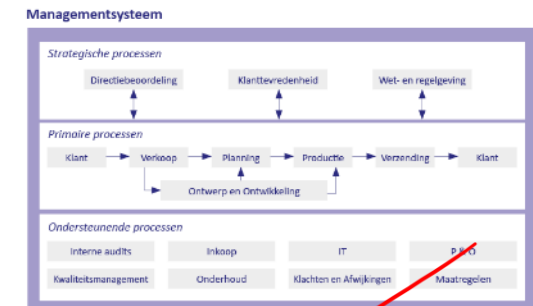
Level I – Create a solid foundation



PROFESSIONAL WORK ENVIRONMENT



STANDARDIZED WORK



QUALITY MANAGEMENT SYSTEM

1. CREATING A SOLID FOUNDATION

- **Process (HOW):**

- Standardize assembly line tasks. ✓
- Implement basic quality checks at each workstation. ✓
- Ensure a clean, professional, and safe work environment. ✓

- **People (WHO):**

- **Employees:** Follow standardized work instructions. ✓
- **Middle Management:** Train staff, enforce quality standards.
- **Top Management:** Invest in workplace safety and quality systems. ✓

CONTINUOUS IMPROVEMENT MATURITY MODEL

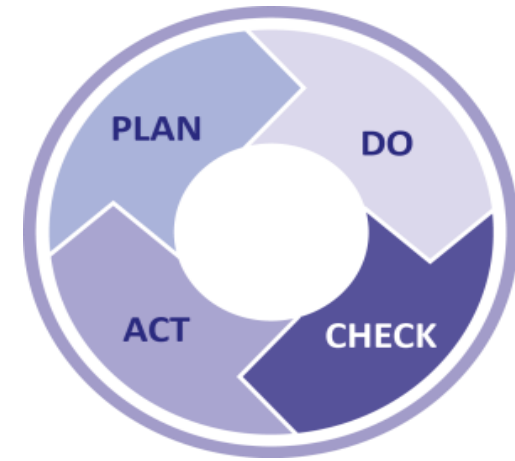
Level II – Create a Continuous Improvement Culture



**VISUAL MANAGEMENT &
STAND UP MEETINGS**



SHORT CYCLIC IMPROVEMENT



**KAIZEN EVENTS &
GO TO THE GEMBA**



2. CREATING A CONTINUOUS IMPROVEMENT CULTURE

•Process (HOW):

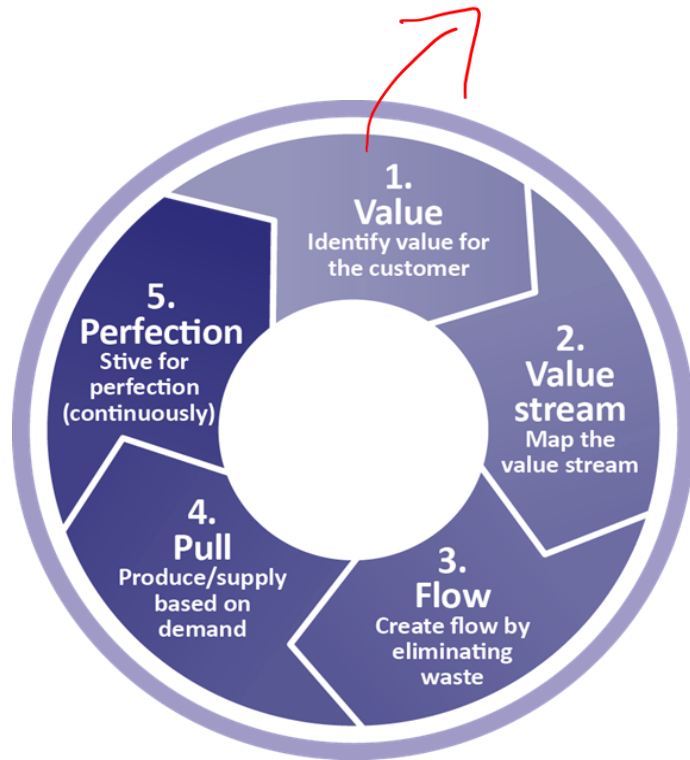
- Run Kaizen events to reduce waste (e.g., shorten machine setup times).
- Introduce daily performance dashboards to track output and defects.

•People (WHO):

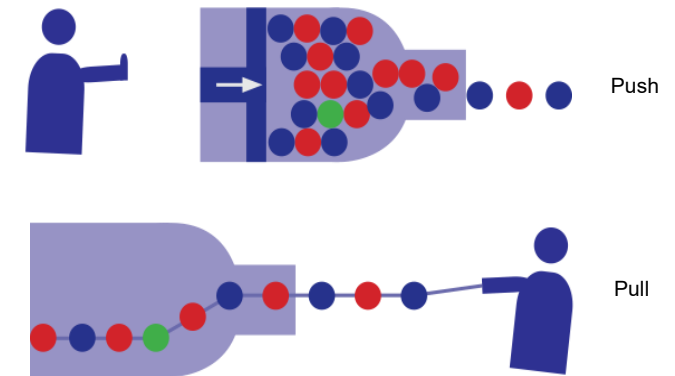
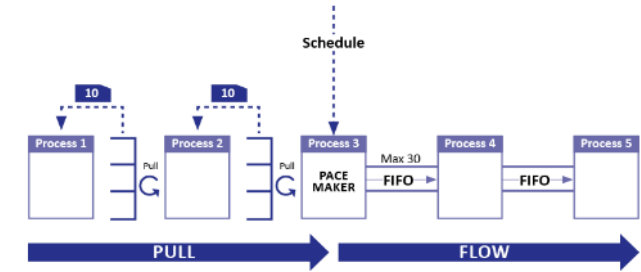
- Employees:** Suggest improvements, participate in problem-solving.
- Middle Management:** Facilitate Kaizen workshops, monitor KPIs.
- Top Management:** Recognize and reward improvement initiatives.

CONTINUOUS IMPROVEMENT MATURITY MODEL

Level III – Create stable and predictable processes



-  **1. Over-production** ✓
-  **2. Waiting** ✓
-  **3. Transport** ✓
-  **4. Over-processing** ✓
-  **5. Inventory** ✓
-  **6. Movement** ✓
-  **7. Defects** ✓
-  **8. Unused expertise** ✓

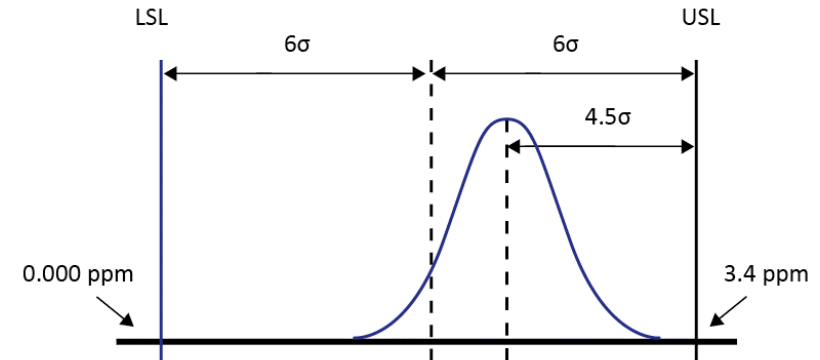
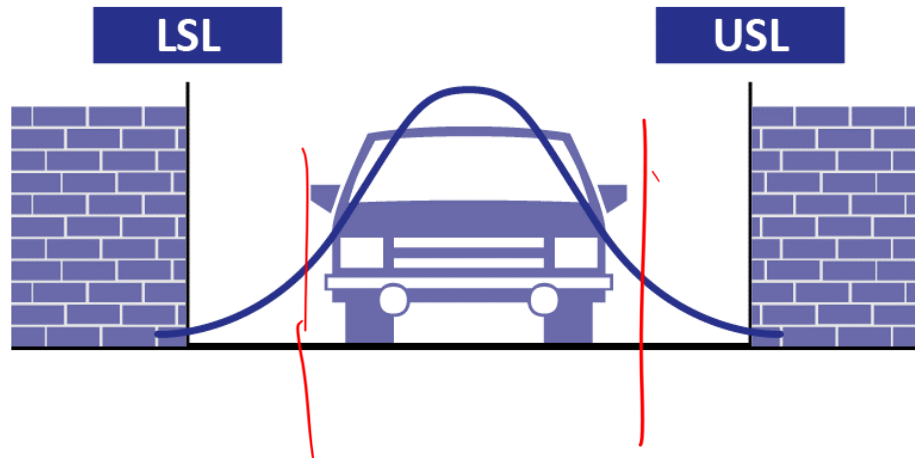
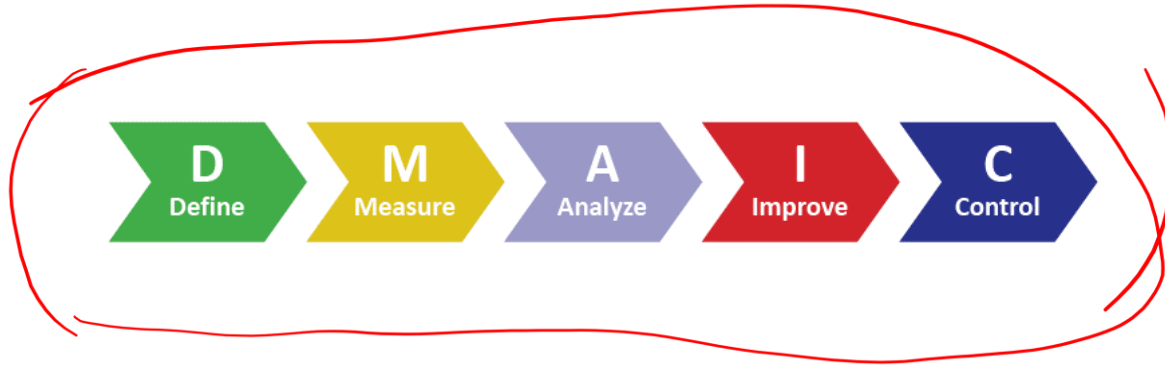


3. CREATING STABLE AND EFFICIENT PROCESSES

- **Process (HOW):**
 - Apply risk management to ensure “First Time Right” production (e.g., mistake-proofing tools).
 - Implement Lean flow principles—parts move smoothly without bottlenecks.
- **People (WHO):**
 - **Employees:** Use error-proofing devices, flag issues immediately.
 - **Middle Management:** Balance workloads, remove bottlenecks.
 - **Top Management:** Support Lean transformation projects.

CONTINUOUS IMPROVEMENT MATURITY MODEL

Level IV – create capable processes



4. CREATING CAPABLE PROCESSES (PART 2)

- **Process (HOW):**

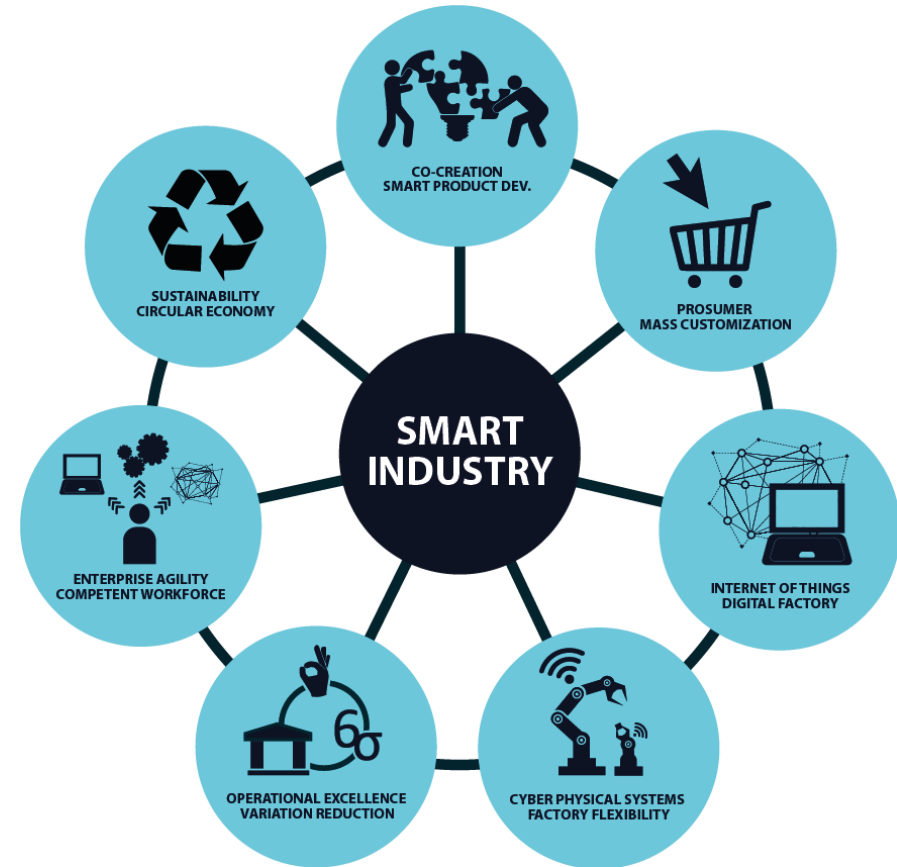
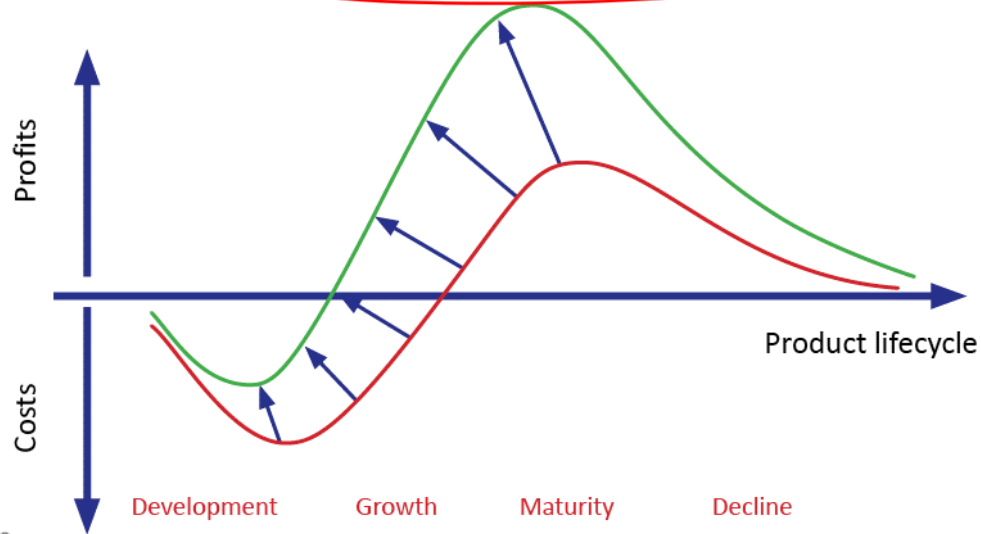
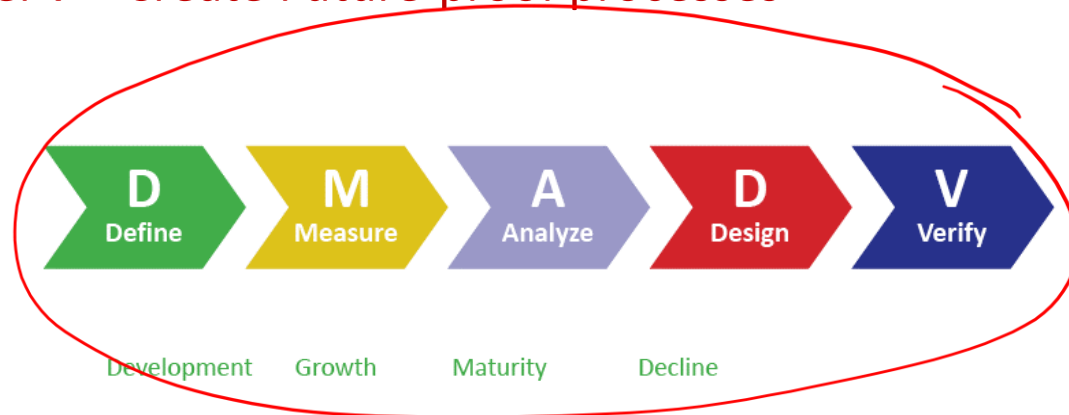
- Use advanced analytics to predict machine breakdowns (predictive maintenance).
- Apply Six Sigma to reduce variation in part dimensions.
- Build a Lean Six Sigma team to drive structured projects.

- **People (WHO):**

- **Employees:** Collect accurate data, follow improved procedures.
- **Middle Management:** Lead Six Sigma projects, coach Green Belts.
- **Top Management:** Sponsor projects, allocate resources for analytics.

CONTINUOUS IMPROVEMENT MATURITY MODEL

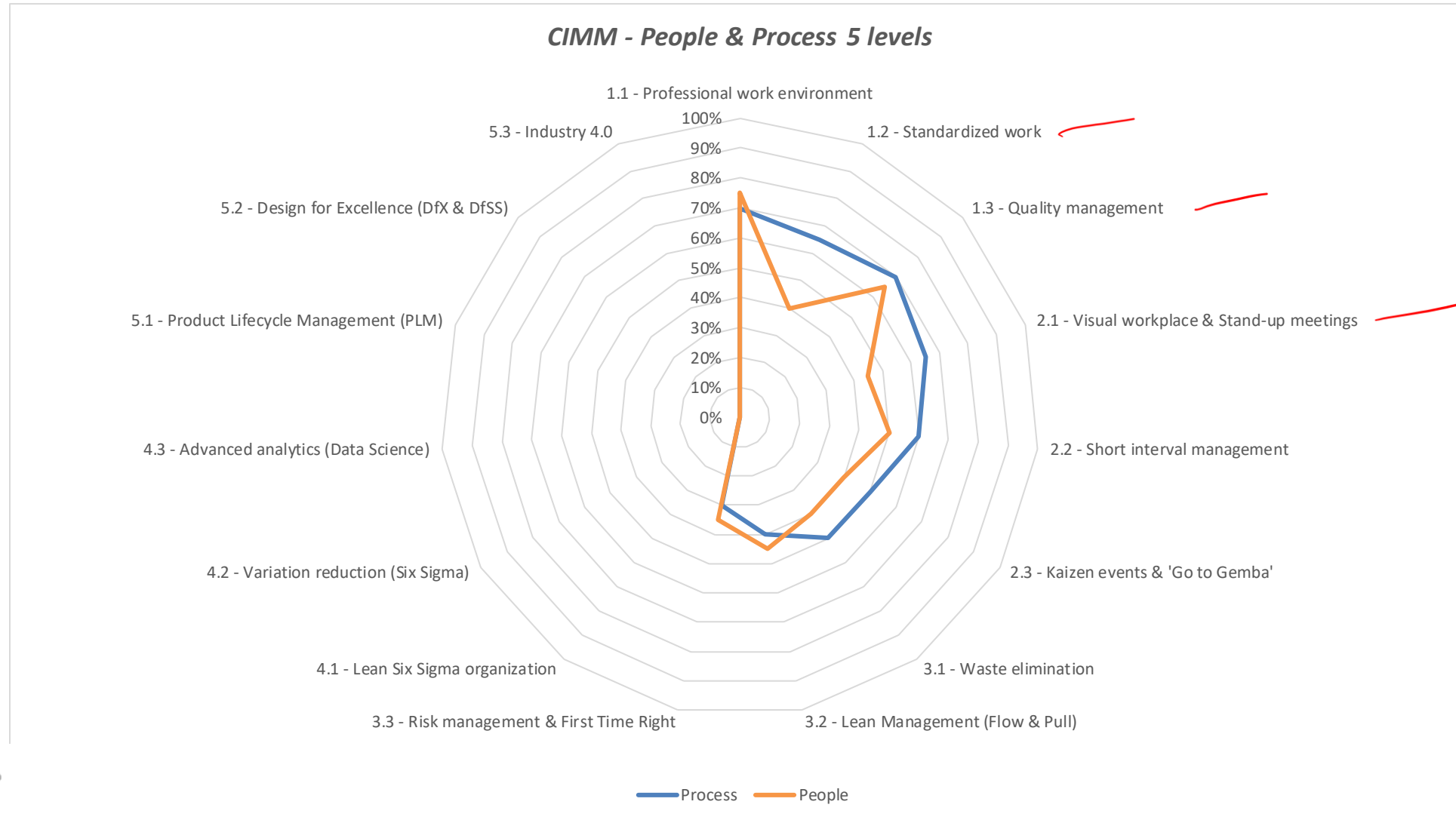
Level V – Create Future-proof processes



5. CREATING FUTURE-PROOF PROCESSES

- **Process (HOW):**
 - Adopt Industry 4.0 tools (IoT sensors on machines, AI-driven scheduling).
 - Use Design for Excellence (DfX) to ensure new parts are easy to manufacture and maintain.
 - Implement Product Lifecycle Management (PLM) to track parts from design to end-of-life.
- **People (WHO):**
 - **Employees:** Learn to work with digital tools and automation.
 - **Middle Management:** Integrate digital systems into daily operations.
 - **Top Management:** Drive digital transformation strategy, ensure long-term competitiveness.

CONTINUOUS IMPROVEMENT MATURITY MODEL

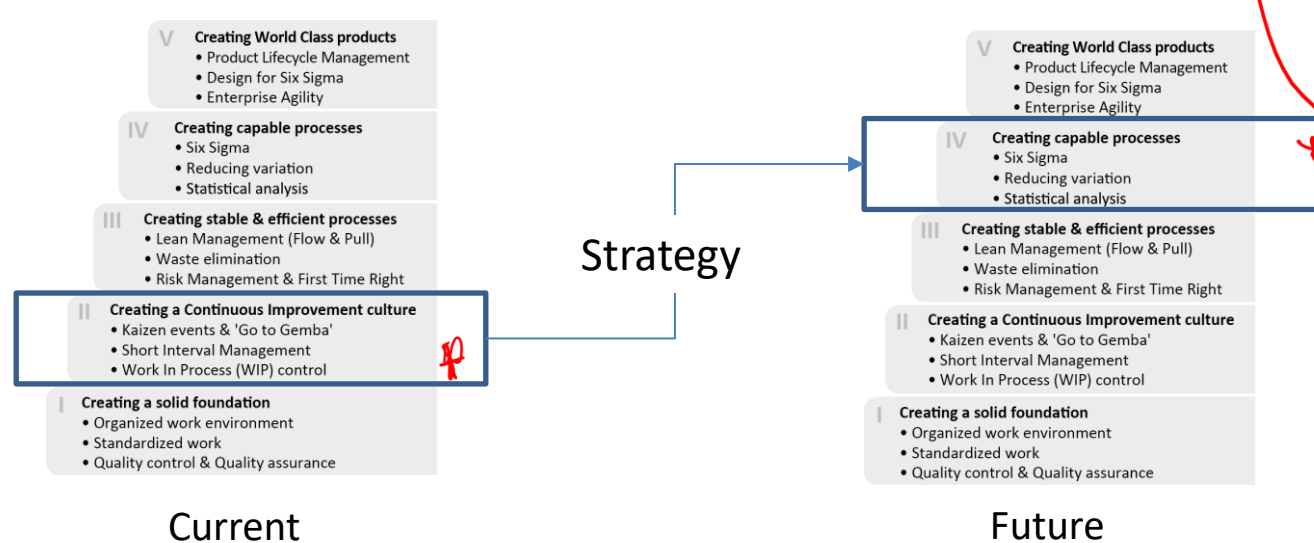


PROCESS IMPROVEMENT STRATEGY

- Define the Current maturity level of the organization. ✓
- Define the desired Future maturity level of the organization.
- Define breakthrough opportunities. —
- Select process improvement methods and techniques to achieve objectives.

CI MM

PDCA, DMAIC
 DVMAIC



At the start of the working day, a technician collects the activity planning forms for the next 8 hours work, After preparing the workplace the technician starts to manufacture and assemble the components into a complicated mechanical valve. When carrying out the work several critical characteristics are measured and the relevant data is recorded in the computer. After completing the work on the valve, the technician fills in the activity form.

Which activity carried out by the technician can be classified as a transactional process?

- a) Preparing the workplace → Physical process
- b) Filling in an activity form after completing the work → Physical
- c) Measuring critical characteristics and data → Electronic (→ transactional)
- d) Collecting the activity planning forms →

Read page 18-19 to answer the question * * *

Which Lean thinking statement is **NOT** true?

a) Lean improves processes to achieve better output ✓

b) Lean thinking focuses on doing the same work with lesser workforce

c) Lean concepts include value, value stream, flow, pull, and perfection ✓

d) Lean spans product development, manufacturing, purchasing, and customer support ✓

↳ Scrum



A call center operates in a stressful environment where thousands of calls must be answered each hour.

A 'call resolution' Key Performance Indicator (KPI) measures the outcome of each call handled by agents, to monitor how well customer issues are being resolved.

Quality of resolution —

Which measurement outcome of the 'call resolution' KPI would indicate success?

- a) Low percentage of issues resolved in the first contact *x*
- b) Multiple calls required to resolve each issue *x*
- c) Low percentage of unresolved issues
- d) 75% of calls answered within 20 seconds

A platform company works with an ordering-app and has its own delivery service. The company analyzes data with advanced statistical techniques. The delivery service reports many accidents on the road. The new 'Refrigerated transport' service experiences regularly insufficiently refrigerated delivery.



The company performs a CIMM-assessment (Continuous Improvement Maturity Model) to define the performance at the five maturity levels.

What are the expected scores at the lowest level I and the highest level V?

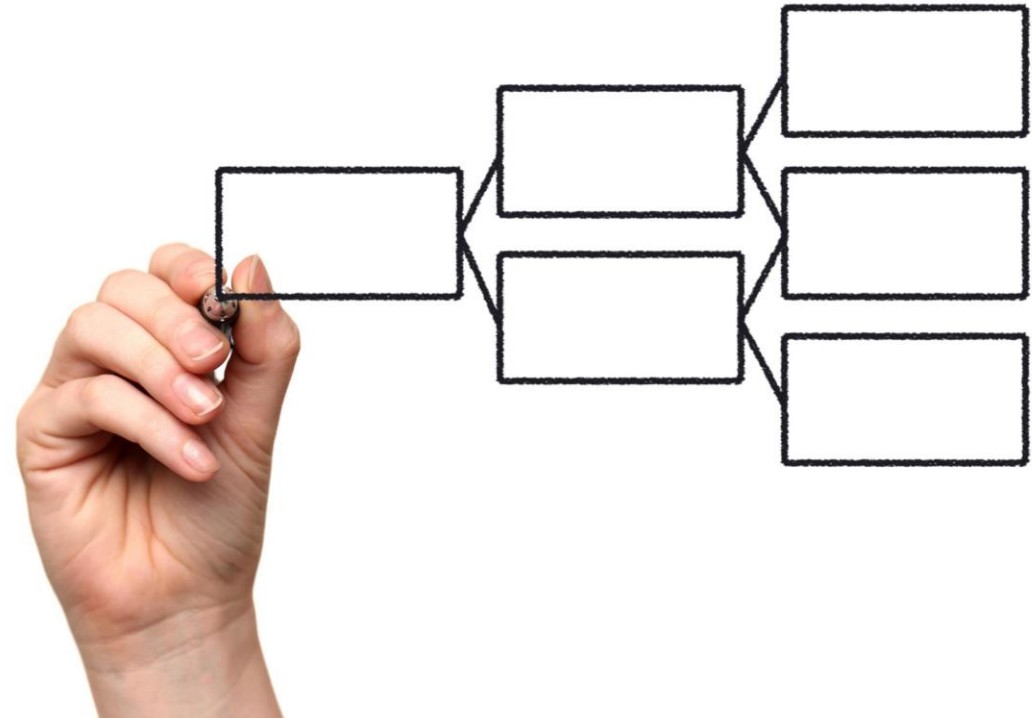
- a) Low at I and low at V
- b) Low at I and high at V
- c) High at I and low at V
- d) High at I and high at V

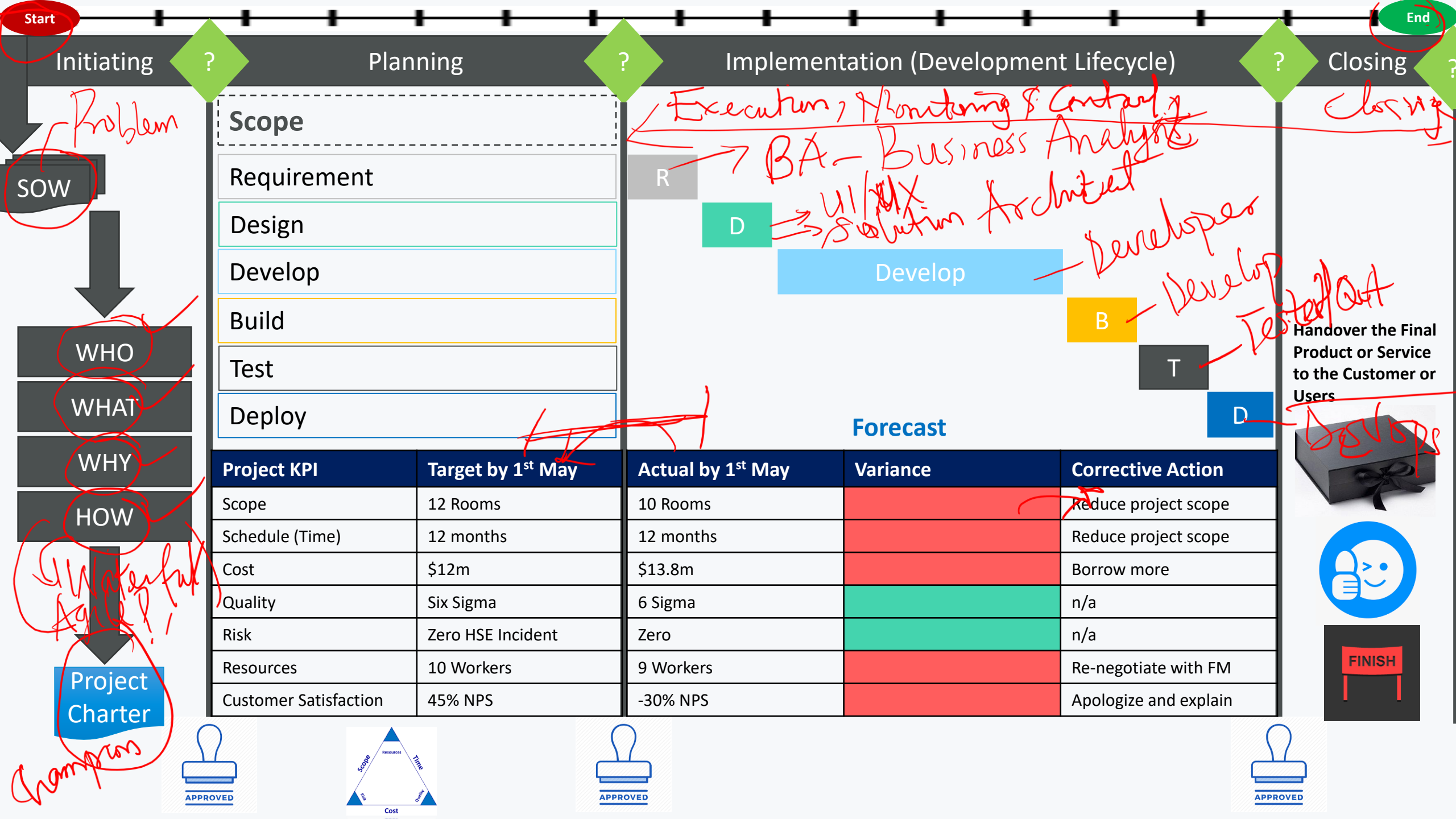
Process Improvement Practitioner:

- Change Manager — Buy-in/adoption ②
- Project Manager — Execution ①
- Process Improvement Expert ~~***~~ ③

What is a Project?

- A project is a temporary endeavor with a clear start and finish.
- It aims to create a unique product, service, or result.
- Projects have specific objectives to achieve desired outcomes. ✓
- Resources such as time, money, and personnel are consumed.
- Project goals guide the planning and execution processes.





Start

End

Initiating

Planning

Implementation (Development Lifecycle)

Closing

Scope

Requirement

Design

Develop

Build

Test

Deploy

Execution, Monitoring & Control

BA - Business Analysts

UI/UX Solution Architect

Developers

Tested Out

Handover the Final Product or Service to the Customer or Users



Problem

SOW

- WHO
- WHAT
- WHY
- HOW

Waterfall Agile?

Project Charter

Champions

Project KPI	Target by 1 st May	Actual by 1 st May	Variance	Corrective Action
Scope	12 Rooms	10 Rooms		Reduce project scope
Schedule (Time)	12 months	12 months		Reduce project scope
Cost	\$12m	\$13.8m		Borrow more
Quality	Six Sigma	6 Sigma		n/a
Risk	Zero HSE Incident	Zero		n/a
Resources	10 Workers	9 Workers		Re-negotiate with FM
Customer Satisfaction	45% NPS	-30% NPS		Apologize and explain





Initiating

Planning

Implement Incrementally 1-4 week Iterations⁽ⁿ⁾

Ongoing Success

Lean Six Sigma Implementation

Description

Clarify the process problems or pains.
Identify & engage key stakeholders to
identify the requirements and the
benefits to be realized.

LSS Activities

- LSS Activities**
- Clarify the Problem & Goal ✓
 - Identify & Analyze Stakeholders ✓
 - Create & agree Team Structure ✓
 - Engage Process Stakeholders to:
 - Create SIPOC, flow, swim ✓
 - Perform Process Audit ✓
 - Gather VOC/VOB ✓
 - Create CTQ Flowdown ✓
 - Prioritize requirements ✓
 - Create Business Case ✓
 - Agree the approach including roadmap and Kotter Approach ✓

- Conduct 5S Assessment ✓
- Create SOP for Processes ✓
- Create Job Aids as OPL to help TWI ✓
- Implement QMS system (QP, QA, QC) ✓
- Obtain QMS accreditation ✓

Change Mgt

- People Activities**
- Review Organizational Culture ✓
 - Consider Reasons for resistance and Kubler Ross Change Curve ✓
 - Motivation – Herzberg, MBTI ✓
 - Team Leadership and Team roles ✓
 - Coaching, stakeholder & Comm Plan ✓

-
-
-
-

Output

Project Charter ✓
Stakeholder Engagement, ✓
Communication & Coaching Plans

Problem

- **Problem:** During 2016, 20% of overseas customer payment took longer than the agreed invoice terms. This resulted in an average outstanding debt of £357k, at a 5% cost of capital. (4 30 days)
- **Goal:** Reduce the percentage of overseas customer payments that take longer than agreed invoice terms from 20% to 5%, by the end of quarter 4, 2017
- **Problem:** From Oct 2016 to March 2017, 5% of Product A manufactured on production line 1 failed the final test. This resulted in an extra inspection/rework process being implemented (at a cost of £25,000 per month), and a scrap rate of 2% costing £20k per month in lost revenue.
- **Goal:** Reduce the Product A final test failure rate on production line 1 from 5% to 2% by the end of October 2017

Problem

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- **Goal:** Reduce the Product A final test failure rate on production line 1 from 5% to 2% by the end of October 2017



Initiating – “WHO”

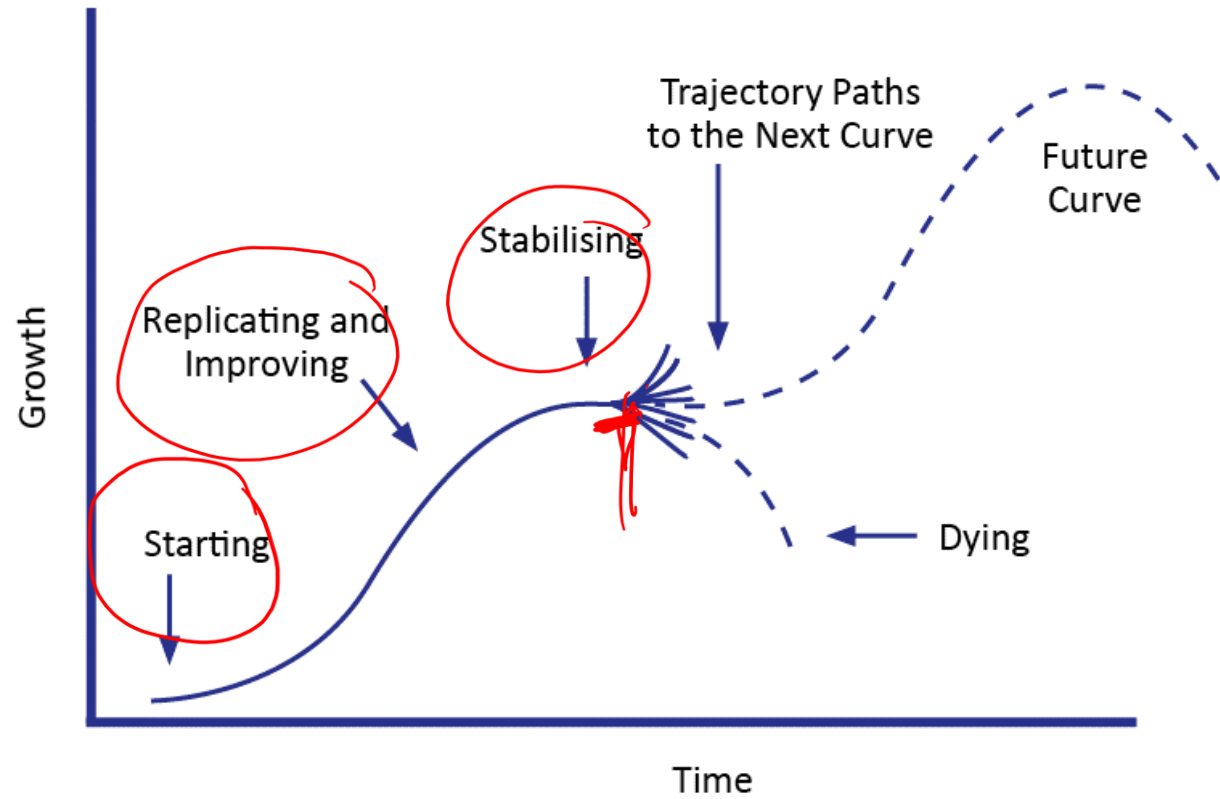
U2 – POLICY DEVELOPMENT AND DEPLOYMENT

E2 – POLICY DEPLOYMENT



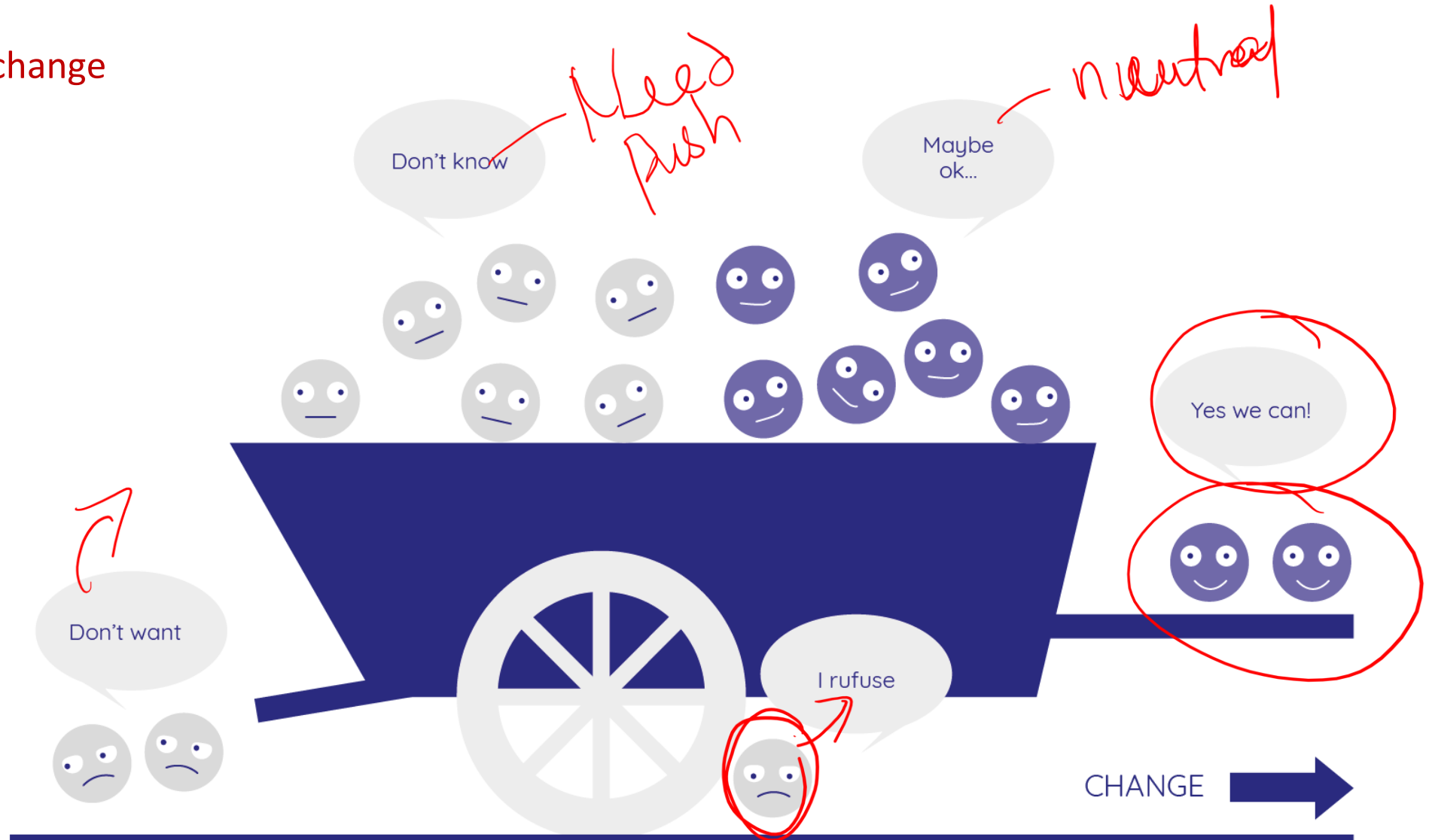
MANAGEMENT OF CHANGE

Change management S-curve



MANAGEMENT OF CHANGE

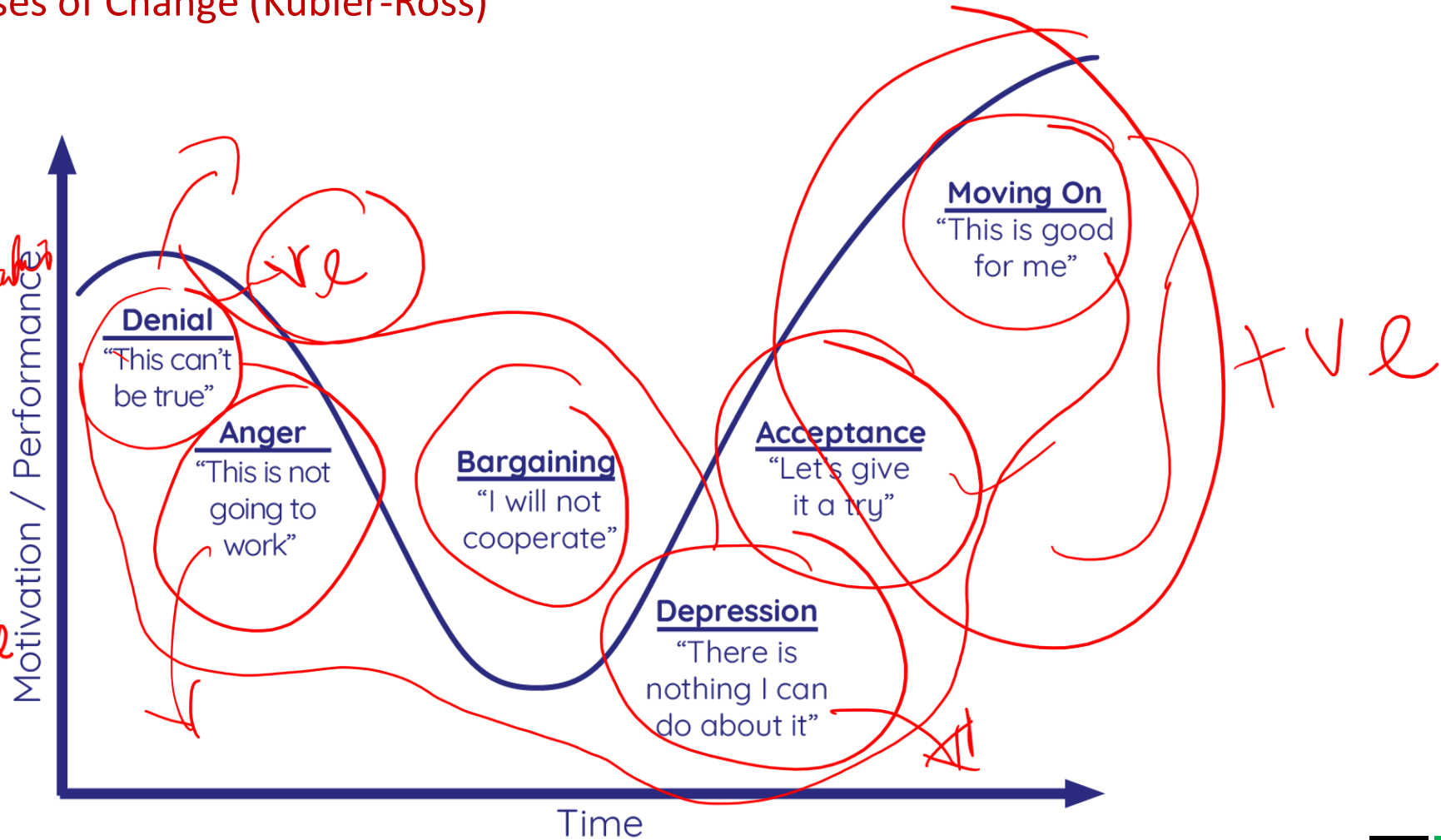
Resistance to change



MANAGEMENT OF CHANGE

Emotional phases of Change (Kübler-Ross)

- * Clear communication
- * Impact
- * What expect
- * Coach
- * listen
- * involve people
- * Negotiate

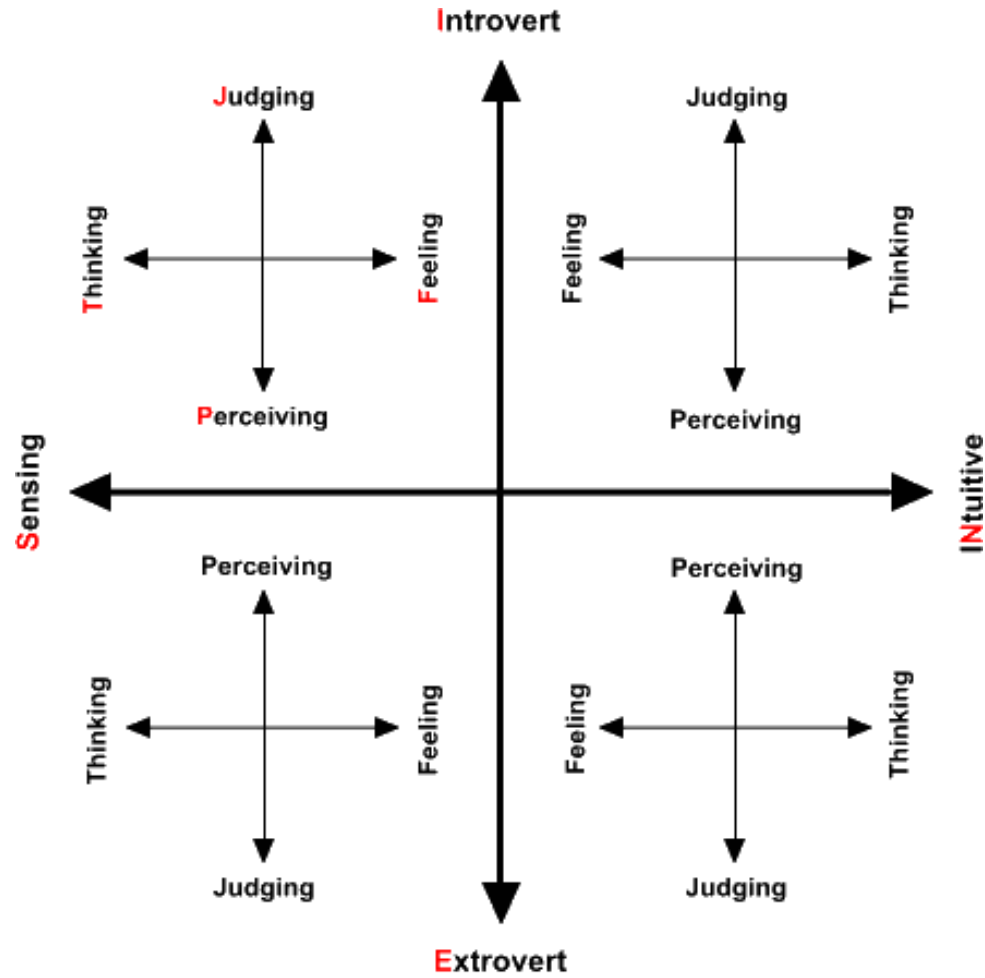


PROJECT TEAM

Jung's theory

- 2 mental activities
 - 4 mental processes
 - 2 orientations of energy
 - 8 fundamental behaviour patterns
-
- 16 types

ISTJ	ISFJ	INFJ	INTJ
ISTP	ISFP	INFP	INTP
ESTP	ESFP	ENFP	ENTP
ESTJ	ESFJ	ENFJ	ENTJ



Note: The red capitals in the main and first quadrants refer to the Myers-Briggs Type Indicators (MBTI)

KNOW THYSELF - PERSONALITY

As a PM, you Promote team performance through the application of emotional intelligence

- Assess behaviour through the use of personality indicators
- Analyze personality indicators and adjust to the emotional needs of key project stakeholders

MBTI Dichotomies

E

Extraversion

Energized by people and things in the external world.

Energy

I

Introversion

Energized by ideas or impressions in the inner world.

S

Sensing

Gather details and facts that can be confirmed by experience.

Learn

N

Intuition

Gather ideas and see future possibilities.

T

Thinking

Make decisions by logic and analysis.

Decision

F

Feeling

Make decisions based on personal values.

J

Judging

Enjoy planning and deciding.

Lifestyle

P

Perceiving

Enjoy remaining open to new options.

INTJ THE ARCHITECT IMAGINATIVE STRATEGIC PLANNERS	INTP THE LOGICIAN INNOVATIVE CURIOUS LOGICAL	ENTJ THE COMMANDER BOLD IMAGINATIVE STRONG-WILLED	ENTP THE DEBATER SMART CURIOUS INTELLECTUAL
INFJ THE ADVOCATE QUIET MYSTICAL IDEALIST	INFP THE MEDIATOR POETIC KIND ALTRUISTIC	ENFJ THE PROTAGONIST CHARISMATIC INSPIRING NATURAL LEADERS	ENFP THE CAMPAIGNER ENTHUSIASTIC CREATIVE SOCIABLE
ISTJ THE LOGISTICIAN PRACTICAL FACT-MINDED RELIABLE	ISFJ THE DEFENDER PROTECTIVE WARM CARING	ESTJ THE EXECUTIVE ORGANIZED PUNCTUAL LEADER	ESFJ THE CONSUL CARING SOCIAL POPULAR
ISTP THE VIRTUOSO BOLD PRACTICAL EXPERIMENTAL	ISFP THE ADVENTURER ARTISTIC CHARMING EXPLORERS	ESTP THE ENTREPRENEUR SMART ENERGETIC PERCEPTIVE	ESFP THE ENTERTAINER SPONTANEOUS ENERGETIC ENTHUSIASTIC

EXTRAVERSION VS. INTROVERSION

- Extraverts direct energy outward toward people and activities.
- Introverts turn inward, gaining energy through solitary reflection.
- Extravert example: Maya engages actively and recharges through social interaction.
- Introvert example: Daniel processes ideas alone and enjoys quiet reflection.



SENSING (S) VS. INTUITION (N) IN DECISION-MAKING

- Sensors rely on concrete facts and present realities.
- Intuitives focus on patterns and future possibilities.
- Sensor example: Carla uses step-by-step recipes and adjusts based on taste.
- Intuitive example: Jamal experiments with new flavors inspired by imagination.



THINKING (T) VS. FEELING (F) DECISION-MAKING

- Thinkers decide using logical analysis and objective criteria.
- Feelers consider personal values and emotional impacts in decisions.
- Thinking example: Raj chooses a job based on salary and growth.
- Feeling example: Elena picks a job for team culture and support.



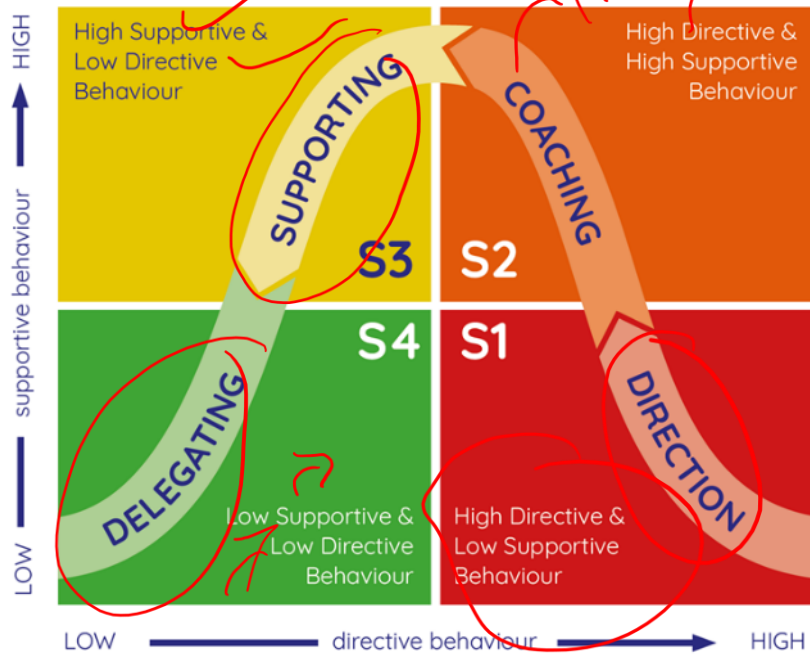
JUDGING VS. PERCEIVING: UNDERSTANDING PREFERENCES

- Judges prefer structured plans and clear deadlines.
- Perceivers enjoy flexibility and spontaneity in their activities.
- Judges seek decisive closure in decision-making.
- Perceivers like to keep their options open for opportunities.
- Example of Judging: Felipe plans his vacation itinerary months ahead.
- Example of Perceiving: Lina plans loosely and explores spontaneously.



PROJECT TEAM

Situational Leadership (Hersey-Blanchard) & Tea, stages (Tuckman)



Intervention Type	Forming	Storming	Norming	Performing
Overview	Set objectives	Resolve conflicts	Facilitate processes	Coach
Direction	High	High	Low	Low
Support	<u>Low</u>	High	High	Low
Leader focus	Individual tasks	<u>People interactions</u>	Task interactions	Self-development
Persuasion style	Tell/push	<u>Sell/Consult</u>	Listen/advise	Observe/support
Team Interaction	Leader provide links	<u>Facilitate relationships</u>	Facilitate team processes	Dynamic grouping
Summary	Individuals	<u>Relationships</u>	Processes	Self-development

MANAGEMENT OF CHANGE

The 8 steps of change (John Kotter)



MANAGEMENT OF CHANGE



Stakeholders

People who have an interest in or have an influence on the project



- **Problem:** During 2016, 20% of overseas customer payment took longer than the agreed invoice terms. This resulted in an average outstanding debt of £357k, at a 5% cost of capital
- **Goal:** Reduce the percentage of overseas customer payments that take longer than agreed invoice terms from 20% to 5%, by the end of quarter 4, 2017

Finance:

* CFO, Head of Finance,

Marketing: ^{of} Head of marketing & Head of Sales, ^{of} Sales, ^{of} product delivery, ^{of} Communication team

M&A practitioners,

IT: CTO/CIO,

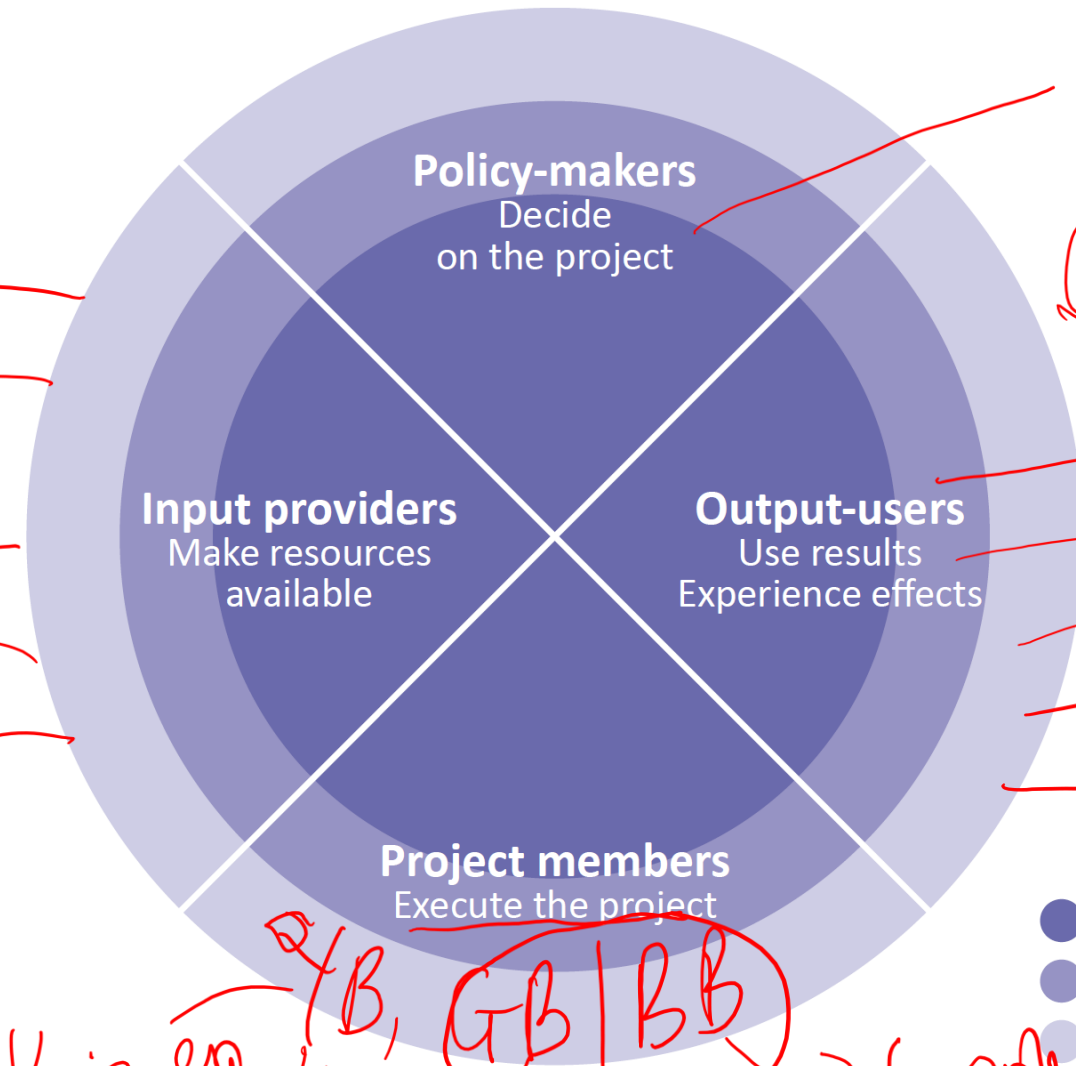
Board of directors, Int. Audit team,

Finance team
 Sales team
 Marketing
 IT
 Internal
 legal
 Foreign

Kaizen project
 GB, GB/BB
 less complex
 complex

Sponsor / champion, CFO,
 Head of sale / Marketing
 Head of legal etc.
 MBB

Foreign customers
 Sales team
 Marketing team
 legal
 IT



- Direct
- Indirect
- Invisible

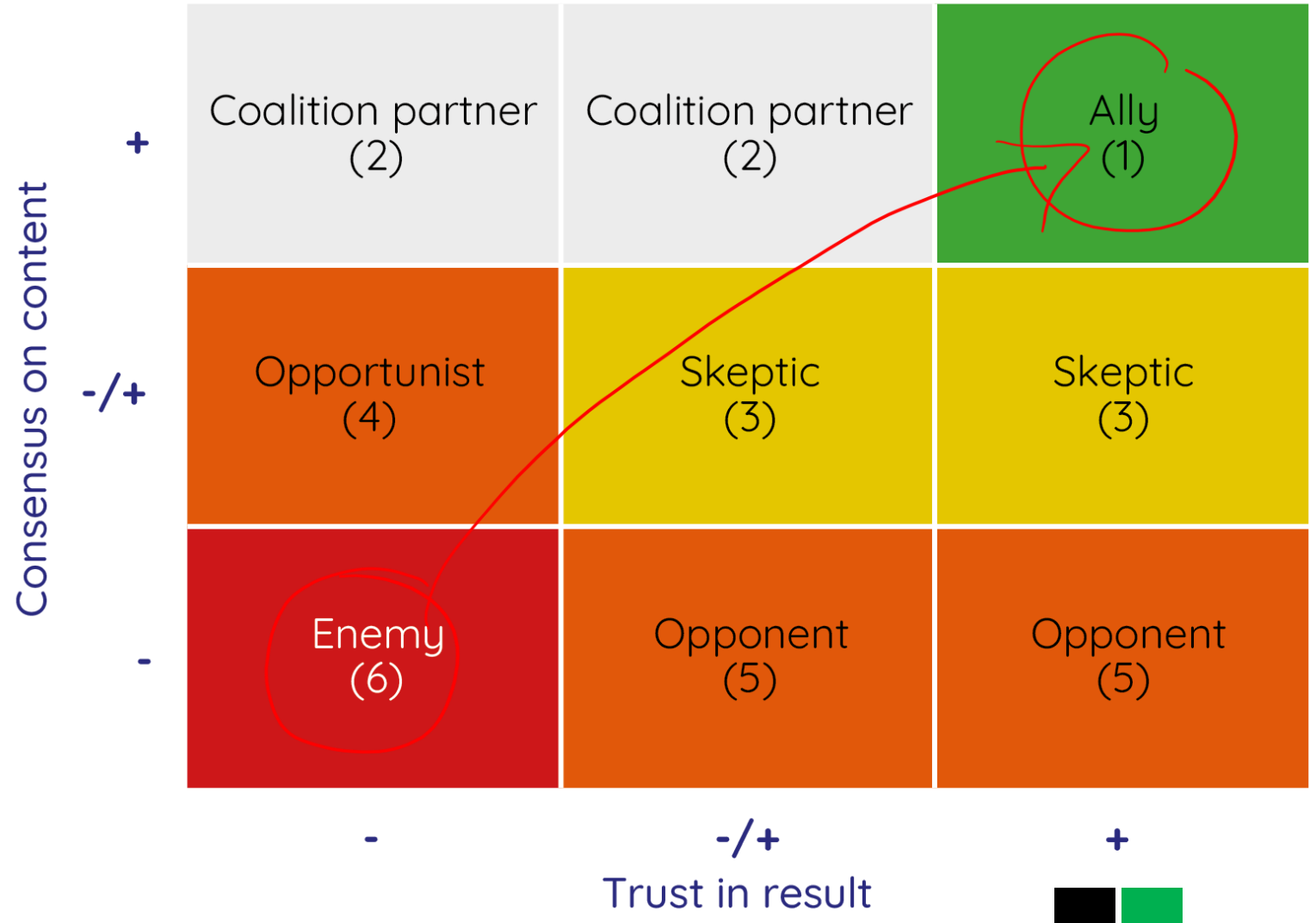
Figure 25 - Stakeholder influence and interest

Problem: During 2016, 20% of overseas customer payment took longer than the agreed invoice terms.
This resulted in an average outstanding debt of £357k, at a 5% cost of capital
Goal: Reduce the percentage of overseas customer payments that take longer than agreed invoice terms from 20% to 5%, by the end of quarter 4, 2017

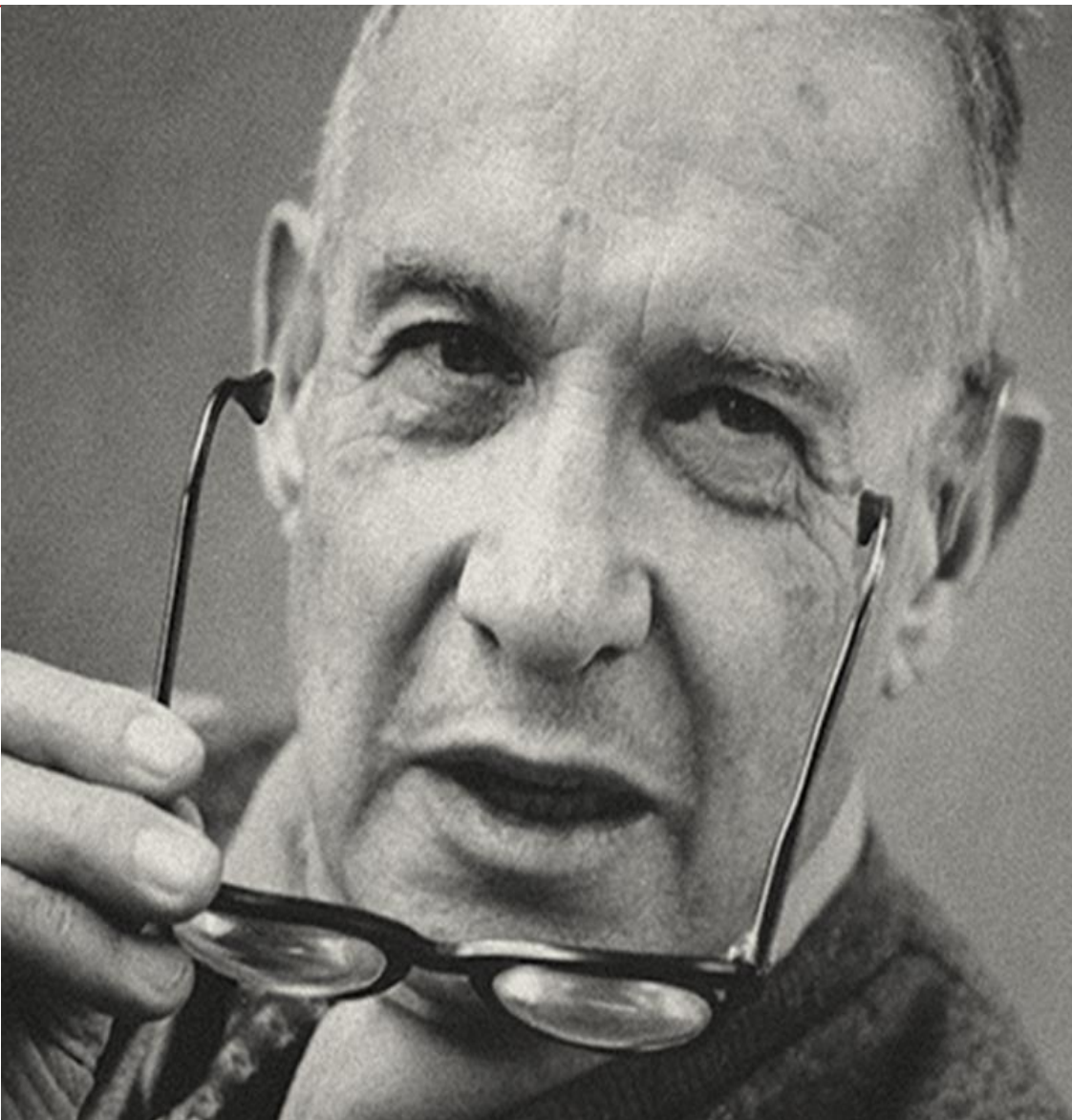
MANAGEMENT OF CHANGE

Estimate relationships

APMER
50



LEADERSHIP



*“Management is doing things right.
Leadership is doing the right things.”*

Peter Drucker

LEADERSHIP



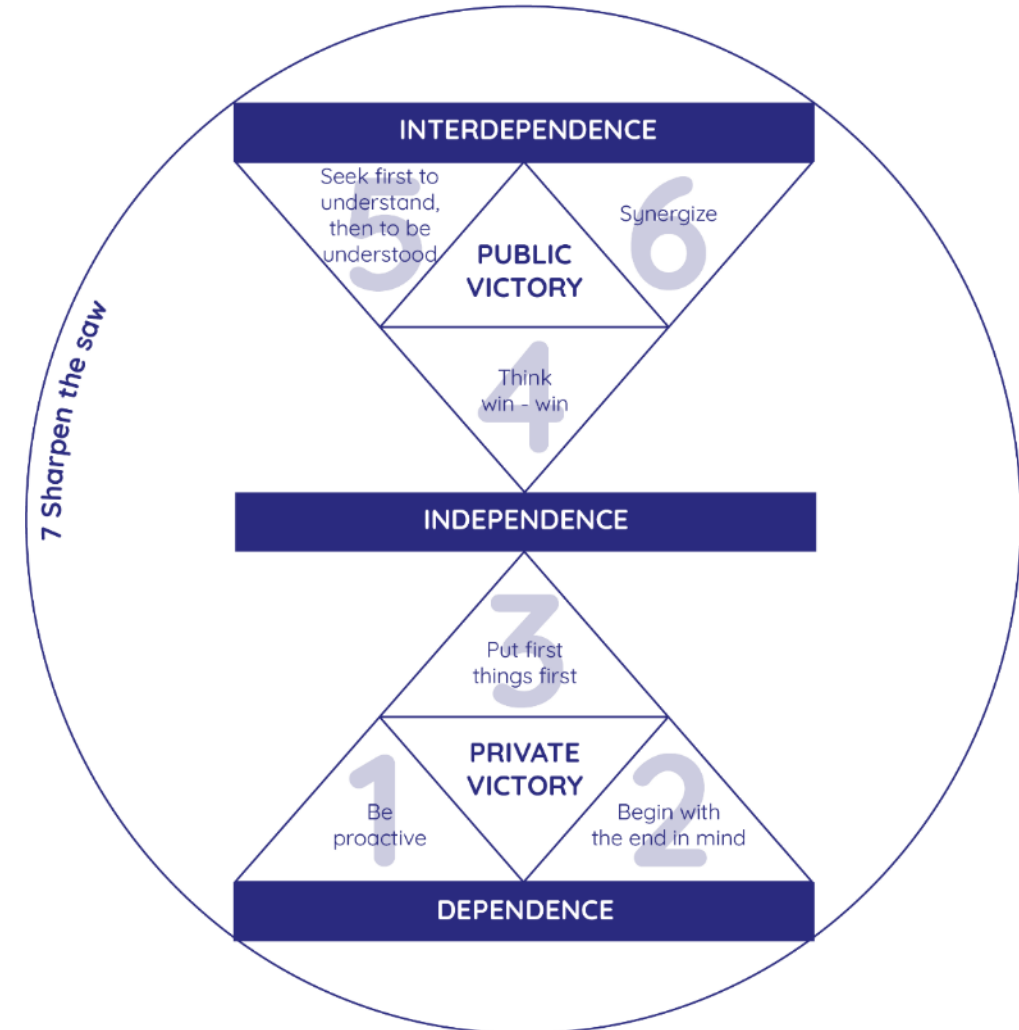
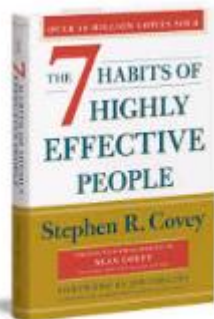
“Management is efficiency in climbing the ladder of success; Leadership determines whether the ladder is leaning against the right wall.”

Stephen Covey

LEADERSHIP

The 7 Habits of Highly Effective People

1. Be Proactive ✓
2. Begin with the end in mind ✓
3. Put First things First ✓
4. Think Win-Win ✓
5. Seek first to understand, then to be understood
6. Synergize
7. Sharpen the saw



PROJECT TEAM

Project Board & Project team

- Champion: Problem owner
- Supplier: Resource manager
- User: Reap the project benefits
- (Master) Black Belt: Project Board coach and project leader



Project Team:

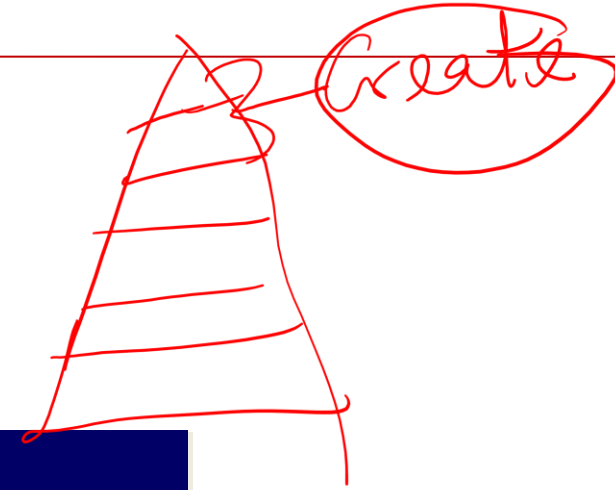
Name	Role	Responsibility	Phone	E-mail



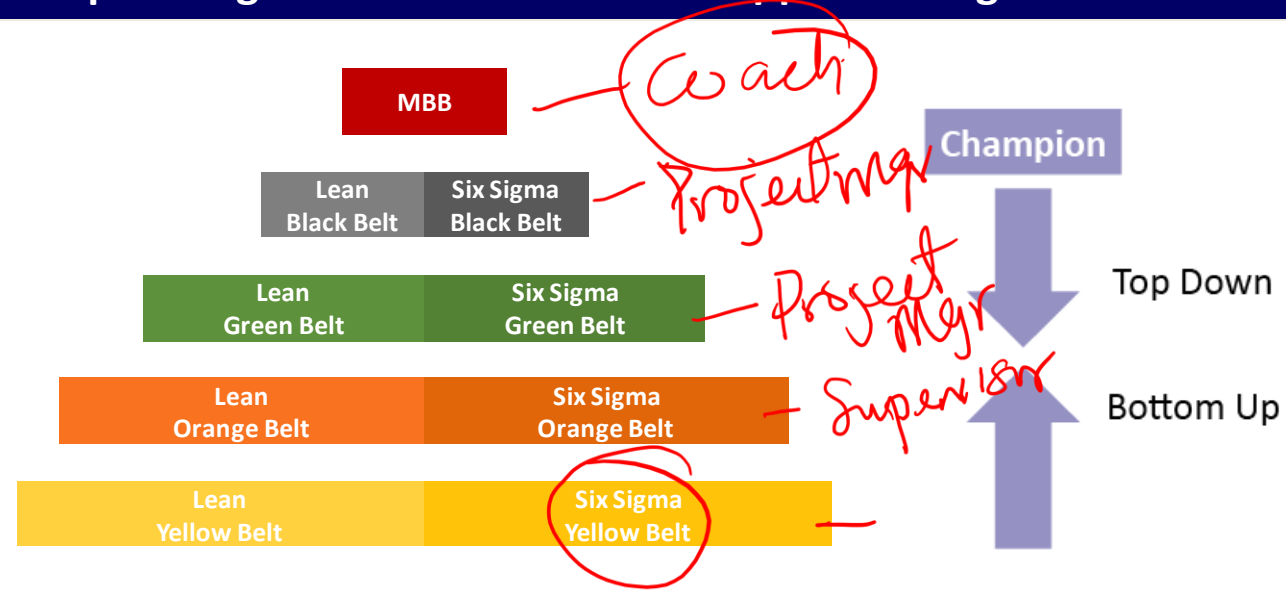
CONTINUOUS IMPROVEMENT ROLES AND RESPONSIBILITIES

Continuous improvement organization and Belt-levels

- There are different roles and responsibilities within Lean and Six Sigma.
- In addition to the Belt-structure, the Champion has an important role.



Top management must drive and support Six Sigma

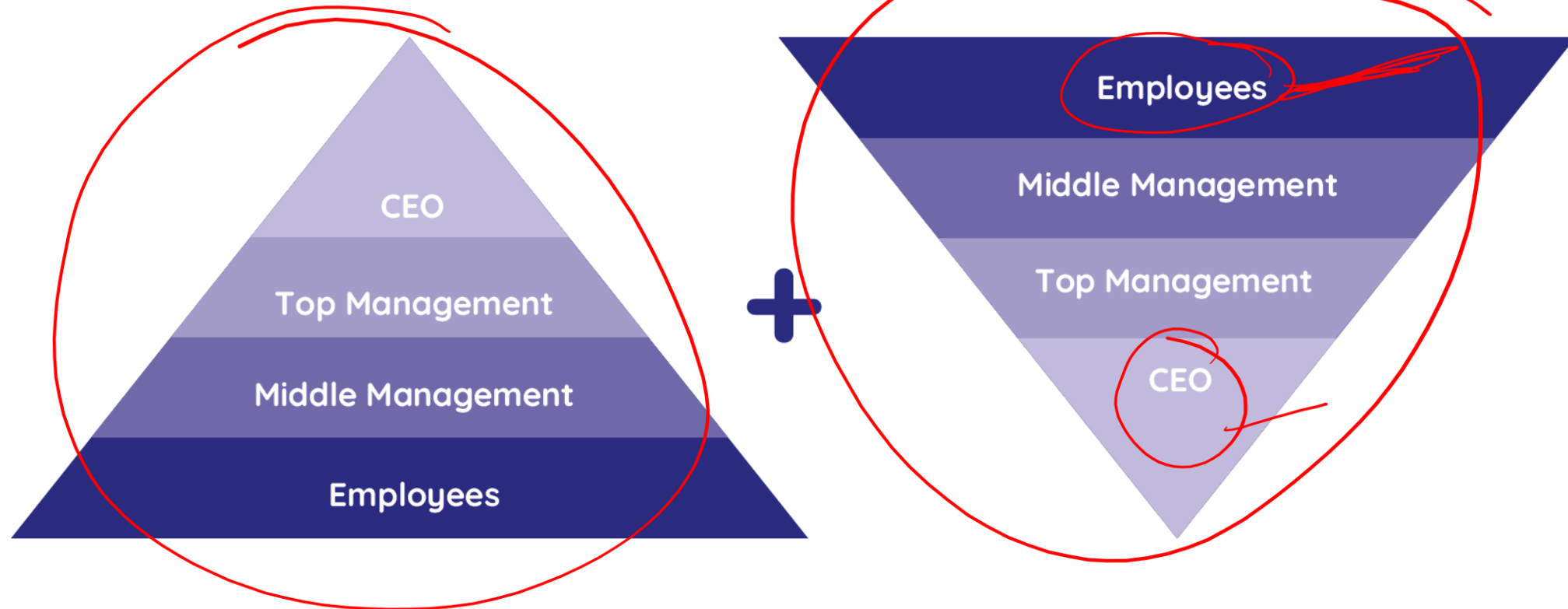


There should be a broad support system throughout the whole organization



CONTINUOUS IMPROVEMENT ROLES AND RESPONSIBILITIES

Flipped pyramid: Top-down versus Bottom-up



Traditional Hierarchy (Top-Down):

- Authority & decisions concentrated at the top
- Directions flow downward (objectives, budgets, timing)
- Limits agility, communication, creativity, and problem-solving
- Change depends only on managers → unsustainable

Flipped Pyramid (Bottom-Up, Lean Leadership):

- Employees closest to customers/processes are empowered
- Managers act as facilitators & coaches, not controllers
- Workforce gains decision-making authority & responsibility
- Boosts motivation, collaboration, and problem-solving agility
- Everyday issues solved by those who experience them
- Involves the *whole organization*, not just senior staff

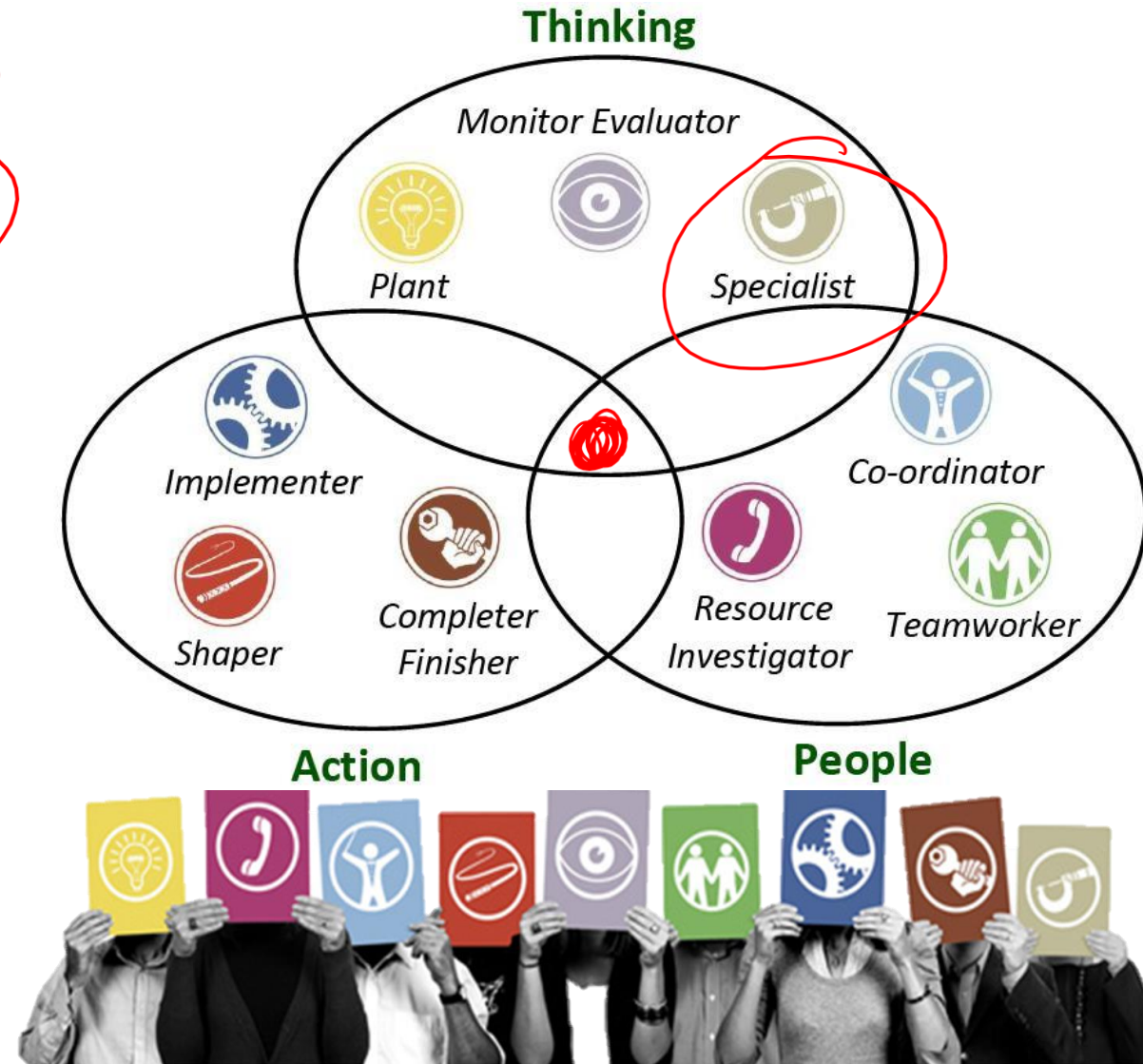
Key Takeaway:

Empowering employees through a bottom-up approach unlocks creativity, accelerates problem-solving, and sustains continuous improvement.

PROJECT TEAM

Team composition (Belbin)

- The nine roles of Belbin



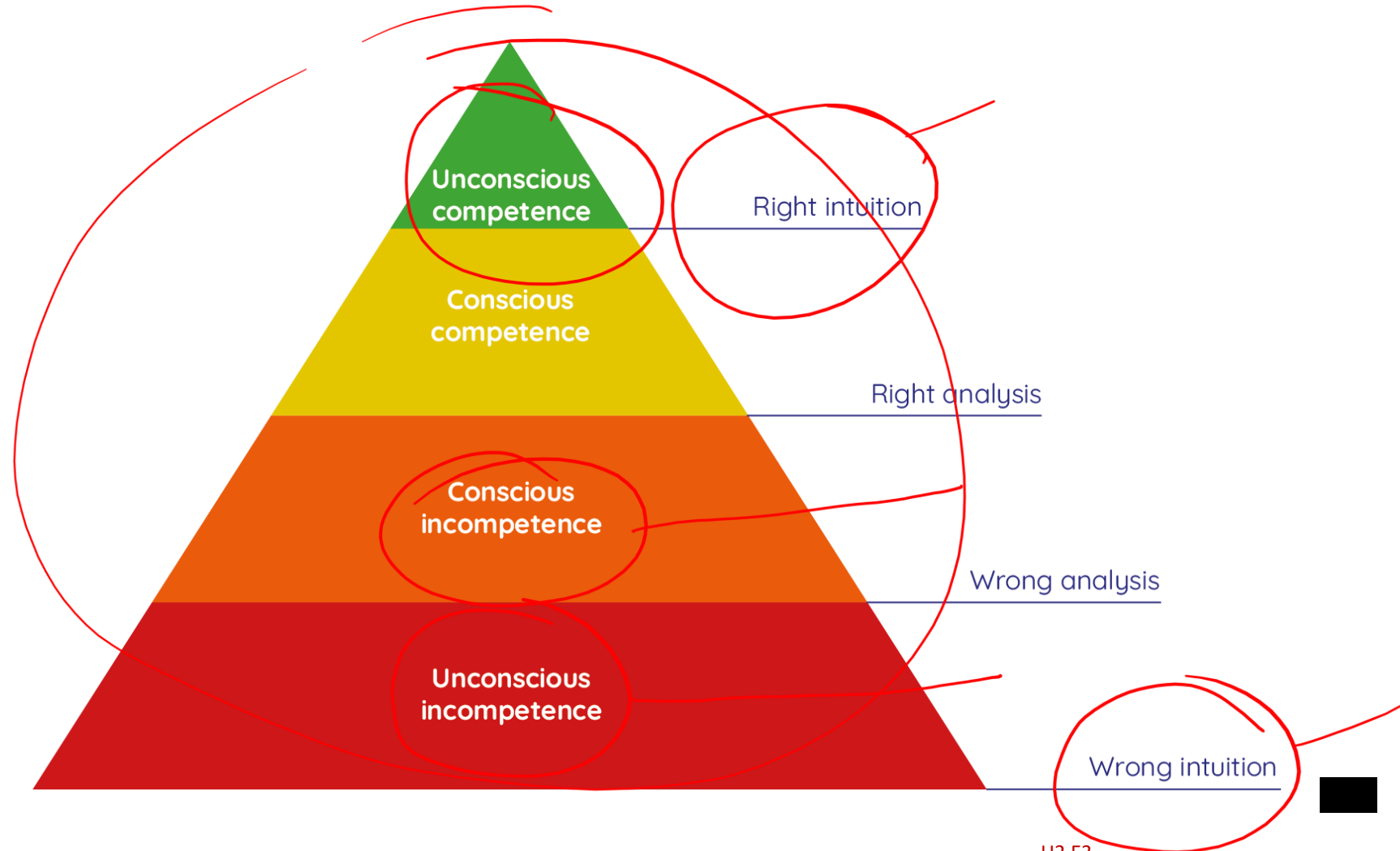
U2 – POLICY DEVELOPMENT AND DEPLOYMENT

E3 – COMPETENCE DEVELOPMENT



LEARNING ORGANIZATION

Four stages of learning (Martin M. Broadwell)



COACHING AND INTERVISION

Toyota KATA

Destinatio

Understand the direction



Understand Current State



Capture next Future State

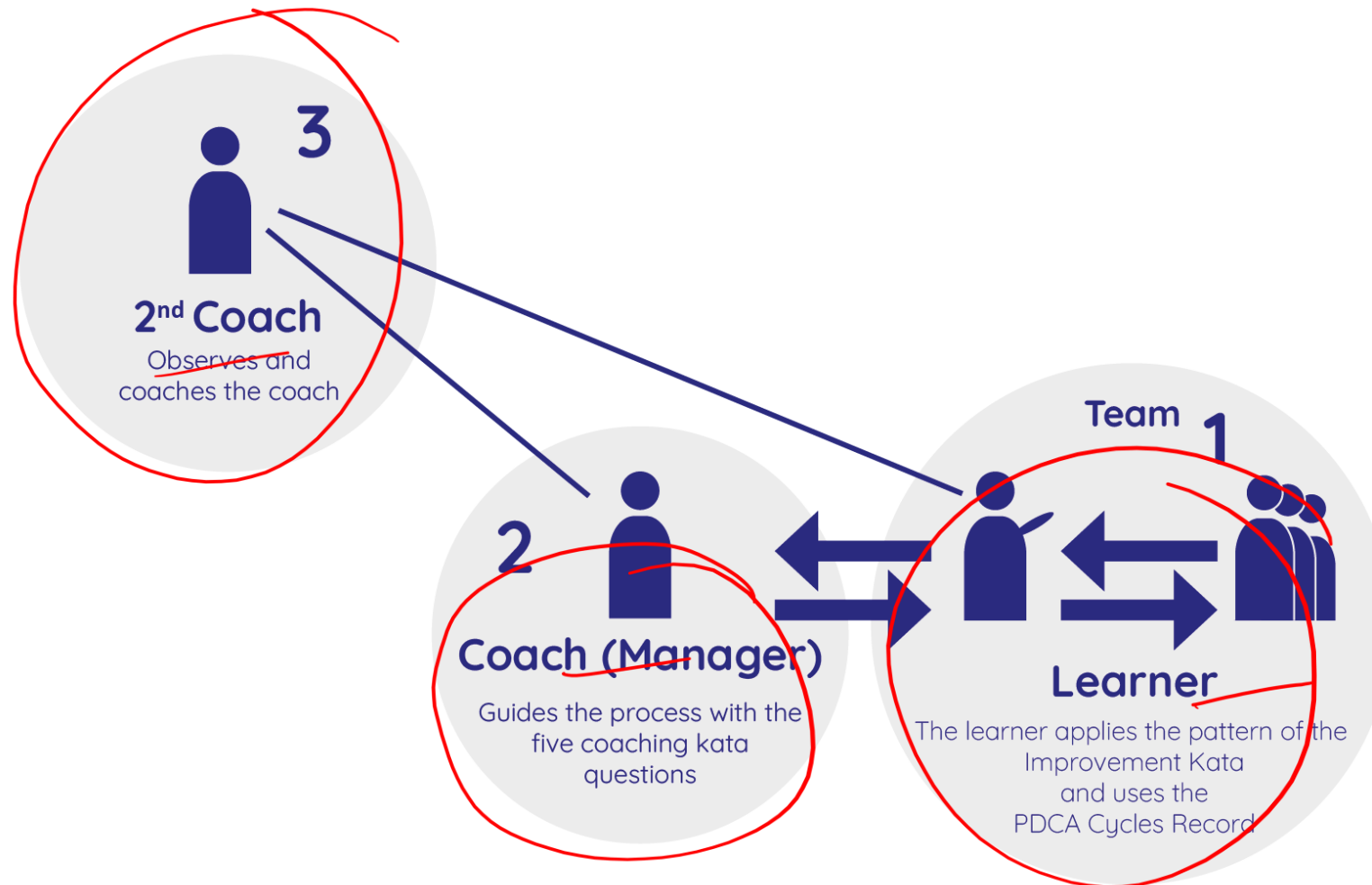


PDCA towards Future or Target State



COACHING AND INTERVISION

Coaching KATA



COACHING AND INTERVISION

Coaching KATA – The five questions

0. What is the challenge (ideal situation)?

1. What is the target condition? —

1a. How does this relate to the challenge? —

2. What is the current condition? (actual condition, state)?

3a. What are the obstacles from achieving your target condition? —

3b. Which one obstacle are you addressing now? —

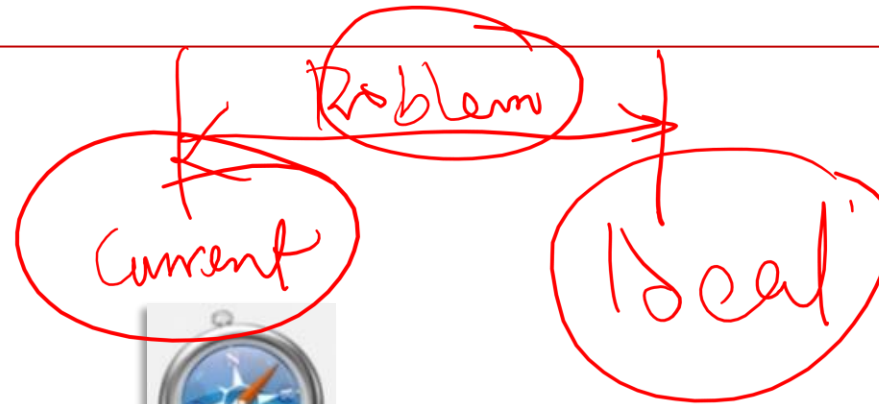
Reflect on your last step:

- What was your last step? —
- What did you expect? —
- What really happened? —
- What did you learn? —

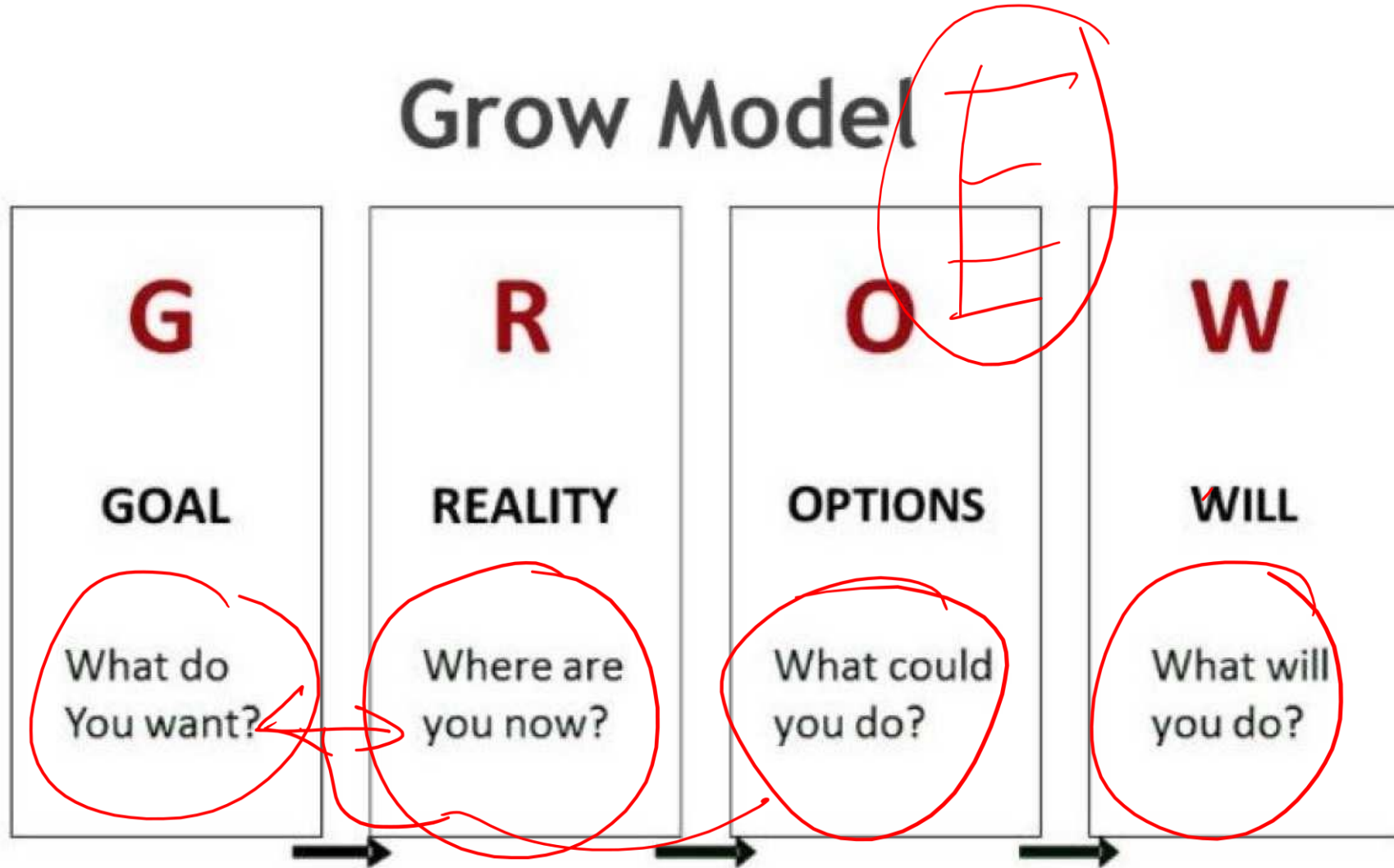
4. What will your next step be? (next PDCA cycle)

What do you expect to happen? —

5. When can we see what we have learned from this step? —



Grow Model



Goal: *what do you want?*

The end point: where the client/mentee wants to be

Agree topic for discussion

Agree specific outcomes

Set long-term aims

Reality: *where are you now?*

The current reality: where the client is now

Invite self assessment of client

Offer specific feedback

Examine assumptions

Opportunity: *what could you do?*

All of the options of as to how the client will progress

Invite suggestions from the client

Carefully offer suggestions

Ensure that some choices are made

Way Forward: *what will you do?*

Action steps which will take the client to their goal

Prepare a plan with specific steps and timings

Identify possible future obstacles and solutions

Agree support for throughout the process

A newly created development team has been working together for a few weeks. One of the team members has proposed a change to the way they work. However, the very experienced team leader rejected the proposal without having a team discussion. The other team members did protest, but it was a fruitless attempt, because their voices were not heard.

What stage of development is this team experiencing?

a) Forming

b) Storming

c) Norming

d) Performing

(Conflicts)

A company delivers groceries by bicycle. The formulated challenges for this year are 20% fewer accidents and a 10% increase in quality at the same cost per delivery. A manager acts as a coach to someone who works through the Toyota Kata to achieve the target condition 10% faster delivery.

What should this coach do, according to Toyota Kata?

- a) Ask what can be learned from achieving this target state X
- b) Ask what the next experiment is that this coachee will perform X
- c) Stop all activities around this target state X
- d) Ask the coachee why this target state contributes to the challenges to be achieved

↳ relates

A Green Belt is executing a process improvement project in an organization's finance department and identifies the urgent need for a new software license that ensures compliance to legislation. The project budget does not include funding for this additional requirement.

Which person is likely to have the authority to approve this additional funding?

- a) Champion
- b) Master Black Belt
- c) Black Belt
- d) IT specialist

Sponsor (money)

Please read the elements below.

1. Ensure all of the team are of the same understanding of what is expected ✓
2. Go to Gemba, define objectives and lead the team by example ✓
3. Set goals for the team that are SMART, and delegate responsibility ✓
4. Drive the team to perform to the edge of their capability ✗

Which are examples of how a team leader should motivate and improve the performance of the team?

- a) 1, 2, 3
- b) 1, 2, 4
- c) 1, 3, 4
- d) 2, 3, 4

A hotel is trying to improve its customers' experience to achieve its strategic objective of receiving more positive reviews on the internet.

1. Paying the service team higher rates for work undertaken during the more stressful evening periods ~~X~~ *H Recognition*
2. Reviewing the service given to identify where the service team have done more than required
3. Highlighting case studies in company newsletters where a member of the service team has been commended by a customer — *Recognition M*
4. Enabling the service team to contribute to reviewing and updating the standards which govern their work — *M*

Which are appropriate 'motivation' factors, as defined by Herzberg, to encourage the care team to help meet this objective?

- a) 1, 2, 3
- b) 1, 2, 4
- c) 1, 3, 4
- d) 2, 3, 4

— 10 — \$100
— 20 — \$150

(Note: The \$150 is circled in red, and there is a red arrow pointing to it from below.)

Please read the below.

1. Clash of personality ~~✓~~
2. Lack of relevant skills ✓
3. Poor attendance at team meetings ✓
4. Failure to progress sub-tasks ✓

Which are valid reasons to remove a team member from a team?

- a) 1, 2, 3
- b) 1, 2, 4
- c) 1, 3, 4
- d) 2, 3, 4

Which **BEST** describes a typical learning organization?

- a) The way of working is adjusted by reflection and evaluation ✓
- b) A learning organization gains knowledge by making plans for the future ✗
- c) Visible aspects of Continuous improvement are part of the organizational DNA ✗ ✓
- d) Individuals' learning is facilitated but NOT learning of the organization itself

Initiating – “WHAT”

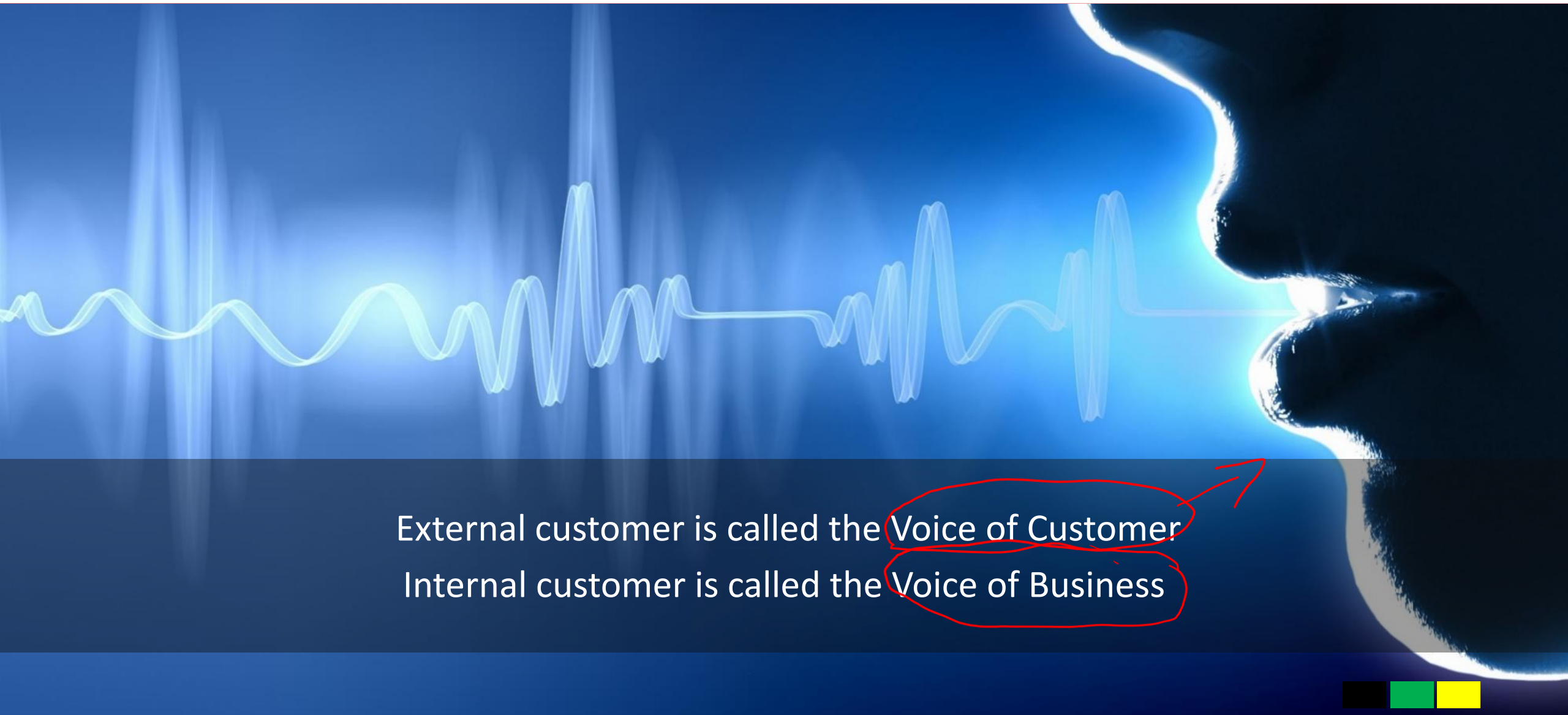
Example of Project Scope at Level 1

U1 – WORLD CLASS

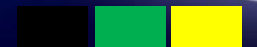
E2 – CUSTOMER VALUE (VOC & CTQ)



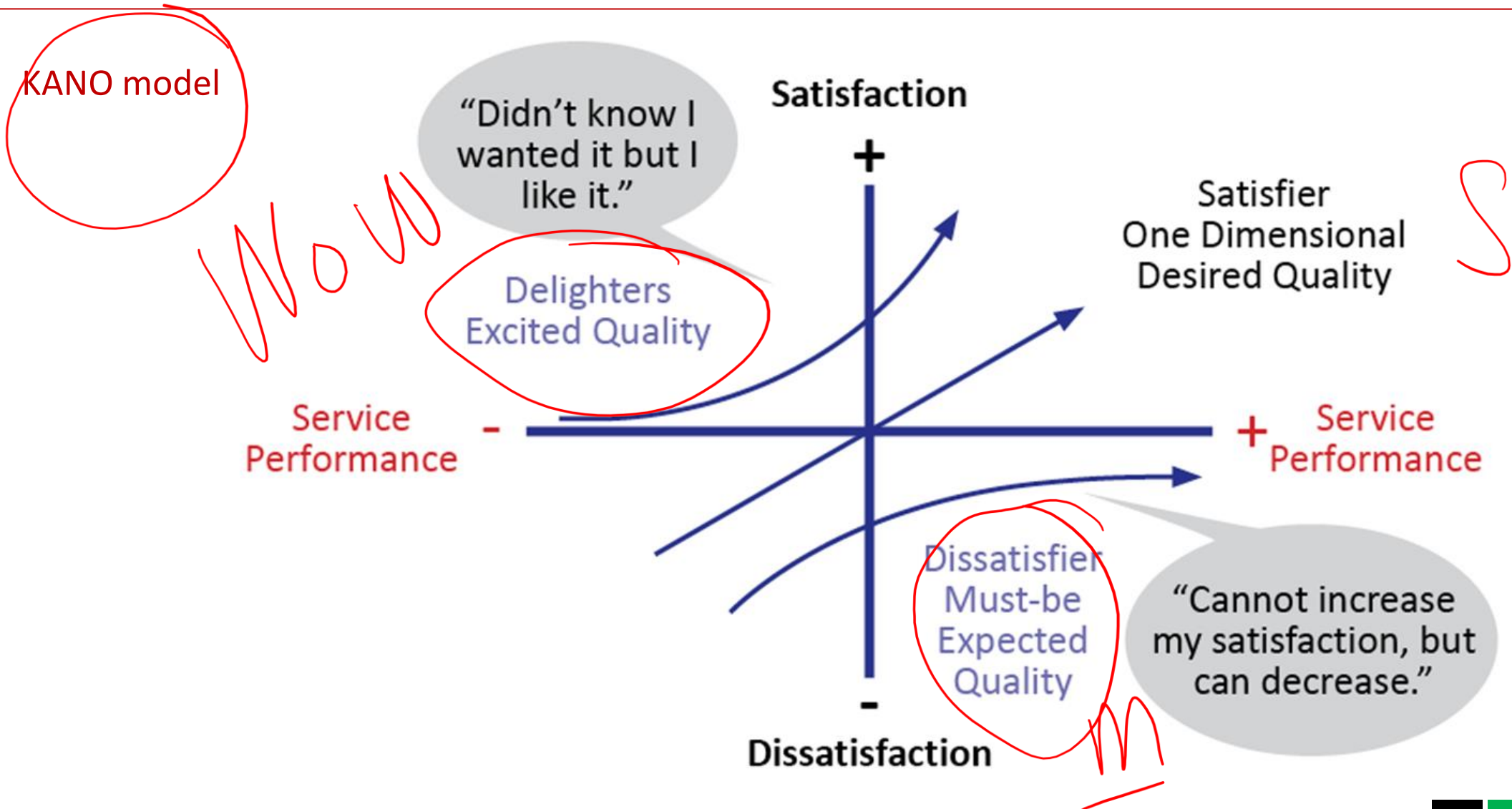
VOICE OF THE CUSTOMER (VOC)



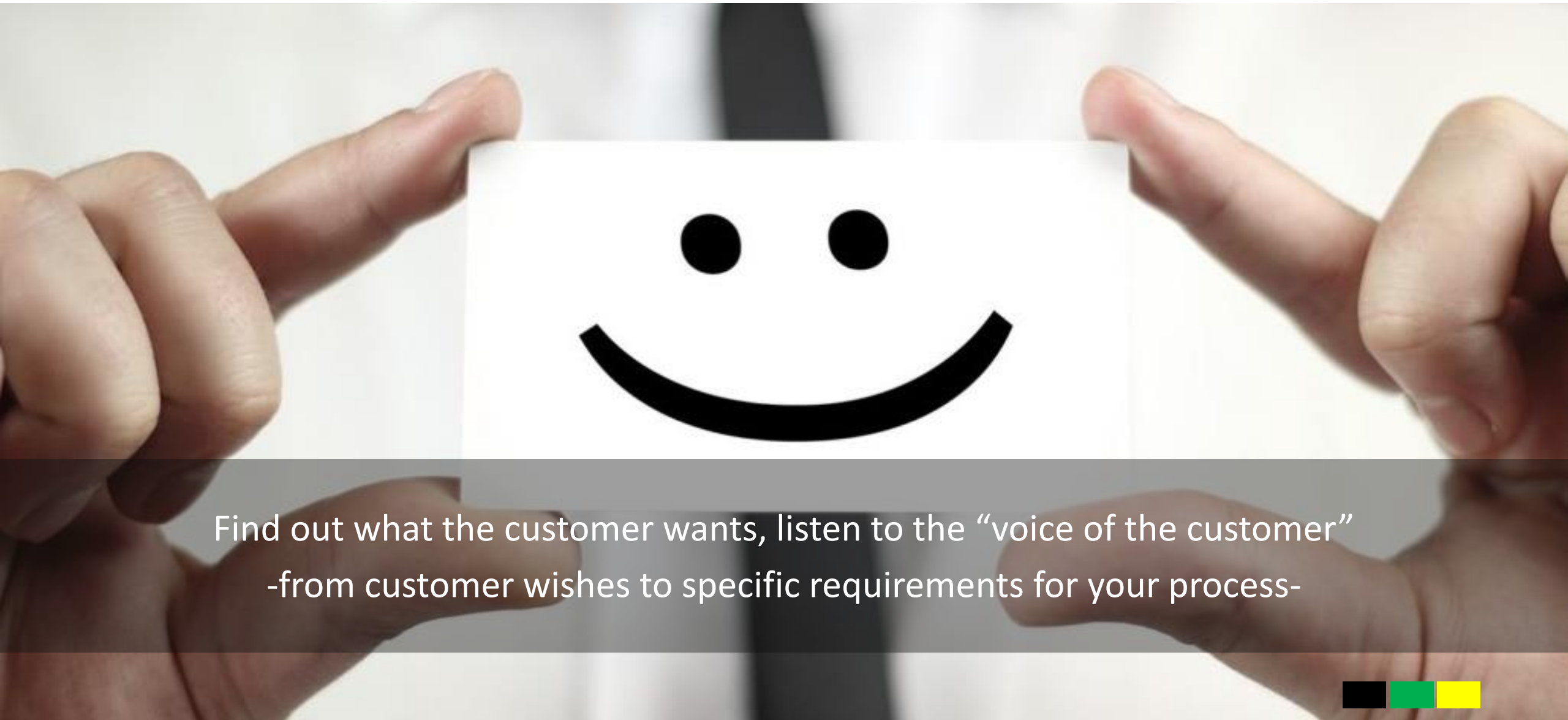
External customer is called the Voice of Customer
Internal customer is called the Voice of Business



VOICE OF THE CUSTOMER (VOC)



VOICE OF THE CUSTOMER (VOC)



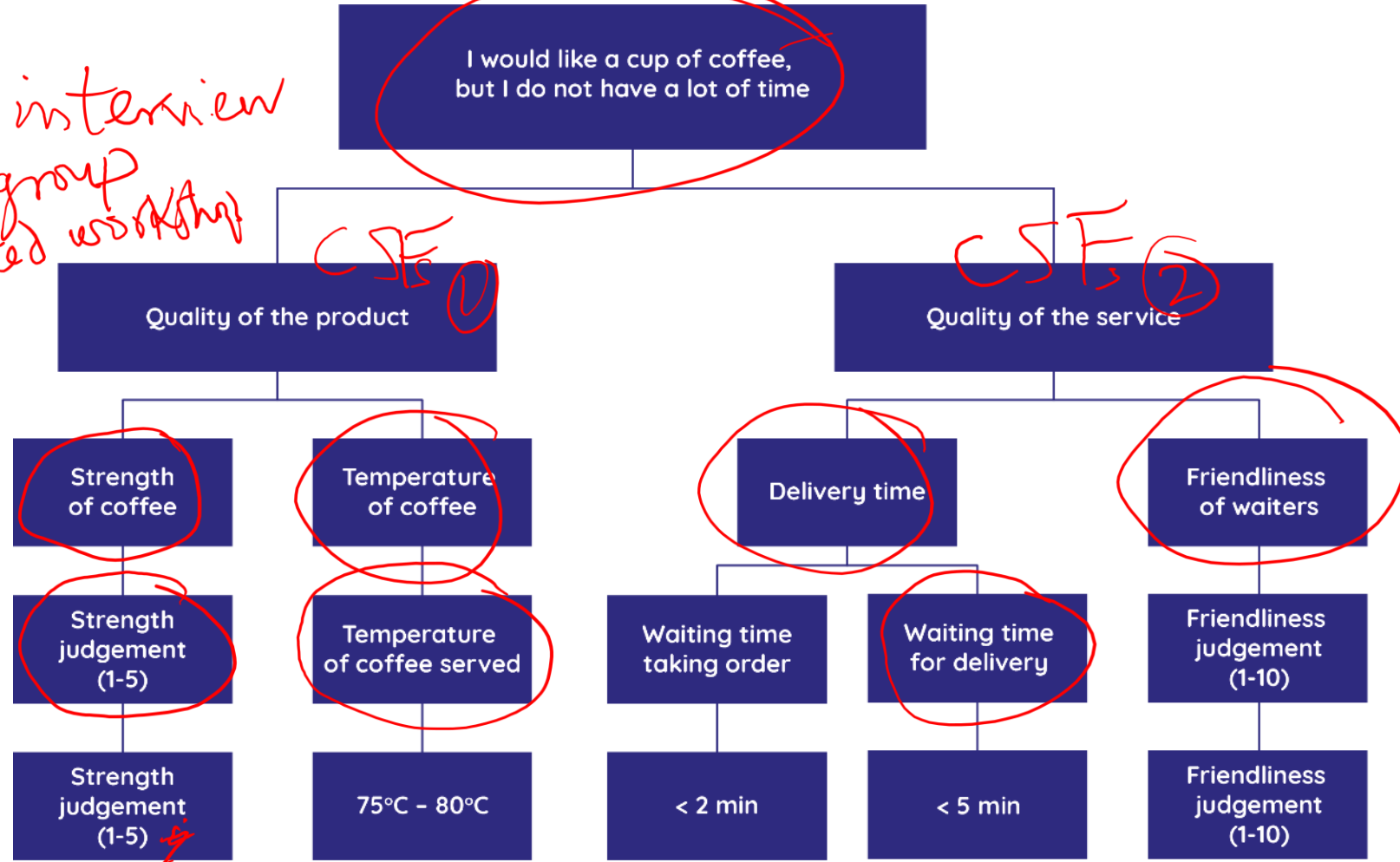
Find out what the customer wants, listen to the “voice of the customer”
-from customer wishes to specific requirements for your process-



CRITICAL TO QUALITY (CTQ)

CTQ Flowdown

- * 1-on-1 interview
- * Focus group
- * facilitated workshop
- * Survey
- * Observe
- * Research
- * Document
- * analysis
- * Prototype
- * Desk



- VOC use the wording of the customer ①
- VOC elements ②
- CTQ ext measures ③ KPIs
- CTQ int measures ④
- CTQ int specifications ⑤

MoSCoW Prioritisation

Must have = **Minimum **U**sable **S**ubse**T** (Guaranteed)**

With out this requirement ...
no point on this date or not legal or unsafe
or not a viable solution

Should have

Important but not vital
May be painful to leave out but solution still viable
May need workaround, which may be temporary

Could have

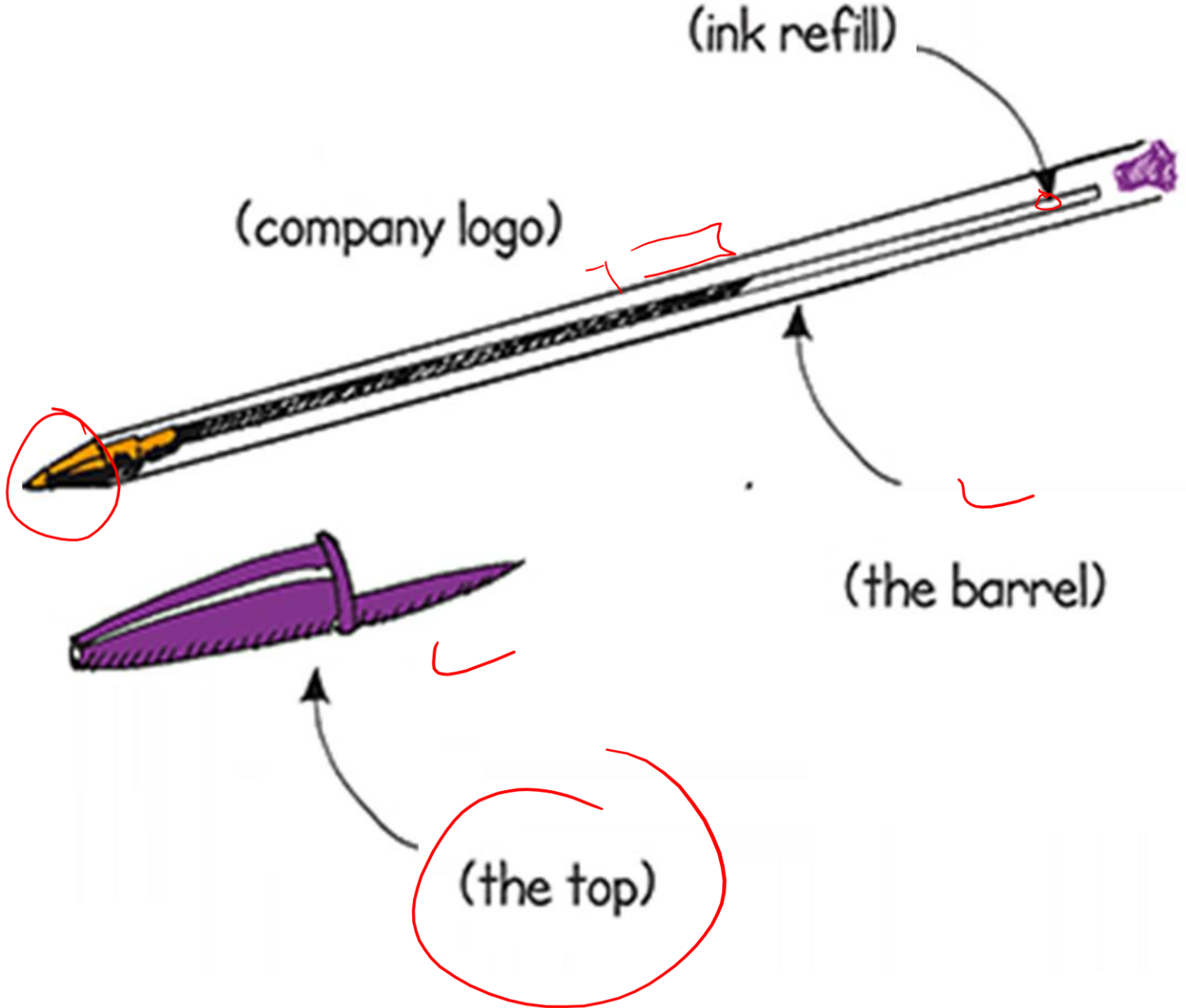
Wanted or desirable but less important
Less impact if left out (compared with a Should)

Wow

Won't have this time

out of scope

Will not be delivered in this timeframe



Requirements	Objective: To Write ①	Objective: To Create Awareness (Advert) ②
Ink Refill	m	m
Barrel	S	m
Top Cover	C	S
Bottom Cover	C	S/m
Logo	W	m

Initiating – “WHY”

Benefits, Costs and Risks



TYPES OF BENEFITS

Hard Benefits

- Tangible, measurable, financial impact
- Examples: cost savings, revenue growth, reduced headcount

Soft Benefits

- Intangible, qualitative improvements
- Examples: morale, customer satisfaction, reputation

Risk-Avoided Benefits

- Prevent future losses or penalties
- Examples: avoiding fines, downtime, data breaches

In short: Hard = measurable gains; Soft = intangible improvements; Risk avoided = losses prevented

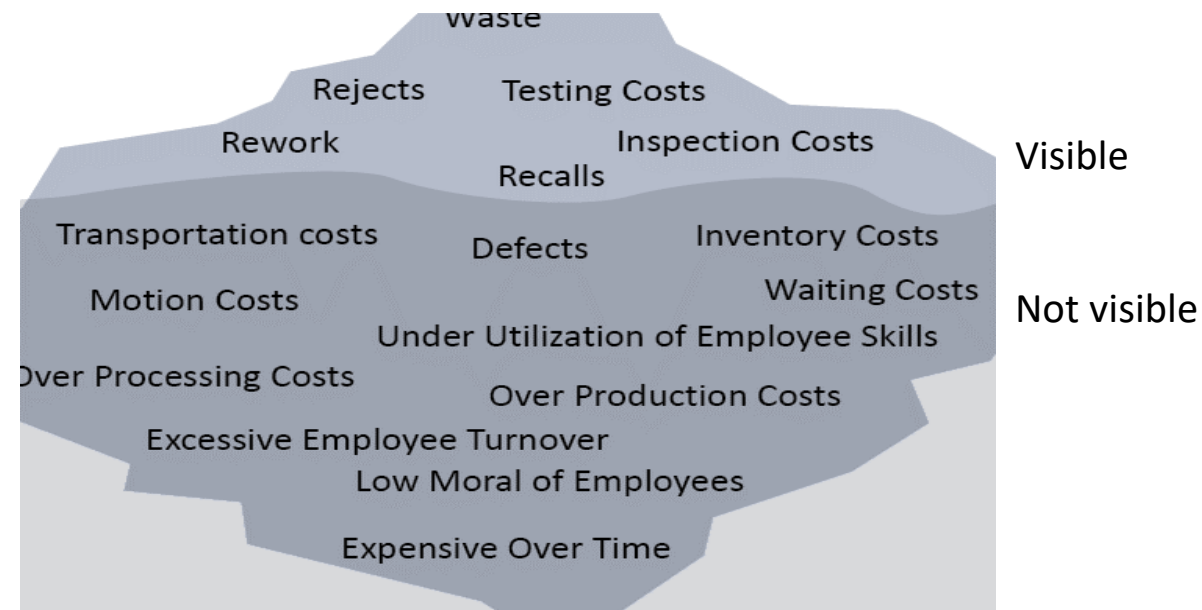
Quantitative

Qualitative

PERFORMANCE AND FINANCIAL METRICS

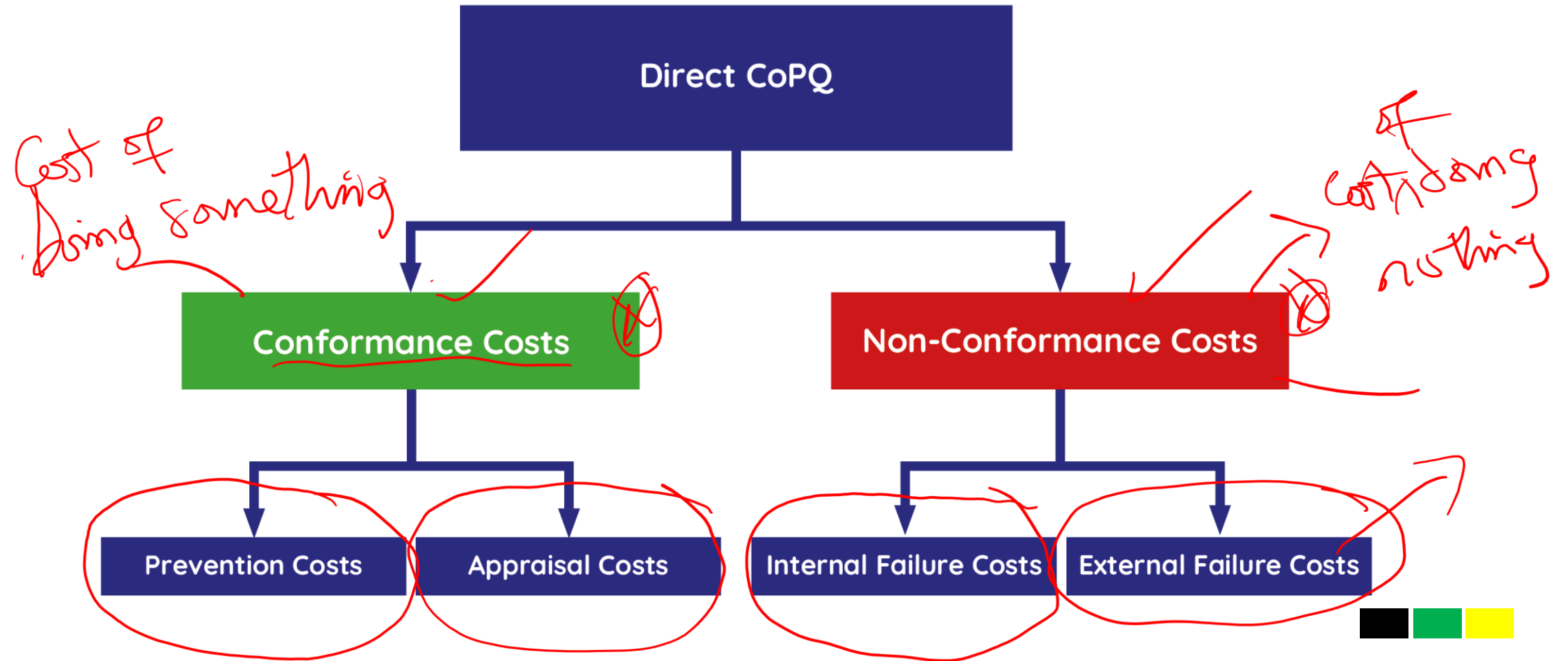
Cost of Poor Quality (Cost Iceberg)

- 1979 - Philip Crosby: "Money is the language of management."
- 1987 - Harrington: Cost of Poor Quality (COPQ).
- 1991 - Feigenbaum: Division of quality costs into preventive costs, inspection costs and failure costs.
- 1999 - Juran: "About a third of what we do consists of redoing work that has been done before."
- 2006 - Krishnan: Cost Iceberg.



PERFORMANCE AND FINANCIAL METRICS

Cost for prevention and failure



COST OF POOR QUALITY EXPLAINED

1. Conformance Costs (the cost of doing things right)

These are the investments a company makes to prevent defects and ensure quality. They include:

- Prevention Costs: Money spent to avoid problems in the first place (e.g., training, process improvement, quality planning).
- Appraisal Costs: Money spent to check and measure quality (e.g., inspections, testing, audits).

These are proactive costs—like paying for regular car maintenance so it doesn't break down later.

2. Non-Conformance Costs (the cost of doing things wrong)

These are the losses a company suffers when quality fails. They include:

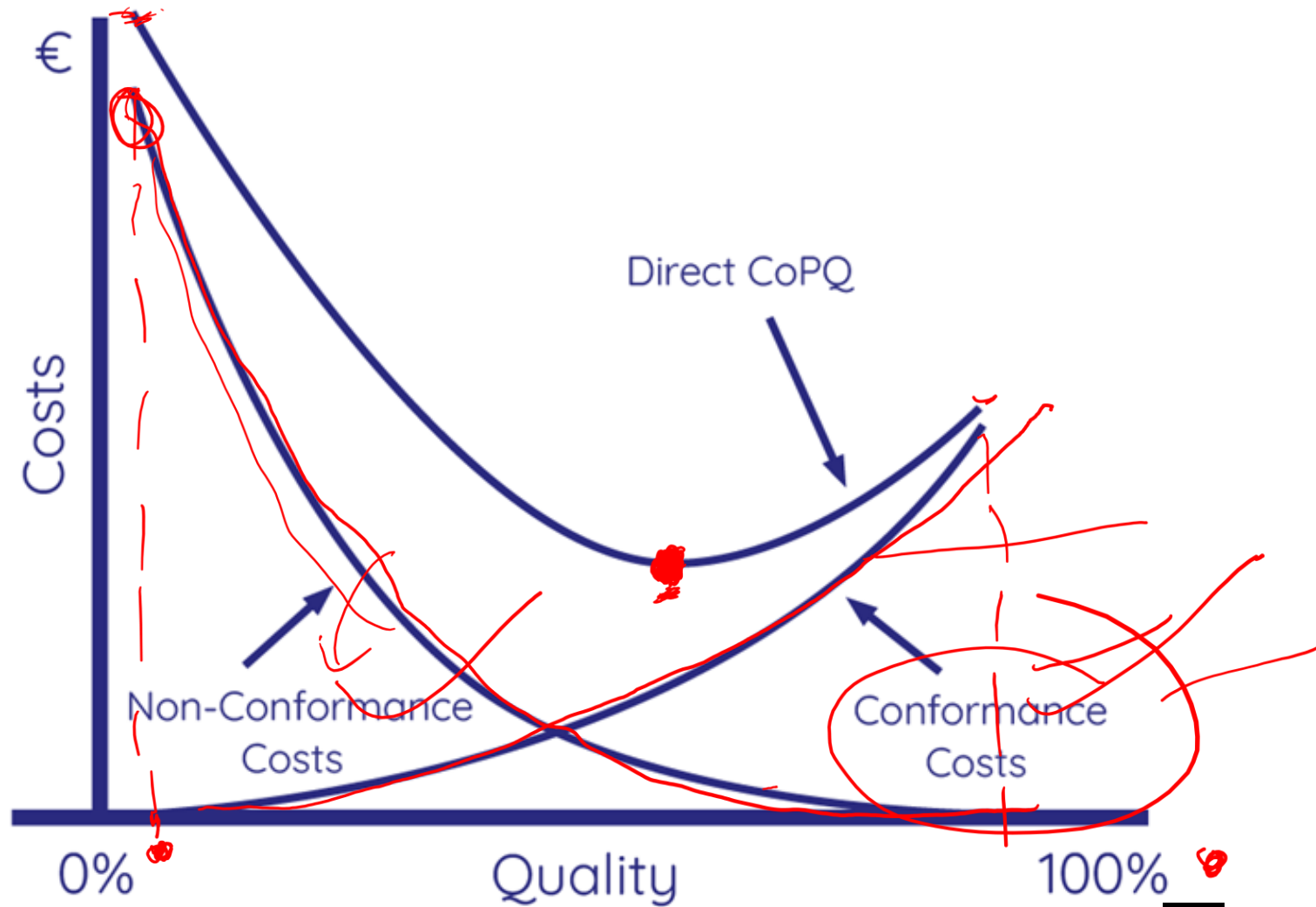
- Internal Failure Costs: Costs from defects found **before** the product reaches the customer (e.g., rework, scrap, downtime).
- External Failure Costs: Costs from defects found **after** the product reaches the customer (e.g., warranty claims, returns, lost reputation).

These are reactive costs—like paying for expensive repairs after your car breaks down.

PERFORMANCE AND FINANCIAL METRICS

Total Cost of Quality

- There is an optimum



PERFORMANCE AND FINANCIAL METRICS

1 – Investment decision: Payback period

- Investment € 200.000,-
- Earnings/year € 40.000,-
- Pro: simple.
- Con: does not measure total returns.
does not measure monetary value (interest aspect).

The lower, the better

$$\text{Payback period} = \frac{\text{Investment}}{\text{Earnings}} = \frac{\text{€ 200.000}}{\text{€ 40.000 p. yr.}} = 5 \text{ year}$$

$$\frac{200.000}{100.000} = 2 \text{ years}$$



PERFORMANCE AND FINANCIAL METRICS

2 – Investment decision: Return On Investment (ROI)

- Return on investment (ROI) or return on costs (ROC) is a ratio between net income (over a period) and investment (costs resulting from an investment of some resources at a point in time).

the higher, the better

$$ROI = \frac{\text{Revenue}}{\text{Investment}} \times 100\% = \frac{€ 40.000}{€ 200.000} \times 100\% = 20\%$$

$$\frac{240,000 - 200,000}{200,000} = \frac{40,000}{200,000}$$



360 / \$
 March 2020, given \$2M

3 – Investment decision: Net Present Value (NPV)

- Discount future cash flows to today.
- Actuarial interest depends on the risk profile of the company and industry.
- Compare to current investment.
- Advantage: takes into account the present value of the capital in the future.

To get £6M in March 2025
 £1600 / \$

~~360~~ → x
~~1600~~ = 6M

$$NPV(i, N) = \sum_{t=0}^N \frac{R_t}{(1+i)^t}$$

t: Time period of the cash flow
 i: Discount rate
 R_t: Netto Cash flow (Cash inflow – Cash outflow)

6 x 360 = 1600
 x = $\frac{6 \times 360}{1600} = 1.35$

PERFORMANCE AND FINANCIAL METRICS

4 – Inventory Turnover Ratio (ITR)

- number of times the inventory is sold or used in a given period.
- metric indicates how effectively a company's inventory is managed, by dividing the Costs of Goods Sold by the Average Inventory for a specified period
- Example:

$$ITR = \frac{\text{Costs of Goods sold}}{\text{Average Inventory}} = \frac{\$ 385.3 \text{ billion}}{\$ 44.3 \text{ billion}} = 8.7$$

- Its days inventory equal :

$$\frac{1}{8.7} \times 365 = 42 \text{ days}$$

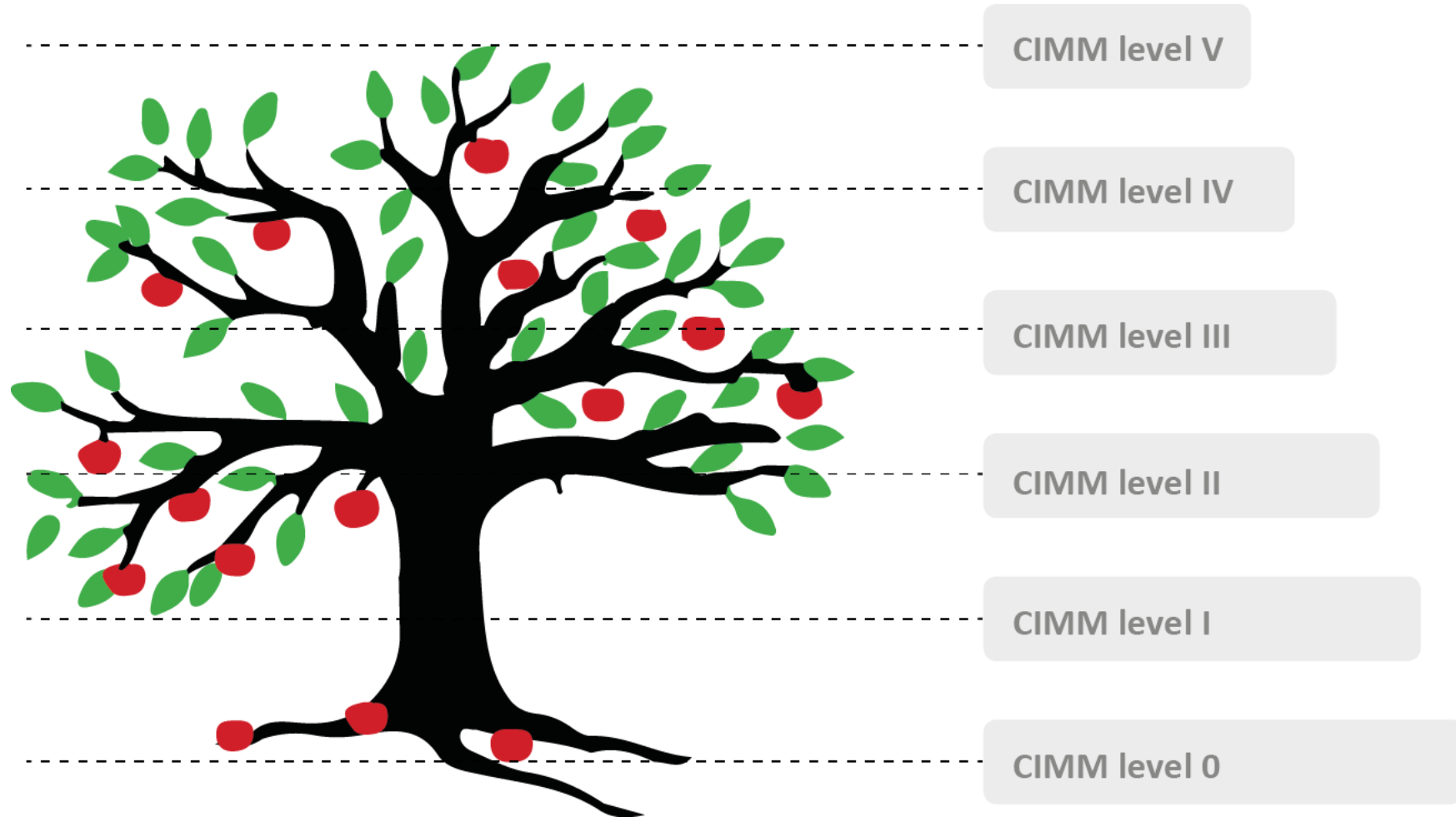


MANAGEMENT OF CHANGE

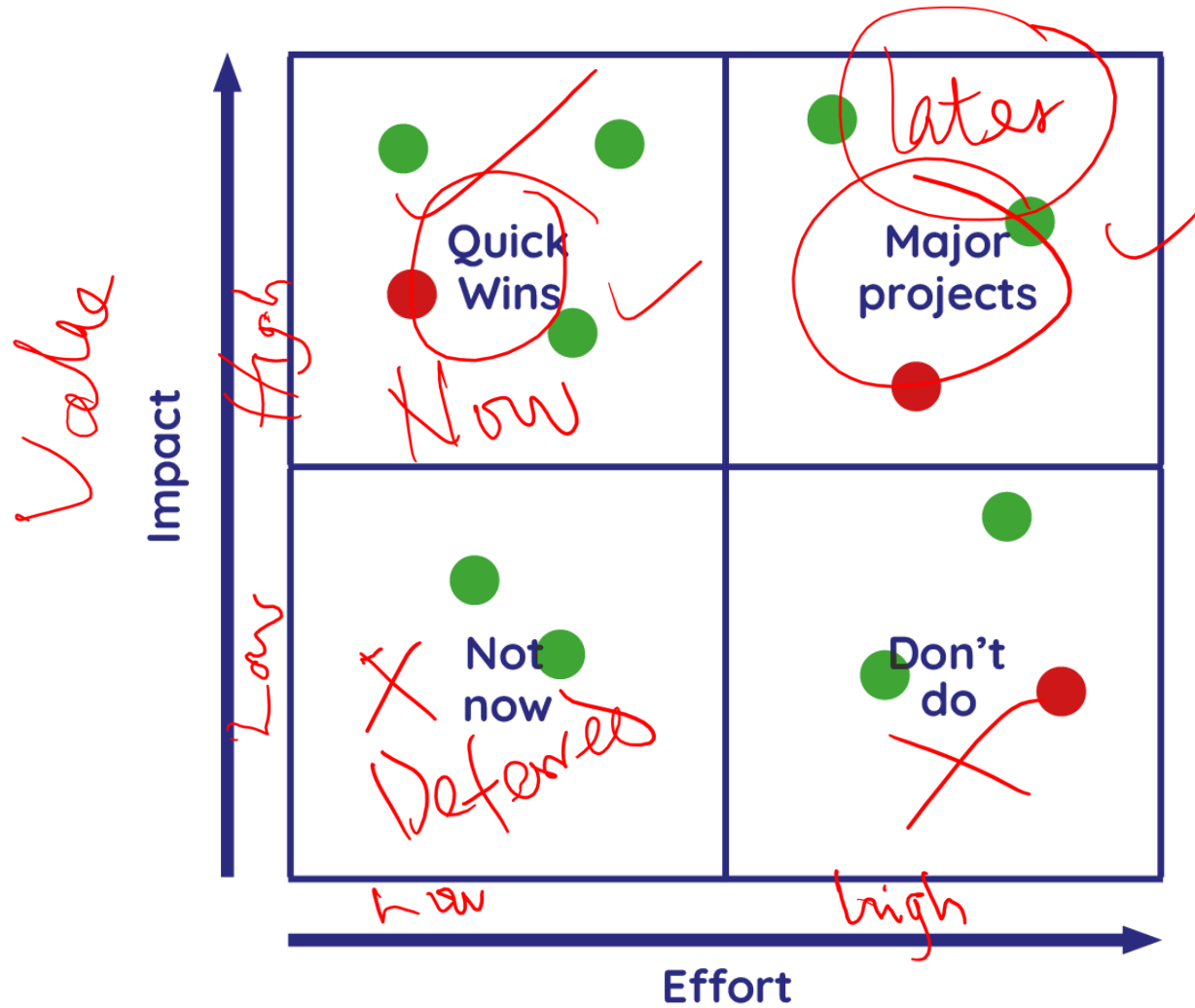
Define opportunities and risks



PROJECT SELECTION



PROJECT SELECTION



U3 – PROJECT MANAGEMENT

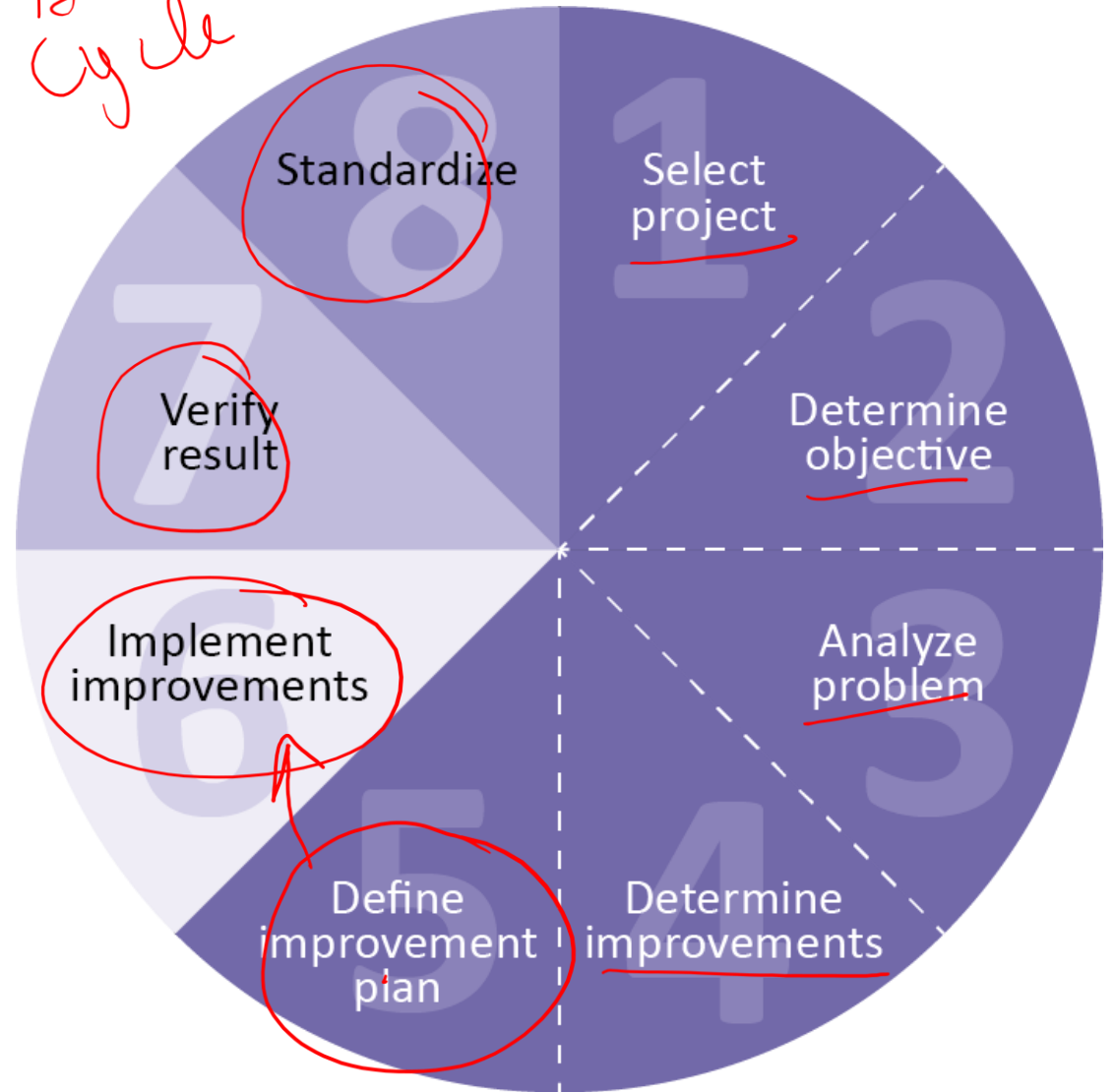
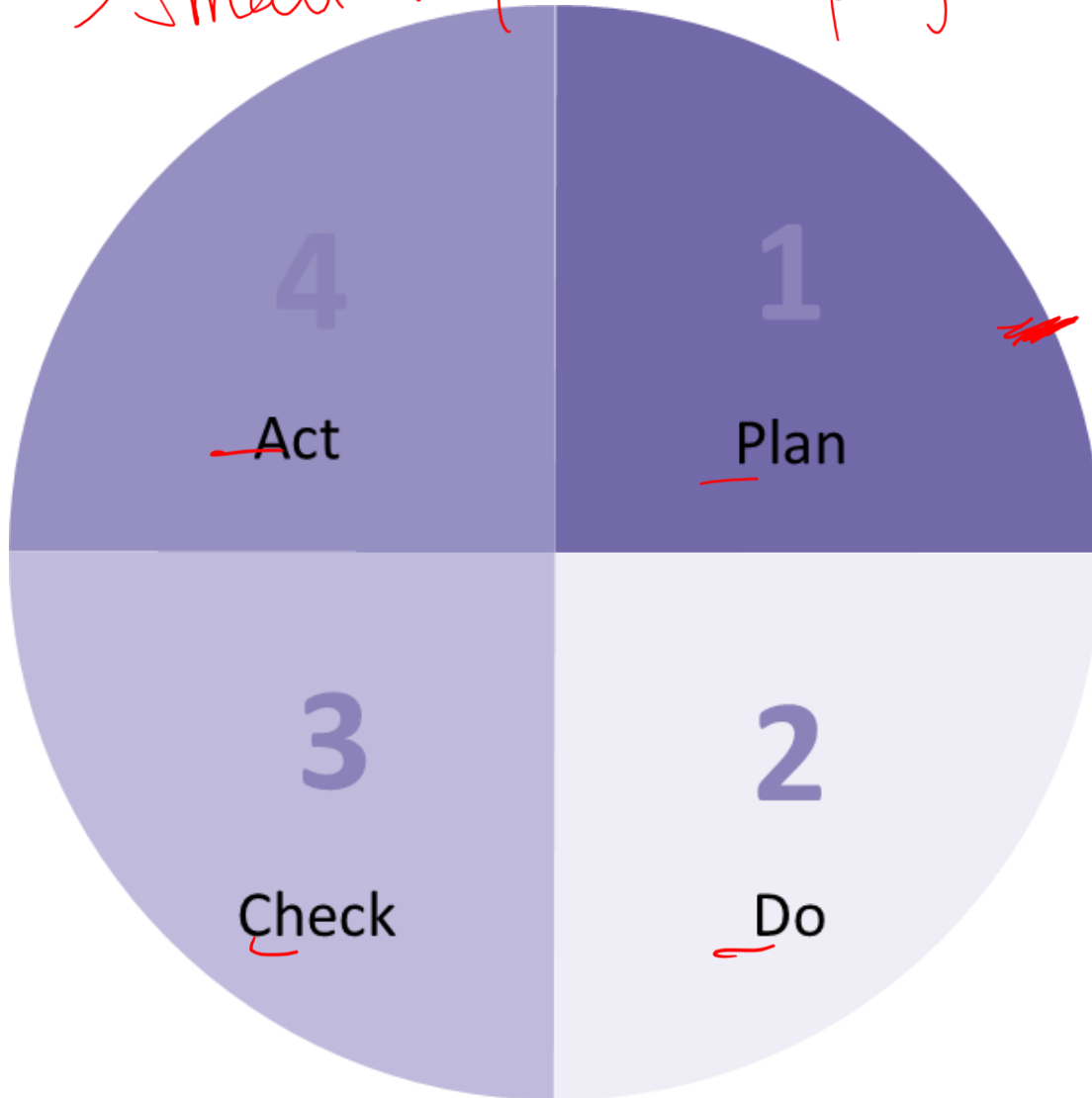
E2 – PROCESS IMPROVEMENT ROADMAPS



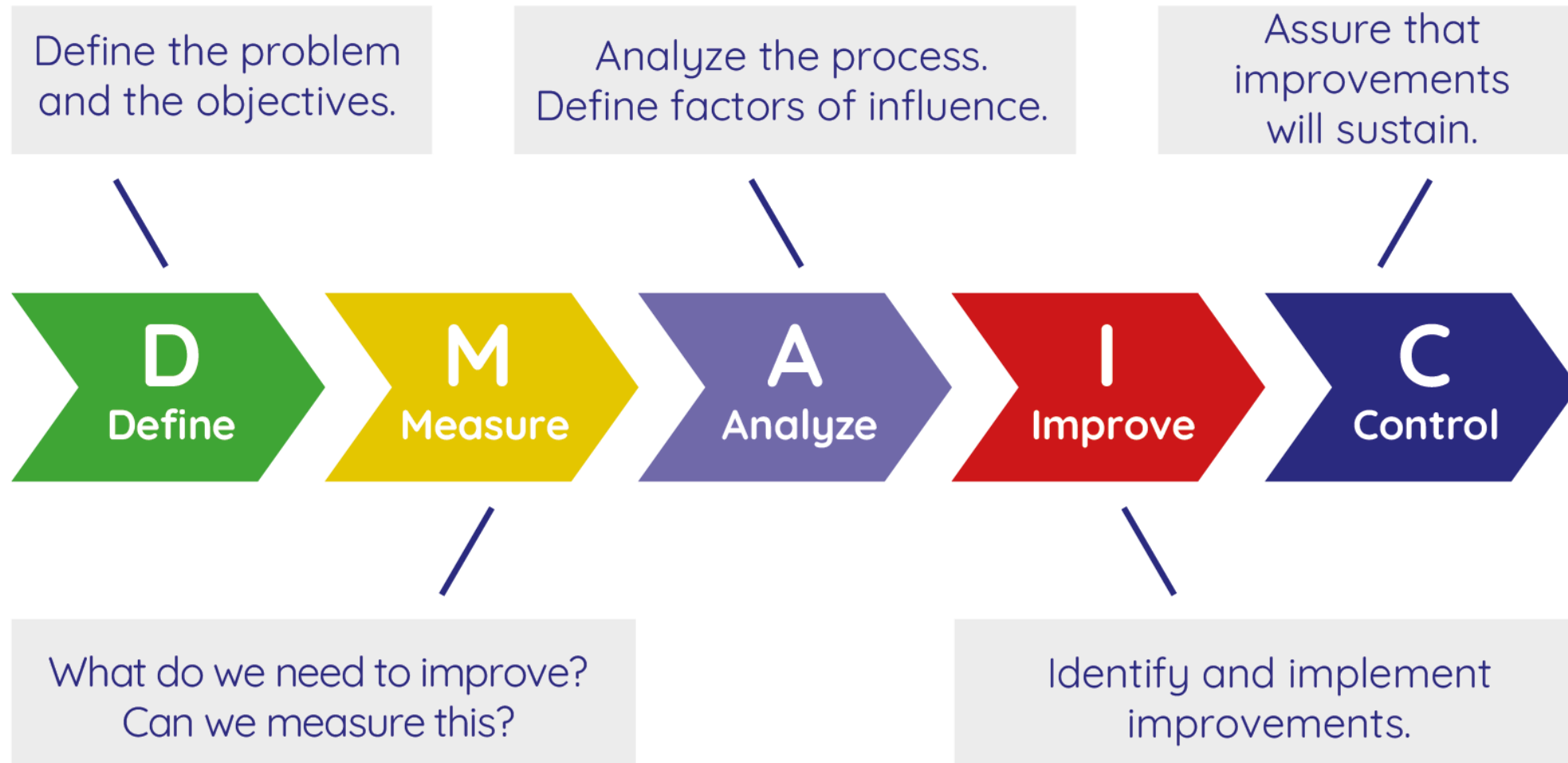
KAIZEN ROADMAP (PDCA)

Small improvement projects

Demming cycle



LEAN SIX SIGMA ROADMAP (DMAIC)



D DEFINE

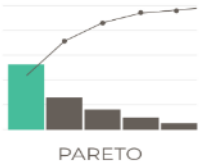
DEFINE AND SCOPE PROJECT
 DEFINE DEFECT AND CTQ'S
 PLAN AND DOCUMENT PROJECT



VOICE OF CUSTOMER



PROJECT CHARTER



S		I		P		O		C	
Suppliers	Inputs	Space	Type	Process	Outputs	Space	Customers		
What are the requirements of the customer?	What does the customer want to buy?	What are the physical requirements of the product?	START	What are the resources needed for the process?	What are the physical characteristics of the product?	What are the physical characteristics of the product?	Who are the customers of the product?		
			PROCESS						
			END						
Step 1	Step 2	Step 3	Step 4	Step 5					

M MEASURE

EVALUATE MEASUREMENT SYSTEM
 ESTABLISH BASELINE
 SET IMPROVEMENT GOALS



TAK TIME
 VS
 CYCLE TIME

$$OEE = \frac{B}{A} \times \frac{D}{C} \times \frac{F}{E}$$

AVAILABILITY RATE PERFORMANCE RATE QUALITY RATE



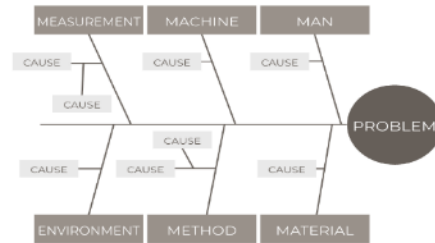
A ANALYZE

MAP PROCESS AND IDENTIFY INPUTS
 ISOLATE KEY INPUTS
 DEVELOP Y=F(X) FUNCTION



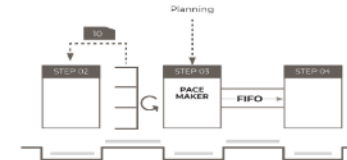
VSM CURRENT STATE

1. OVER PRODUCTION
2. WAITING
3. TRANSPORT
4. OVER PROCESSING
5. INVENTORY
6. MOVEMENT
7. DEFECTS
8. UNUSED EXPERTISE

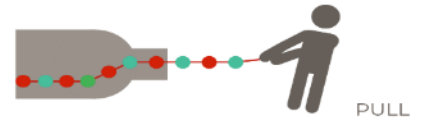


I IMPROVE

DETERMINE OPTIMUM SETTINGS
 IMPLEMENT PROPOSED IMPROVEMENT
 VALIDATE PROPOSED IMPROVEMENT



VSM FUTURE STATE

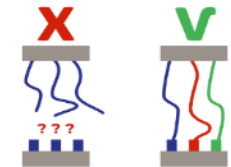


C CONTROL

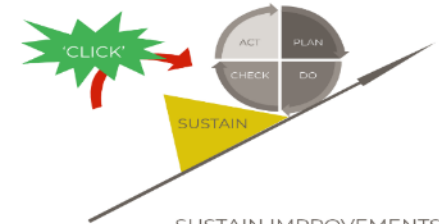
IMPLEMENT CONTROL STRATEGY
 CLOSE OUT PROJECT
 CELEBRATE RESULTS



FIRST TIME RIGHT



POKA YOKE



CONTROL PLAN/
 CHECKLIST

LESSONS
 LEARNED



CELEBRATE RESULTS

D DEFINE

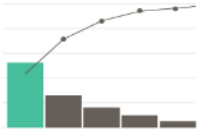
DEFINE AND SCOPE PROJECT
DEFINE DEFECT AND CTQ'S
PLAN AND DOCUMENT PROJECT



VOICE OF CUSTOMER



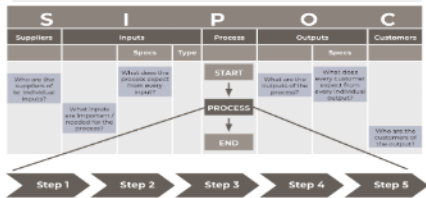
PROJECT CHARTER



PARETO



HARD AND SOFT BENEFITS

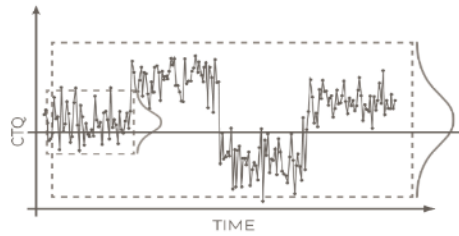


M MEASURE

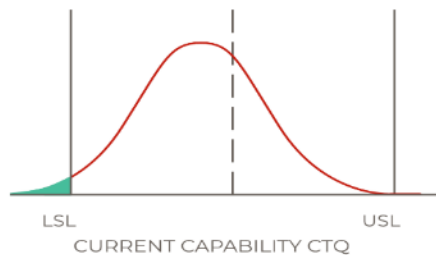
EVALUATE MEASUREMENT SYSTEM
ESTABLISH BASELINE
SET IMPROVEMENT GOALS



MEASUREMENT SYSTEM ANALYSIS



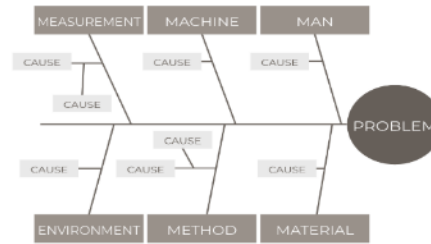
CTQ OVER TIME



CURRENT CAPABILITY CTQ

A ANALYZE

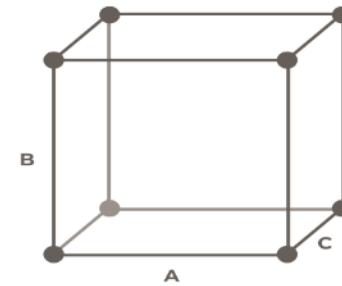
MAP PROCESS AND IDENTIFY INPUTS
ISOLATE KEY INPUTS
DEVELOP Y=F(X) FUNCTION



Y DATA	X DATA	
	DISCRETE	CONTINUOUS
DISCRETE	CROSS TABULATION & CHI-SQUARE	LOGISTIC REGRESSION
CONTINUOUS	HYPOTHESIS TESTING & ANOVA	CORRELATION & REGRESSION

I IMPROVE

DETERMINE OPTIMUM SETTINGS
IMPLEMENT PROPOSED IMPROVEMENT
VALIDATE PROPOSED IMPROVEMENT



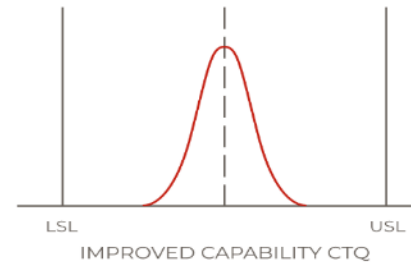
EXPERIMENT



OPTIMIZE



IMPLEMENT



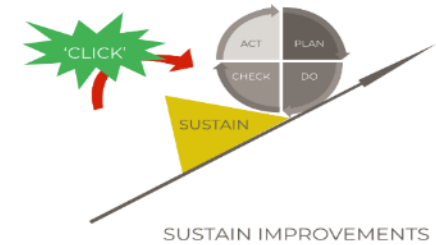
IMPROVED CAPABILITY CTQ

C CONTROL

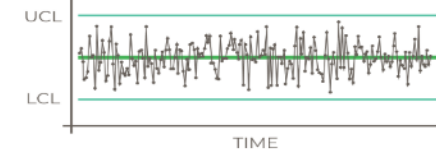
IMPLEMENT CONTROL STRATEGY
CLOSE OUT PROJECT
CELEBRATE RESULTS



FIRST TIME RIGHT



SUSTAIN IMPROVEMENTS



STATISTICAL PROCESS CONTROL (SPC)

LESSONS LEARNED



CELEBRATE RESULTS

PROBLEM SOLVING ROADMAP (8D)

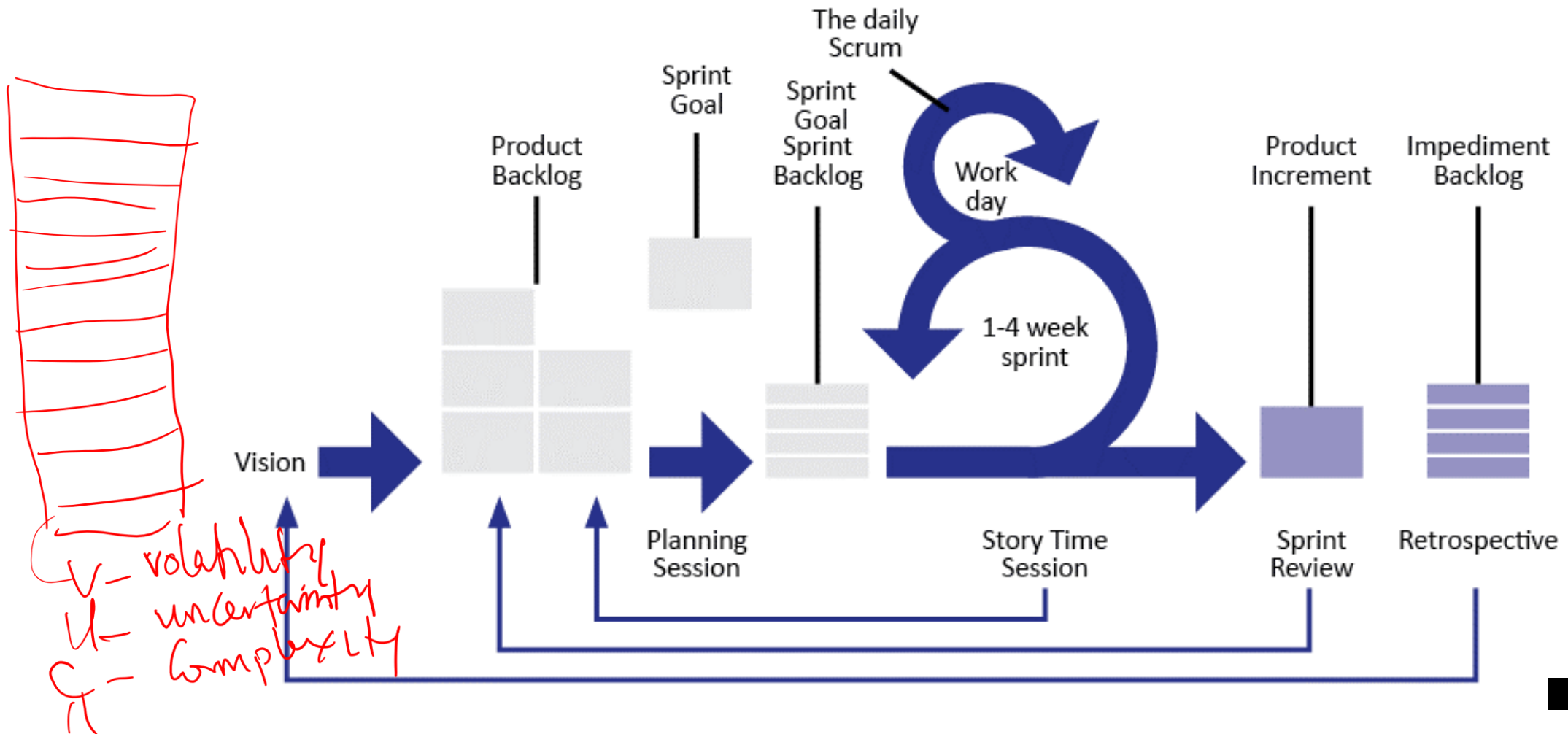
Roadmap for problem solving and customer complaints

Step	Description
D0	Emergency Response Actions (ERA)
D1	Establish a team
D2	Define and describe the problem
D3	Temporarily contain the problem (Interim Containment Actions; ICA)
D4	Find the root cause
D5	Identify the “Permanent Corrective Actions (PCA)”
D6	Implement & validate the PCA
D7	Prevent Recurrence
D8	Congratulate your team



SCRUM

Roadmap for Agile project management



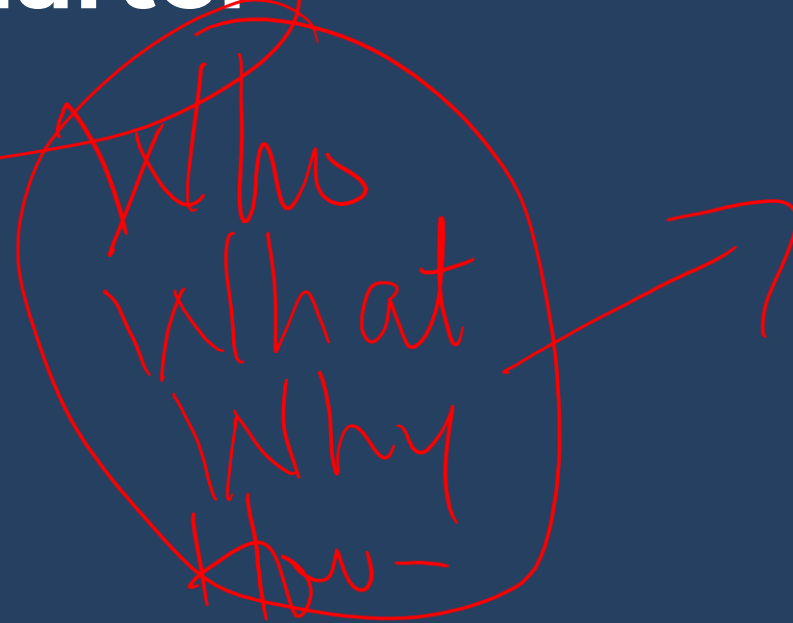
U3 – PROJECT MANAGEMENT

E1 – MANAGING A PROJECT



Initiating – Summary

Project Charter



PROBLEM STATEMENT

Filling in the Header:

- Business Unit or Division
- Name of Project Leader
- Sort of project
- Project title and number

Handwritten notes in red: WHAT / WHERE, WHO, WHAT, WHAT

Filling in Problem Description:

- Explain why this specific project is being executed
- Product / Process, which is the focus?
- Who is the most important customer?

Handwritten notes in red: WHY, WHO, WHAT

Calculate Initial Benefits:

- Determine hard benefits?
- Estimate required budget
- Net saving = profits - budget
- Describe soft benefits

Handwritten notes in red: WHY, WHY, WHY, WHY

Filling in Footer:

- Is there an interface with other projects?
- Fill in start and end date

Handwritten notes in red: WHAT, WHAT

Project Charter		
Business unit: Department	Project Leader: Name of project leader	Belt level / Method: GB/BB & DMAIC/DMADV
Project title: Short name of the project	Project Number: Project number assigned	
Problem Statement: Short description of the problem / Reason for the project		
Product / Service: What is delivered?		
Process: Operational process		Customer: Who receives the product?
Hard Benefits: Direct bottom-line savings <input type="checkbox"/> Benefit Enabler <input type="checkbox"/> Benefit Realisation		
Hard Benefits /yr: Direct Monetary savings	Budget: Estimated investment costs	Net Savings /yr: Savings minus Costs
Soft Benefits: Risk avoidance and Nonmonetary benefits		
Interface with other projects: Is the project part of another project? Will the project impact another device or customer?		
Start Date: Date the team will start	Target Completion Date: Completion of Control / Verify	Actual Closure Date: Release of team

Handwritten note in red: PMO (circled)

PROBLEM STATEMENT

VOC & VOB:

- VOC: benefits for the customer
- VOB: benefits for the organisation

(WHAT)

Goal Statement:

- Objective: Goals
- Target : the quantified objective

WHAT

Project Scope:

- In-Scope: What is in scope?
- Out-Scope: What is out of scope?

WHAT

Deliverables:

- What are the deliverables of the project?
- How to choose / measure these deliverables?

WHAT

Risk Assessment:

- What potential risks can occur?
- How to mitigate these risks?

WHY

Project Planning:

- What are the milestones and end date?

(1.5-1m)

Project Charter	
Benefit description: VOB: Benefit for the Business?	VOC: Benefit for the Customer?
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
Goal Statement: What are the improvement objectives?	What are the targets / How are these measured?
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
Project Scope: What is in scope?	What is out of scope?
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
Characteristics to be improved: What is the main CTQ to improve?	How is it measured?
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
Project deliverables: Products, documents and photos that are delivered	Type of deliverable
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
Main Risks: What are the project main risks?	What is the mitigation plan?
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
Project Planning: Milestone?	Completion date of deliverable:
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>

PROJECT CHARTER

Template DMAIC practical project

Problem Description:	
----------------------	--

Objectives:	
-------------	--



PROJECT CHARTER

Template DMAIC practical project

Target:	
In Scope:	
Out of Scope:	
Deliverables:	
Hard Benefits:	
Soft Benefits:	
Risk Assessment:	

SPECIFIC
MEAASUREABLE
ATTAINABLE
RELEVANT
TIMELY



NET PROMOTER SCORE (NPS)

- Detractors: score of 0 to 6; the 'not-satisfied customer'
- Passives: score of 7 or 8; the 'satisfied customer'
- Promoters: score of 9 or 10; the 'loyal customer'



+10%

Handwritten calculation:
 100
 - 40 = 1-6 ~~ve~~
 - 30 = 7-8
 30 = 9-10 +ve

-40 + 30 = -10

-10 x 100%
 100 = -10%

$$\text{Net Promoter Score} = \frac{\text{Number of Promoters}}{\text{Total respondents}} \times 100 - \frac{\text{Number of Detractors}}{\text{Total respondents}} \times 100$$

Frederick Herzberg: Two-factor motivation theory.

Hygiene factors

Motivation factors

Doesn't lead to job satisfaction and motivating but if absent, can demotivate

If present, will lead to satisfaction and motivation and if absent, will not necessarily lead to demotivation





Planning – Project Schedule



Problem

- 28 June 50k
- 10 delivery
- **Problem:** During 2016, 20% of overseas customer payment took longer than the agreed invoice terms. This resulted in an average outstanding debt of £357k, at a 5% cost of capital
 - **Goal:** Reduce the percentage of overseas customer payments that take longer than agreed invoice terms from 20% to 5%, by the end of quarter 4, 2017

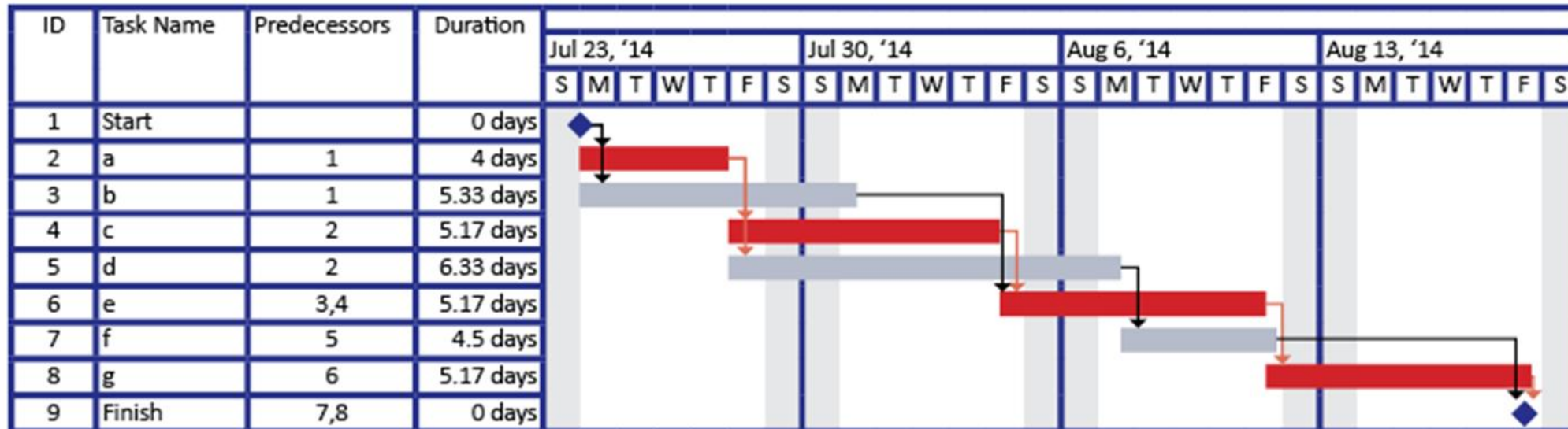
- **Problem:** From Oct 2016 to March 2017, 5% of Product A manufactured on production line 1 failed the final test. This resulted in an extra inspection/rework process being implemented (at a cost of £25,000 per month), and a scrap rate of 2% costing £20k per month in lost revenue
- **Goal:** Reduce the Product A final test failure rate on production line 1 from 5% to 2% by the end of October 2017

- Agree the work breakdown structure (deliverable)
- Agree the project product description and acceptance criteria
- Plan the schedule (Mr Project)
- * Updated TSC, policies
- * Updated notification process
- * Updated product page
- * Update communication
- * Assessment report -
- * Payment platform upgrade

PROJECT PLANNING

Time management (Gantt chart)

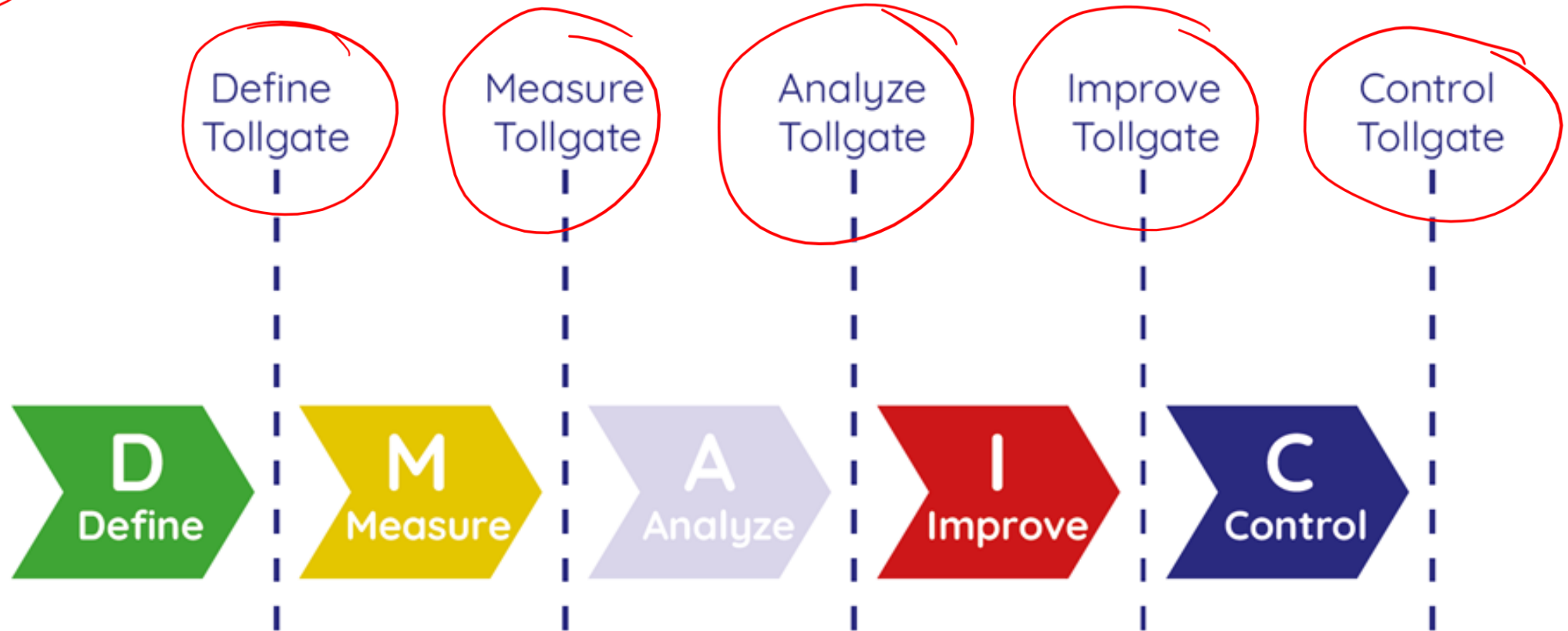
- Determine project objectives in results, products, timing and responsibilities
 - What What should happen? ✓
 - When When should it be ready? ✓
 - Who Who is responsible / who will do it? ✓



Implementation

PROJECT EXECUTION

DMAIC Tollgate reviews



Closing

- Deliver Deliverables
- Learn Lessons

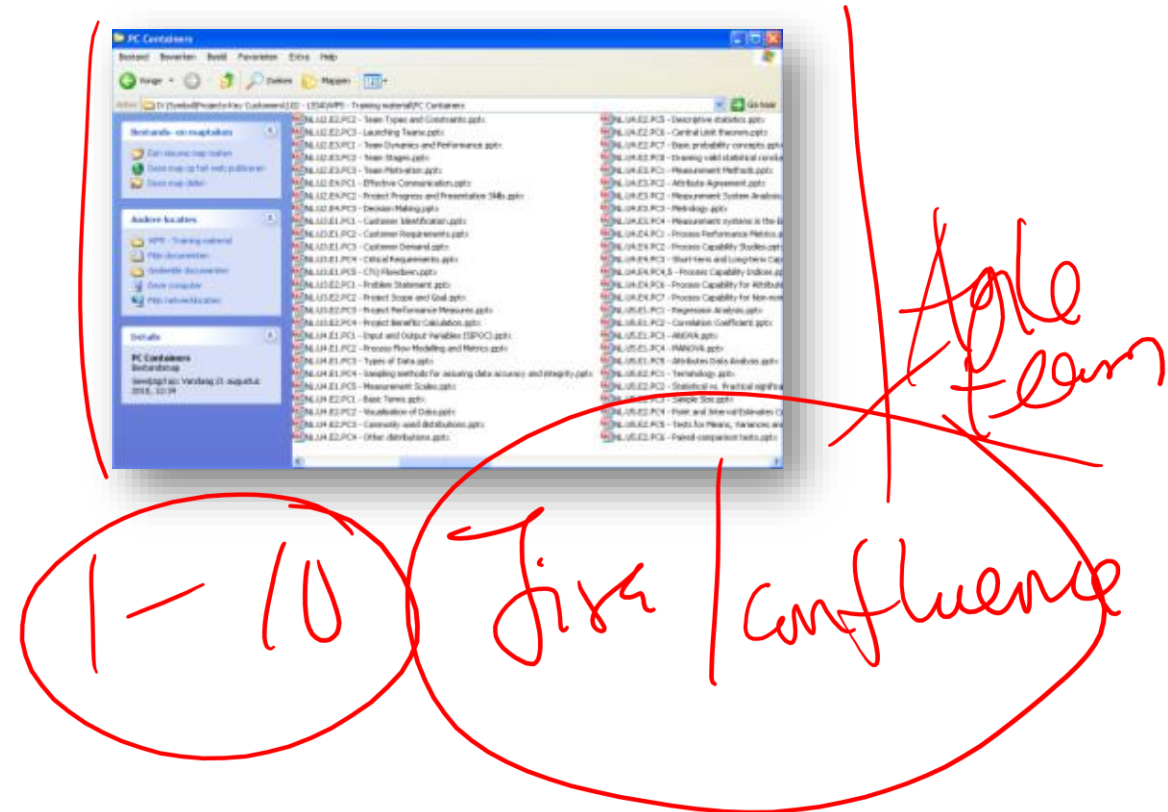
WHAT CAN WE DO BETTER NEXT TIME?

Source: IBM Amsterdam

Question:	Answer
What aspect of the project would you change if doing it over again?	
What have you learned about the methodology that you didn't already know?	
What were the 'ah-hah' moments in the project	
What were the strongest points of this Black Belt engagement?	
What were the weakest points?	
Were there any areas of the DMAIC methodology that you wish you had a deeper understanding of for this project? What would you have done differently?	
Were you provided with all necessary tools to accomplish the project objectives?	
What other positive outcomes came out of this project?	

DOCUMENTATION

- Information must be properly documented and archived both during the project as well as after the project is finalised.
- Follow the procedures in place. _____
- Use standard documents. _____
- Use revision numbers. _____
- Make sure that documents are stored in the correct place (especially after closure of project).
- 5S is also applicable for documents and servers.



Which is the **BEST** reason to record lessons learned?

a) To effectively document the results of the project

b) To list all the tools learned during the training course

c) It is a mandatory deliverable of the Improve phase of the DMAIC roadmap ✗

d) It helps prevent similar projects making the same mistakes

A mobile phone provider has carried out a survey of its customers to determine the current level of customer satisfaction. From the results, a Net Promoter Score (NPS) of +55 has been calculated. How should this score be interpreted?

- a) Poor
- b) Acceptable
- c) Good
- d) Excellent

+20

55%

0-6	15%
7-8	15%
9-10	70%

(70 - 15)
+55

20%
15%
70%
25%

A training organization wants to determine a metric to monitor an improvement project. The team prepares a CTQ flowdown for this.

What is a good definition for the 'internal Critical to Quality' (CTQint) that can be used during the improvement project?

a) The score of participants on the evaluation form

b) All participants passed the exam with a pass

c) The trainer has a score of more than 90% for all necessary knowledge components

d) Participants wish a high-quality training

~~CSF~~
LFT



For what reason do we define soft benefits, taking into account that we can not quantify them in terms of money?

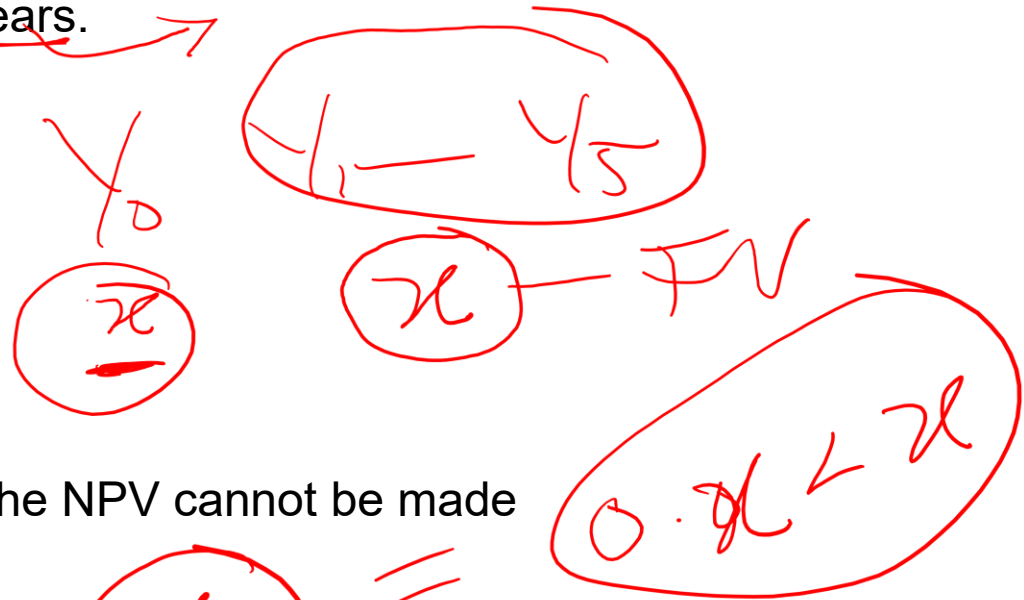
- a) It is always beneficial if we meet them ✘
- b) They support the vision and strategy of our organization ✔
- c) They are easier to achieve ✘
- d) They can compensate the eventual lack of achieving hard benefits ✘

An investment has a payback period of 5 years. An interest rate of 5% is used when calculating the NPV. The period for which the cash flows are included is 5 years.

What is the amount of the investment compared to the NPV?

- a) The investment is higher than the NPV
- b) The investment is lower than the NPV
- c) The investment is the same as the NPV
- d) With this data a comparison between the investment and the NPV cannot be made

$$\underline{NPV} = \frac{FV}{(1+r)^n} = \frac{x}{(1+0.05)^5}$$



The 'Impact-Effort matrix' is often used in Lean to prioritize and select improvement activities. Within Scrum, a different approach is used to prioritize and select improvements (or work).

Which of the descriptions below **BEST** describes this approach?

- a) The Scrum Master ~~first~~ determines the Storypoints of all improvements. Based on this, the Product Owner chooses which improvements will be implemented in the upcoming Sprint. ~~X~~
- b) The Product Owner prioritizes the improvements. After that, the Scrum Master determines with the team how many of these will be implemented in the upcoming Sprint. ~~X~~
- c) During the Sprint Review, the team determines which improvements are ready to be delivered. The Product Owner then makes a selection based on the highest added value. ~~X~~
- d) The Product Owner and the team jointly determine the Storypoints of all improvements. The Scrum Master then facilitates the selection for the upcoming Sprint. ~~X~~

* developer

PO
Scrum
Dev

What does a problem description identify?

- a) The issue that the project team wants to improve
- b) The strategic reasons for the project
- c) The members of the improvement team
- d) The scope of the project

Which of the following descriptions for a LED lamp is a good description for the internal CTQ?

- a) The color temperature of the lamp is 2,800 + 50 Kelvin ✓
- b) The color temperature of the lamp is between 2,700 and 3,000 Kelvin ✓
- c) The lamp must provide enough light to be able to read a book X
- d) The lamp should give a warm white light X

Handwritten notes in red ink:

2800 - 2850

(2700 300 3000)

An improvement project is expected to make the following benefits.

Efficiency Improvement	From 10 to 9 employees
Reduced Cycle Time	From 5 to 4 minutes
Improved Yield	From 80% to 90%
Reduced Downtime	From 14% to 9%
Improved Employee Morale	From 3.4 to 3.7
Improved Customer Satisfaction (NPI%)	From 40% to 50%
Reduction In Reportable Incidents (RI)	From 28 to 11 p.a.
Reduced Risk p.a. of Regulatory Breach	0.9% to 0.75%
Cost per Employee p.a.	€50,000
Cost per RI (est.)	€3,000
Cost per Breach (est.)	€10,000,000

What is the **BEST** statement of soft benefits?

- a) €0,000 plus improved customer satisfaction and employee morale
- b) €15,000 plus improved customer satisfaction and employee morale
- c) €51,000 plus improved customer satisfaction and employee morale
- d) €66,000 plus improved customer satisfaction and employee morale

The costs and benefits of an improvement project are summarized in the table below

	Year 0	Year 1
Cost of team	£8,000	£0 ✓
Capital Cost	£10,000	£0 ✓
Reduction in Defects	£18,000	£36,000
Resources Redeployed	£0	£17,000

~~Risk avoidance~~
Hard benefit

What are the hard benefits of this project for the first year?

- a) £53,000 ✓
- b) £36,000
- c) £71,000
- d) £54,000

$$\begin{array}{r} 36\text{K} \\ 17\text{K} \\ \hline 53\text{K} \end{array}$$

The costs and benefits of an improvement project are summarized in the table below.

Assuming an interest rate of 5%, which of the following conclusions can be drawn?

1. Return on Investment (ROI) at year 1 is 25%
2. Return on Investment (ROI) at year 2 is 150%
3. Net Present Value (NPV) is €31,800
4. Working Capital (WC) is unchanged in year 0

- a) 1, 2, 3
- b) 1, 2, 4
- c) 1, 3, 4
- d) 2, 3, 4

	Year 0	Year 1	Year 2
Cost of Team	€10,000	€0	€0
Time and Cost	€14,000	€0	€0
Reduction in Defects	€0	€13,000	€13,000
Resources Deployed	€0	€17,000	€17,000

Handwritten calculations:

$$\frac{30K - 24,000}{24,000} = \frac{6K}{24K} = \frac{1}{4} = 25\%$$

$$\frac{60K - 24K}{24K} = \frac{36K}{24K} = 1.5 \times = 150\%$$

Additional notes: $30K + 30K$ and $-24,000$ are circled in red.

'Return on Investment' (ROI)

ROI is used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. It is one way of considering profits in relation to capital invested.

$$ROI[\%] = \frac{\text{Net profit } [€]}{\text{Investment } [€]} \times 100\%$$

$$NPV(i, N) = \sum_{t=0}^N \frac{R_t}{(1+i)^t}$$

- t : time period of the Cash flow
- i : Discount rate
(rate of return that could be earned in the financial market, with similar risk)
- R_t : Net Cash flow (i.e. Cash inflow – Cash outflow), during time period t

Handwritten calculation of NPV for three time periods ($t=0, 1, 2$) with a 5% discount rate ($i=0.05$).

The calculation is enclosed in a large red circle:

$$\begin{aligned}
 & t_0 & t_1 & t_2 \\
 & \frac{-24000}{(1+0.05)^0} & \frac{30000}{(1+0.05)^1} & \frac{30000}{(1+0.05)^2} \\
 & -24000 & + \frac{30000}{1.05} & + \frac{30000}{1.05^2}
 \end{aligned}$$



Initiating

Planning

Implement Incrementally 1-4 week Iterations⁽ⁿ⁾

Ongoing Success

Lean Six Sigma Implementation

Description

Clarify the process problems or pains. Identify & engage key stakeholders to identify the requirements and the benefits to be realized.

LSS Activities

- LSS Activities**
- Clarify the Problem & Goal
 - Identify & Analyze Stakeholders
 - Create & agree Team Structure
 - Engage Process Stakeholders to:
 - Create SIPOC, flow, swim
 - Perform Process Audit
 - Gather VOC/VOB
 - Create CTQ Flowdown
 - Prioritize requirements
 - Create Business Case
 - Agree the approach including roadmap and Kotter Approach

Change Mgt

- People Activities**
- Review Organizational Culture
 - Consider Reasons for resistance and Kubler Ross Change Curve
 - Motivation – Herzberg, MBTI
 - Team Leadership and Team roles
 - Coaching, stakeholder & Comm Plan

Output

Project Charter
Stakeholder Engagement,
Communication & Coaching Plans

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U4 – CREATING A SOLID FOUNDATION

E1 – PROFESSIONAL WORK ENVIRONMENT



CONTINUOUS IMPROVEMENT MATURITY MODEL



ORGANIZED WORK ENVIRONMENT (5S)

5S: phases

Japanese	English
S1: <u>S</u> eiri	<u>S</u> ort
S2: <u>S</u> eiton	<u>S</u> traighten
S3: <u>S</u> eiso	<u>S</u> hine
S4: <u>S</u> eiketsu	<u>S</u> tandardize
S5: <u>S</u> hitsu <u>k</u> e	<u>S</u> ustain



ORGANIZED WORK ENVIRONMENT (5S)



RED TAG	
Date: _____	Tag Number: 4201
Tagged / Descrip: _____	Date: _____
Asset ID: _____	Tagged By: _____
Where F: _____	Description: _____
Reason: _____	Asset ID# _____
<input type="checkbox"/> Reason for removal:	Where Found: _____
<input type="checkbox"/> Not needed	<input type="checkbox"/> Defective
<input type="checkbox"/> Scrap	<input type="checkbox"/> Aged / Obsolete
<input type="checkbox"/> Other: _____	
<small>SEARCH FOR THE HARRYBAKER Paper Tag on 10/20/2008</small>	

S1 – Sort (Seiri)
Red Tag



SORT (SEIRI): CLEARING THE WORKSPACE

Identify all workspace items and remove unneeded tools or materials.

Unnecessary items are discarded, relocated, or red-tagged for review.

Creates more usable space and reduces distractions.

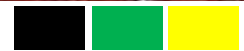


ORGANIZED WORK ENVIRONMENT (5S)



S2 – Straighten (Seiton)
Set in order

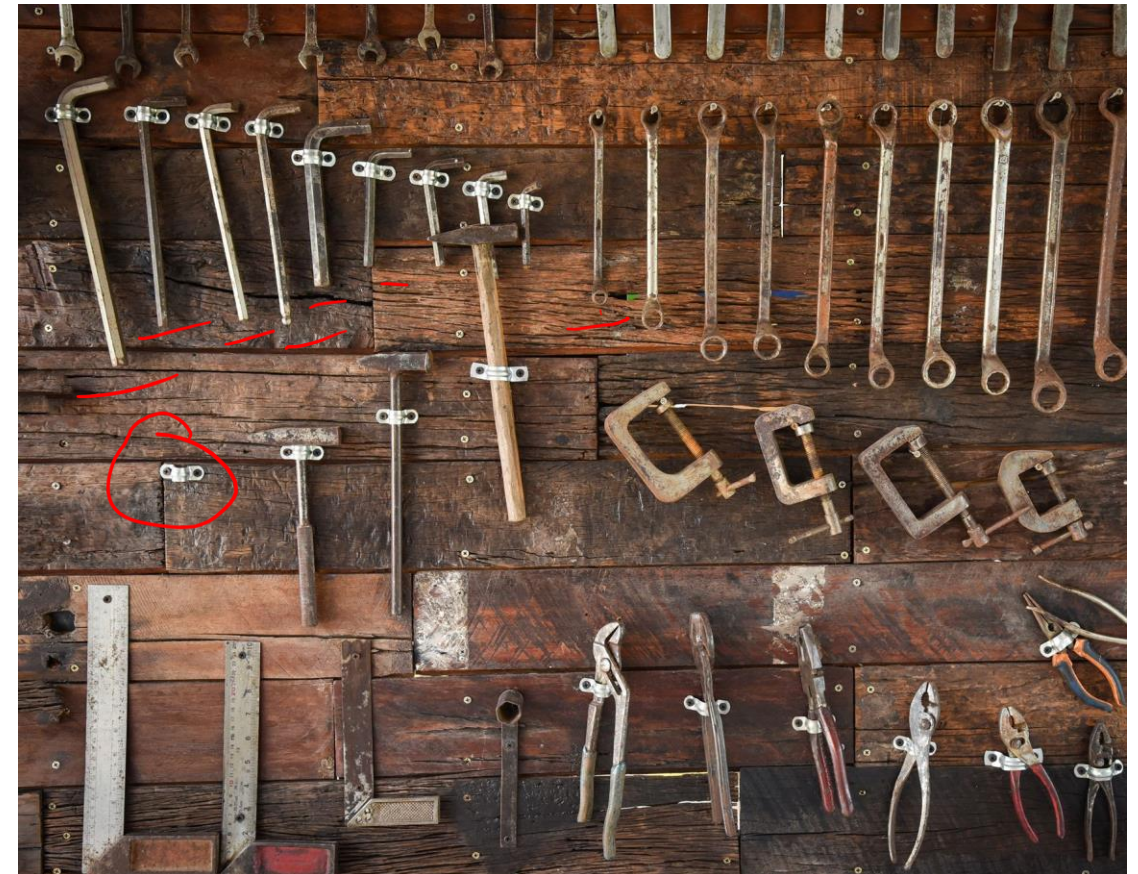
U4.E1



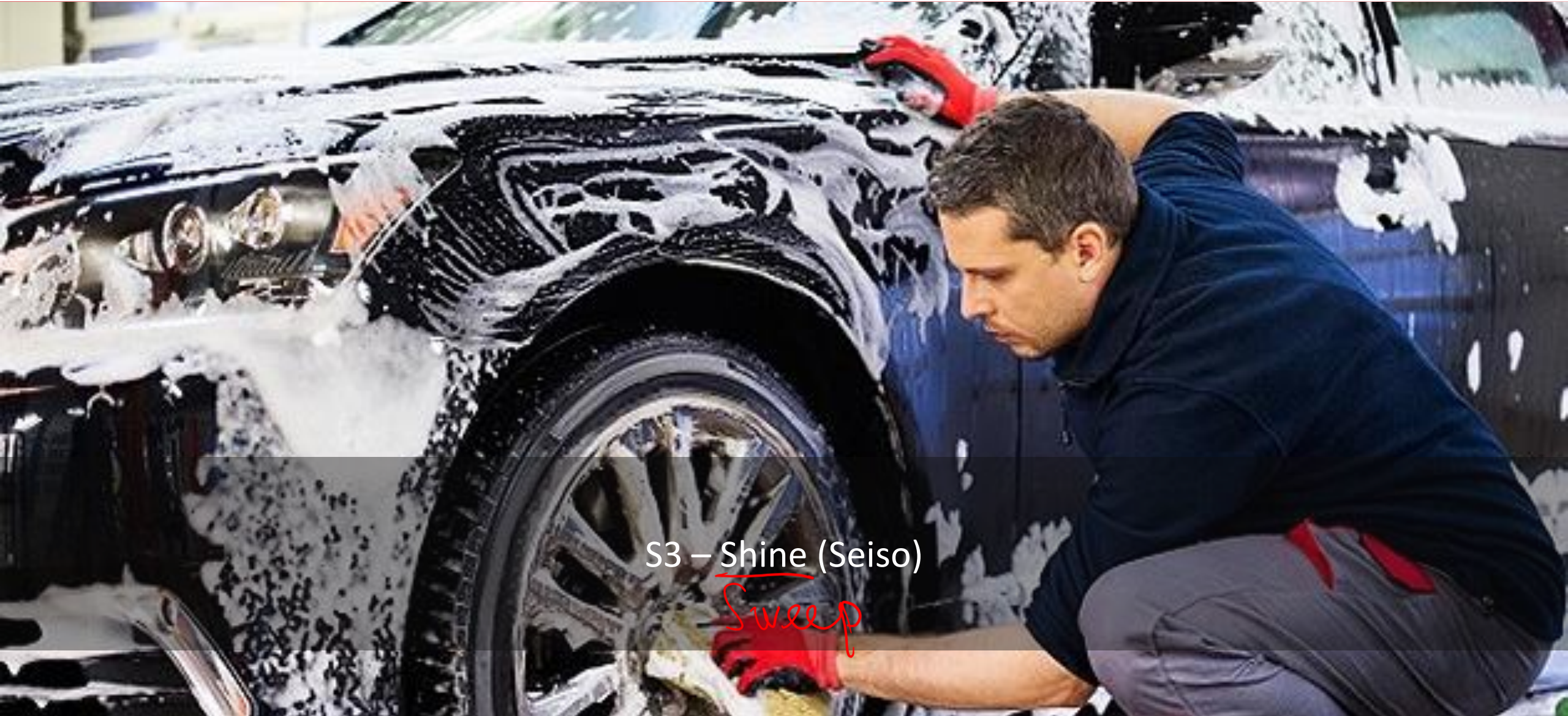
SET IN ORDER (SEITON): LOGICAL ARRANGEMENT

Designate a logical, ergonomic “home” for each necessary item, based on frequency of use and workflow.

Tools and supplies are stored where they’re needed most, with labels, color codes, floor markings, or shadow boards to make missing items obvious at a glance.



ORGANIZED WORK ENVIRONMENT (5S)



S3 – Shine (Seiso)

Sweep



SHINE (SEISO): CLEANING & INSPECTION

Integrate cleaning and inspection into daily work. Teams sweep, wipe, and polish equipment and work areas, simultaneously checking for leaks, wear, or safety hazards.

Regular “shine” routines ensure that abnormalities become visible immediately, preventing small issues from escalating.



ORGANIZED WORK ENVIRONMENT (5S)

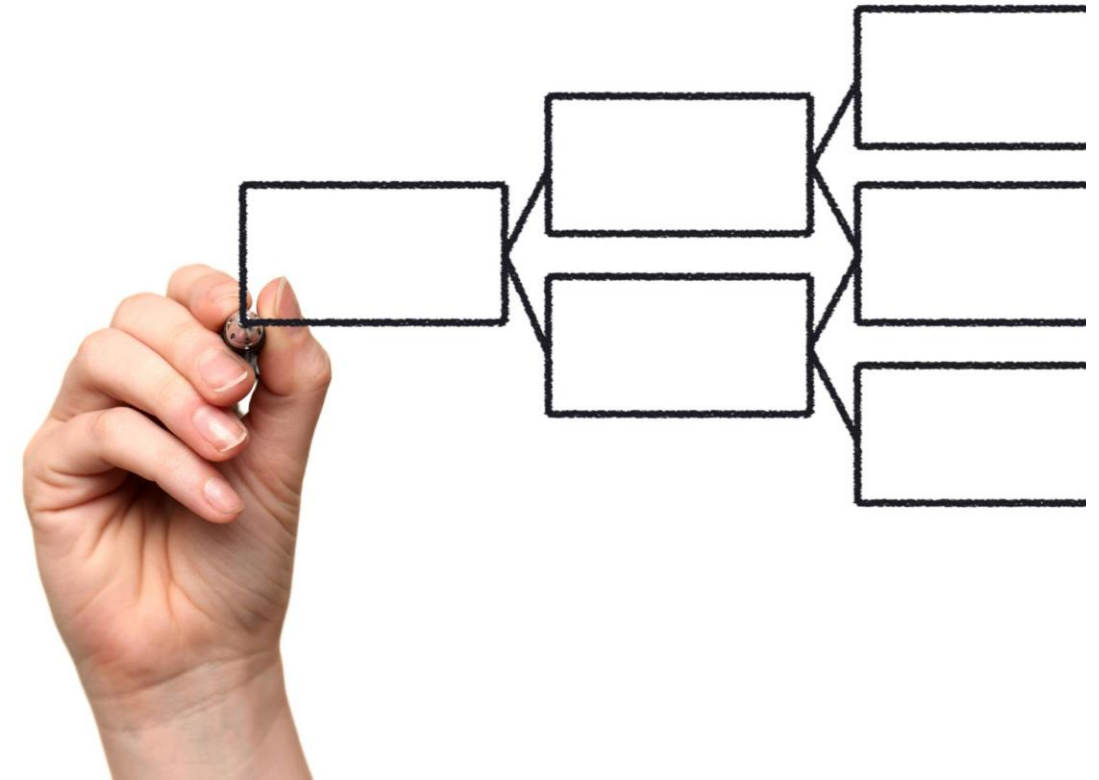


S4 – Standardize (Seiketsu)

STANDARDIZE (SEIKETSU): PROCEDURES & CONTROLS

Develop clear procedures, schedules, and visual controls to lock in the gains from Sort, Set in Order, and Shine.

Checklists, audit sheets, and photo standards help teams follow the same steps every day, making the new level of organization self-evident and repeatable.



ORGANIZED WORK ENVIRONMENT (5S)



S5 – Sustain (Shitsuke)



SUSTAIN (SHITSUKE): CULTIVATING DISCIPLINE

Cultivate a culture of self-discipline so that employees practice the first four S's without reminders.

~~Training, leadership support, recognition programs, and regular audits reinforce habits.~~ Over time, 5S becomes woven into daily routines rather than an occasional project.



BEYOND 5S: EXTENSIONS & APPLICATIONS

- Many companies adopt 6S by adding Safety as the sixth element, embedding hazard prevention in every step of workplace organization.
- 5S isn't limited to manufacturing—healthcare, offices, and even digital workspaces (like shared drives or code repositories) apply the same principles for clarity, efficiency, and morale.
- Digital tools and mobile audit apps streamline 5S checks, photo-documentation, and corrective-action tracking, making sustained compliance easier to manage across multiple sites.



U4 – CREATING A SOLID FOUNDATION

E2 – STANDARDIZED WORK



STANDARD OPERATING PROCEDURE



Standard
Operating
Procedure

STANDARD OPERATING PROCEDURE

Standards and Protocols

1. If there are no standards, these must be developed ✓
2. If there are standards, they must be followed by everyone ✓
3. There must be a constant process to improve the standard ✓

*“There is no logical basis without a standard
to make a decision or take an action ”*

Joseph Juran

GROUP 1

STANDARD OPERATING PROCEDURE

One Point Lesson (OPL)

- A One Point Lesson is a quick and easy way to convey a message to the workplace (Gemba), without having to adjust all kinds of official documents

One Point Lesson	
Department	Operations
Production line	Assembly
Machine	N.A.
Description	Splash-proof electrical connection of power supply
VISUAL INSTRUCTION	
Description of the situation or solution	
Prepared by:	Date:
Approved by:	Date:



TRAINING WITHIN INDUSTRY

TWI

What it is: Practical method to create & maintain standardized work (used in industry, healthcare, services).

Origins: WWII program for rapid worker training; later refined by Toyota.

Purpose: Builds cooperation, strengthens supervisor-employee relations, enables fast & effective training/problem-solving.

Core Pillars:

- **JR (Job Relations):** Positive employee relations → loyalty & fewer problems.
- **JJ (Job Instruction):** Most used; teaches one best way through standardized work, step-by-step training until mastery.
- **JM (Job Methods):** Analyzes & improves jobs by simplifying tasks, eliminating waste (evolved into Standardized Work + Kaizen).

In short: A hands-on system to standardize work, build strong teams & drive continuous improvement.

JOB INSTRUCTION	HOW TO INSTRUCT
<p>HOW TO GET READY TO INSTRUCT</p> <p>Before instructing people how to do a job:</p> <p>1. MAKE A TIME TABLE FOR TRAINING</p> <p>Who to train... For which work... By what date...</p> <p>2. BREAK DOWN THE JOB</p> <p>List Important Steps Select Key Points Safety factors are always Key Points</p> <p>3. GET EVERYTHING READY</p> <p>The proper equipment, tools, materials and whatever needed to aid instruction</p> <p>4. ARRANGE THE WORKSITE</p> <p>Neatly, as in actual working conditions</p>	<p>STEP 1 – PREPARE THE WORKER</p> <ul style="list-style-type: none"> Put the person at ease State the job Find out what the person already knows Get the person interested in learning the job Place the person in the correct position <p>STEP 2 – PRESENT THE OPERATION</p> <ul style="list-style-type: none"> Tell, show and illustrate one Important Step at a time Do it again stressing Key Points Do it again stating reasons for Key Points <p><i>Instruct clearly, completely and patiently, but don't give them more information than they can master at one time</i></p> <p>STEP 3 – TRY-OUT PERFORMANCE</p> <ul style="list-style-type: none"> Have the person do the job—correct errors Have the person explain each Important Step to you as they do the job again Have the person explain each Key Point to you as they do the job again Have the person explain reasons for Key Points to you as they do the job again <p><i>Make sure the person understands</i> <i>Continue until you know they know</i></p> <p>STEP 4 - FOLLOW UP</p> <ul style="list-style-type: none"> Put the person on their own Designate who the person goes to for help Check on the person frequently Encourage questions Taper off extra coaching and close follow-up
<p>TWI INSTITUTE</p> <p>www.TWI-INSTITUTE.ORG</p> <p>004Rev07 (EN)</p>	
<p>IF THE WORKER HASN'T LEARNED, THE INSTRUCTOR HASN'T TAUGHT</p>	



(U4 – CREATING A SOLID FOUNDATION) Level

E3 – QUALITY MANAGEMENT



QUALITY MANAGEMENT SYSTEM



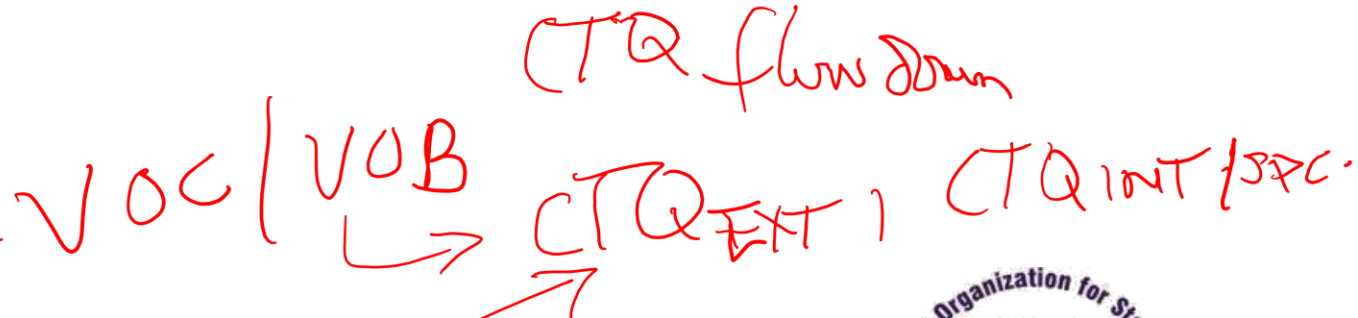
A quality management system is necessary to guard the standard



QUALITY MANAGEMENT SYSTEM

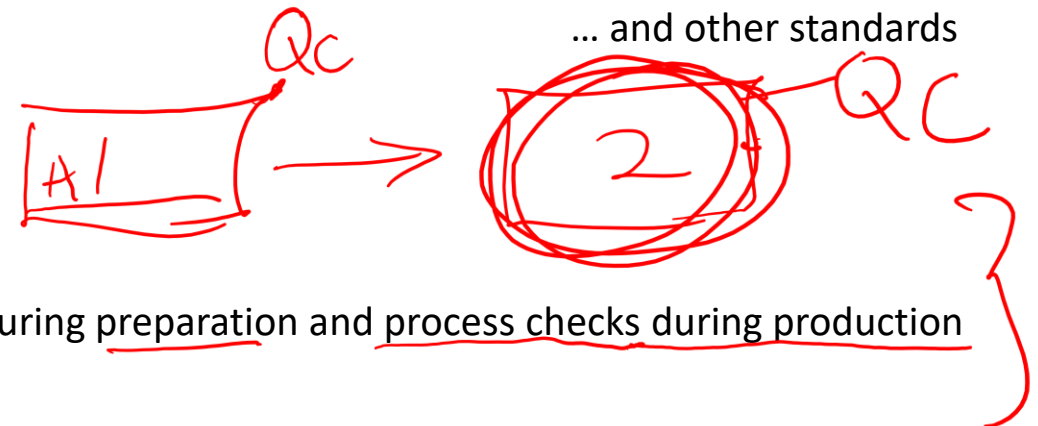
Quality Management System (QMS)

- ① Quality Planning (QP):
- How can we fulfil our quality policy
 - How can quality be translated to measurable targets and demands



... and other standards

- ③ Quality Control (QC):
- Aimed at detection of defects ✓
 - Inspections and checks of the production process.
 - Target to only supply good products to the customer



- ② Quality Assurance (QA):
- Aimed at prevention ✓
 - Prevent defects in products or services by taking measures during preparation and process checks during production



QUALITY MANAGEMENT SYSTEM



audit

Periodic internal audits or customer audits contribute to safeguard the procedures and protocols

CONTINUOUS IMPROVEMENT MATURITY MODEL



An ~~organization~~ applies 'Training Within Industry' (TWI). The result is an instructional video in which a specific task is trained. This is done by presenting the task four times. The first time without explanation. The next three times naming the main steps, the key points and the reasons for the key points respectively.

Is this a good execution of TWI?

- a) Yes, because a film guarantees that everyone receives exactly the same instruction (standardization) X
- b) No, because the trainer cannot intervene if the trainee does something wrong
- c) Yes, because this is a very solid and efficient way of training, and this approach is suitable for large groups X
- d) No, because there is no helpdesk (or person) for the trainees where they can ask questions X

At what stage, as part of 5S Housekeeping, are audits used?

a) Standardize

b) Shine

c) Sort

d) Sustain

(Control)

A project team is tasked with documenting the way in which a process should be operated. The team has been empowered by the Champion to define the various steps in the form of a Standard Operating Procedure (SOP).

Which step should **NOT** be taken by the project team to ensure the SOP is correctly described?

- a) The employees working at the Gemba define how each step will operate ✓
- b) The operating step Cycle Times are calculated and recorded ✓
- c) The final product and required quality checks are defined ✓
- d) Determine the validity period of SOP ✗

Which describes Quality Control?

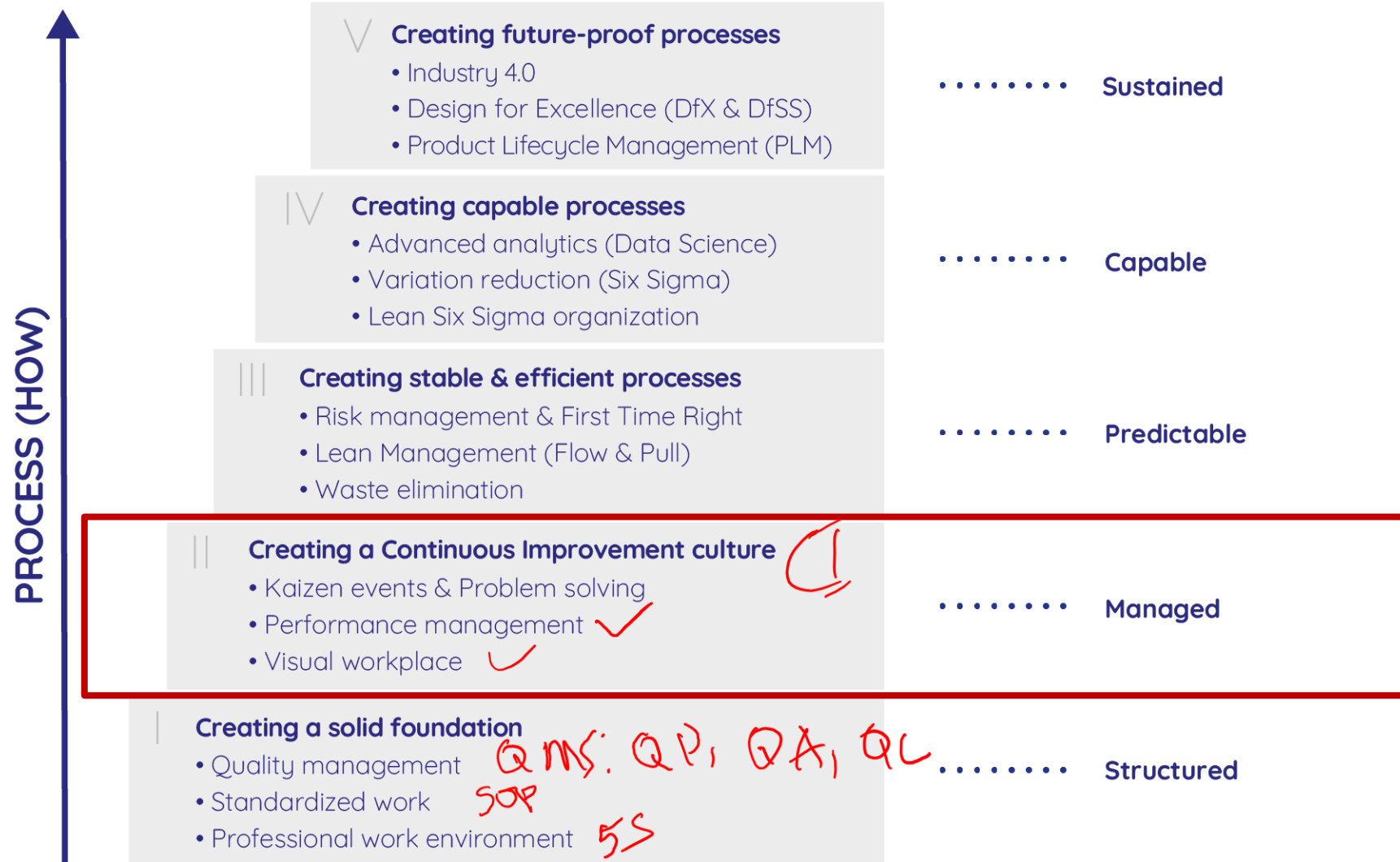
- a) Preventing defects from occurring in the process
- b) Detecting defects as they occur in the process
- c) Translating the quality policy into product/service specifications
- d) Non-value adding activity of detecting product defects

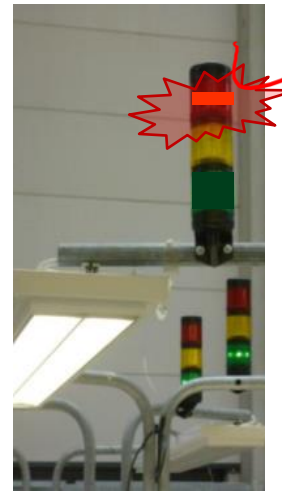
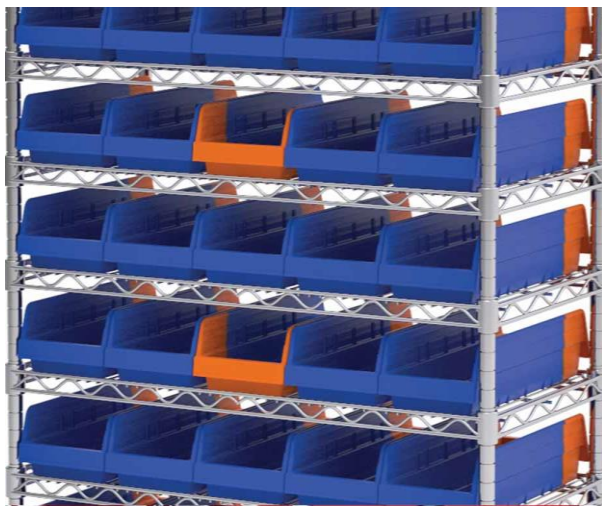
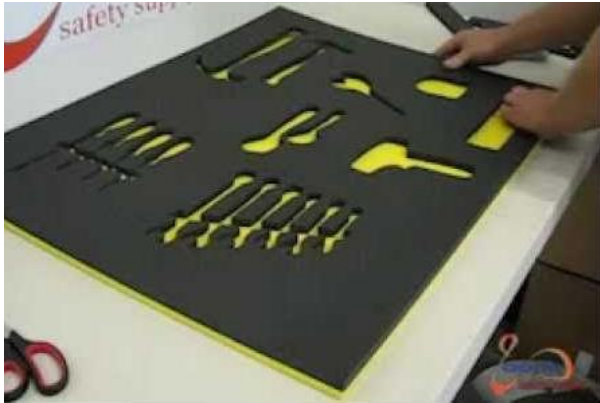


U5 – CREATING A CONTINUOUS IMPROVEMENT ENVIRONMENT









E1 – VISUAL MANAGEMENT

CONTINUOUS IMPROVEMENT MATURITY MODEL





Standard use of color

	Yellow	Aisles, walkways, work cells
	Orange	Temporary storage, equipment for inspection
	Red	On-hold location, errors and rejects
	Green	Materials and finished product
	Blue	Raw materials and components
	Black/Yellow	Safety warning
	Black/White	Leave space for activities
	Red/White	Keep clear for safety (e.g. emergency exit)

U5 – CREATING A CONTINUOUS IMPROVEMENT ENVIRONMENT

E2 – PERFORMANCE MANAGEMENT



Lean Daily Management
to discuss the results and issues

*daily
Scrum*

DAILY STAND-UP MEETINGS



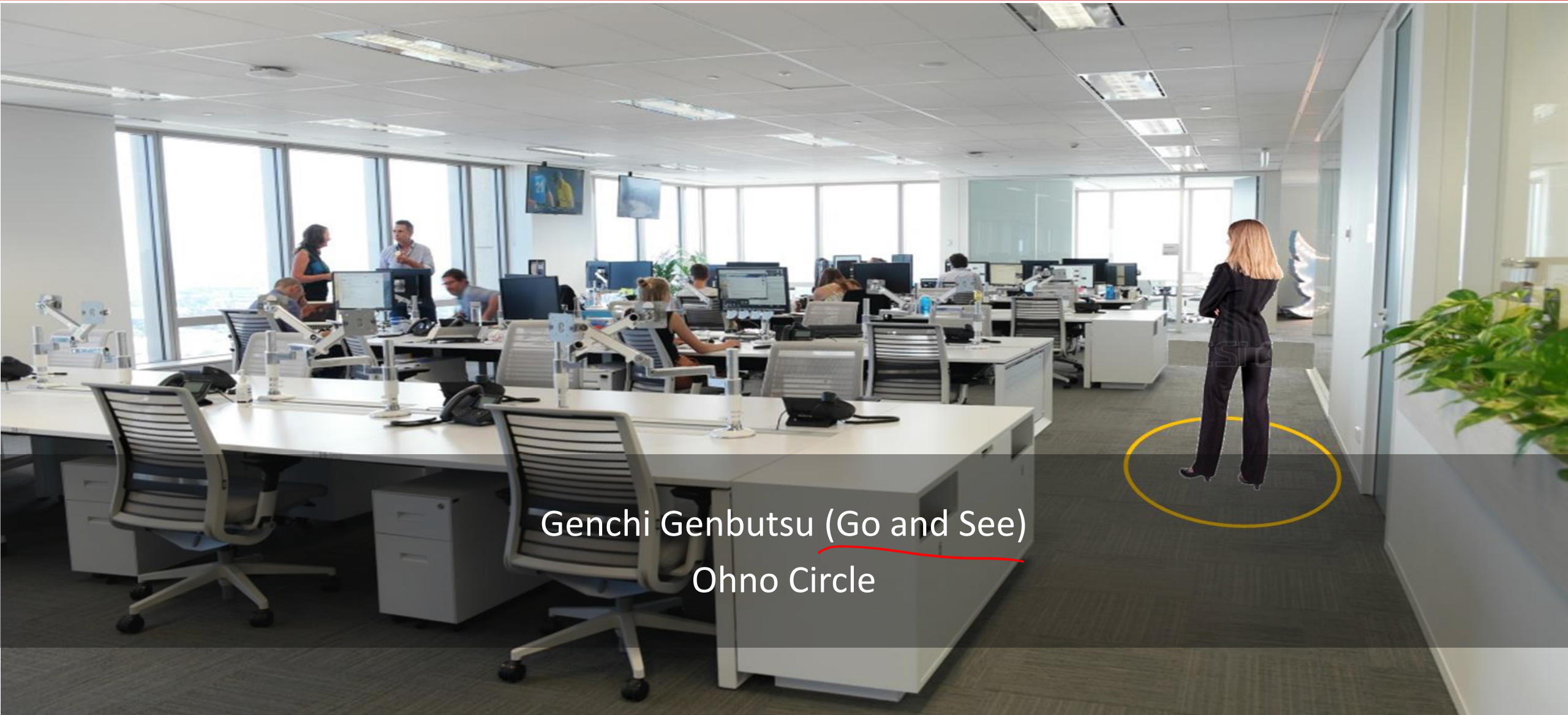
Obeya room (War room)
Visualization of all improvement projects



KAIZEN

Small

‘To disassemble and put together again in a better way’



Genchi Genbutsu (Go and See)
Ohno Circle

5-Whys
Is-Is Not
Cause & Effect

Focus on identifying the root cause of problems

U5 – CREATING A CONTINUOUS IMPROVEMENT ENVIRONMENT

E3 – BASIC QUALITY TOOLS

BRAINSTORM TECHNIQUES

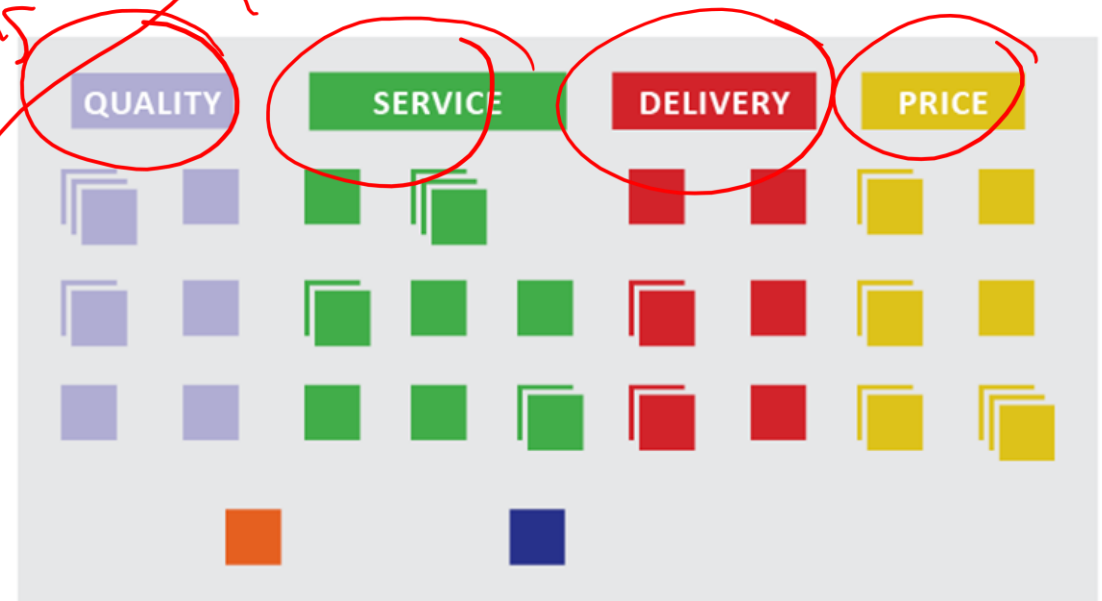
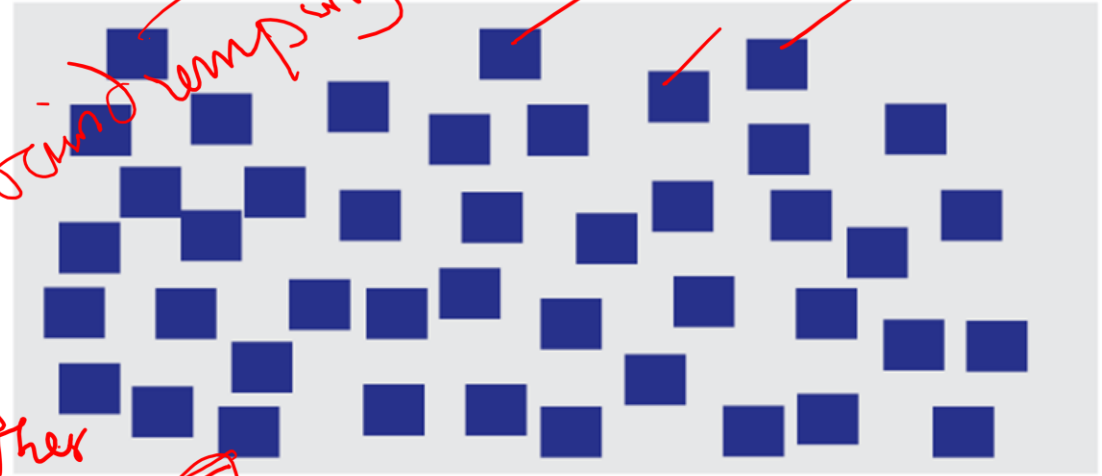
1-2-4-All

Affinity diagram

- * Facilitator shows obj of meeting
- * Get each participant to write their idea - 5 min
- * (1+1) 2 people will talk each other through ideas - consolidate ideas
- * Talk in a group of 4 (10 min)
- * Bring everything together

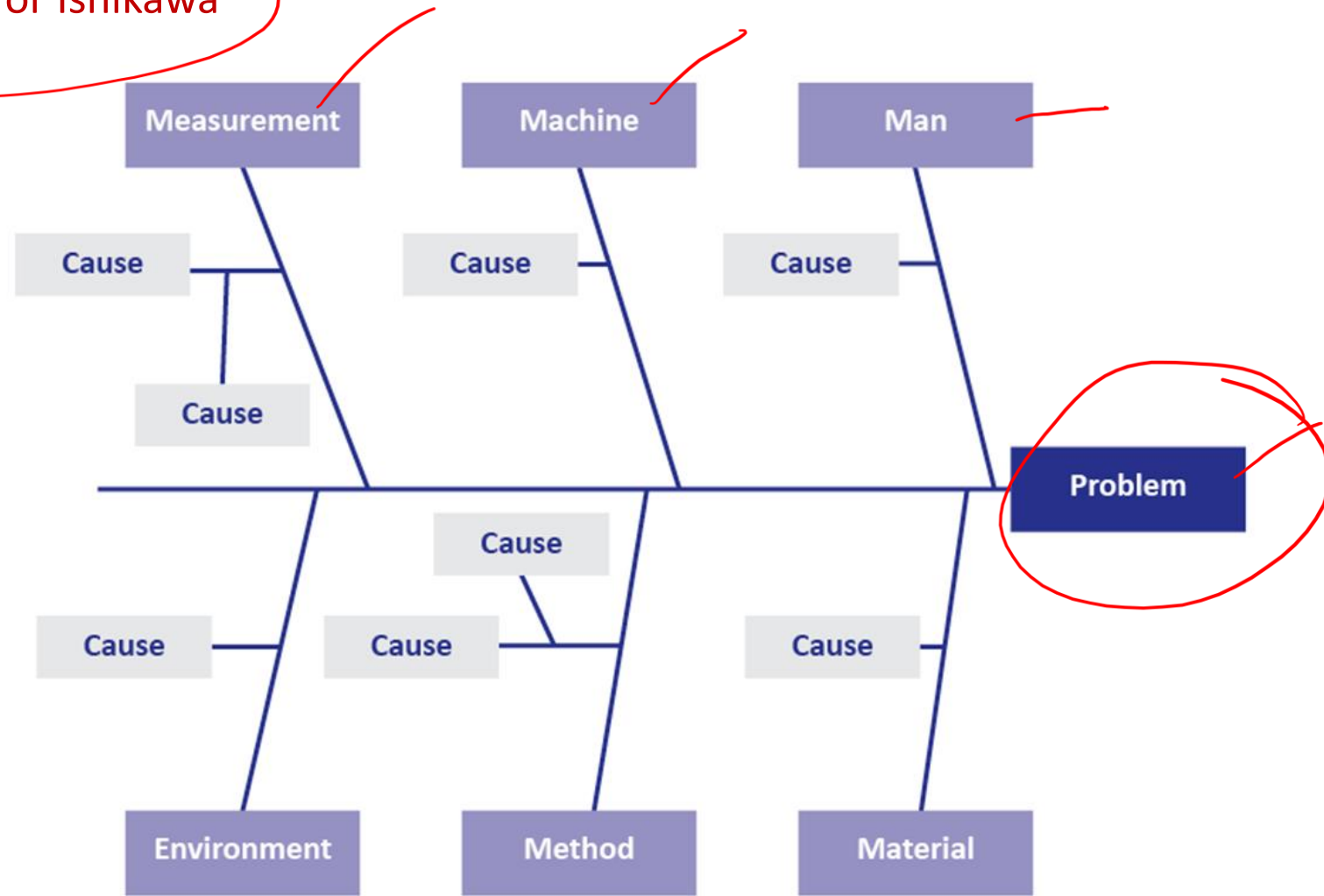
state

bound jumping

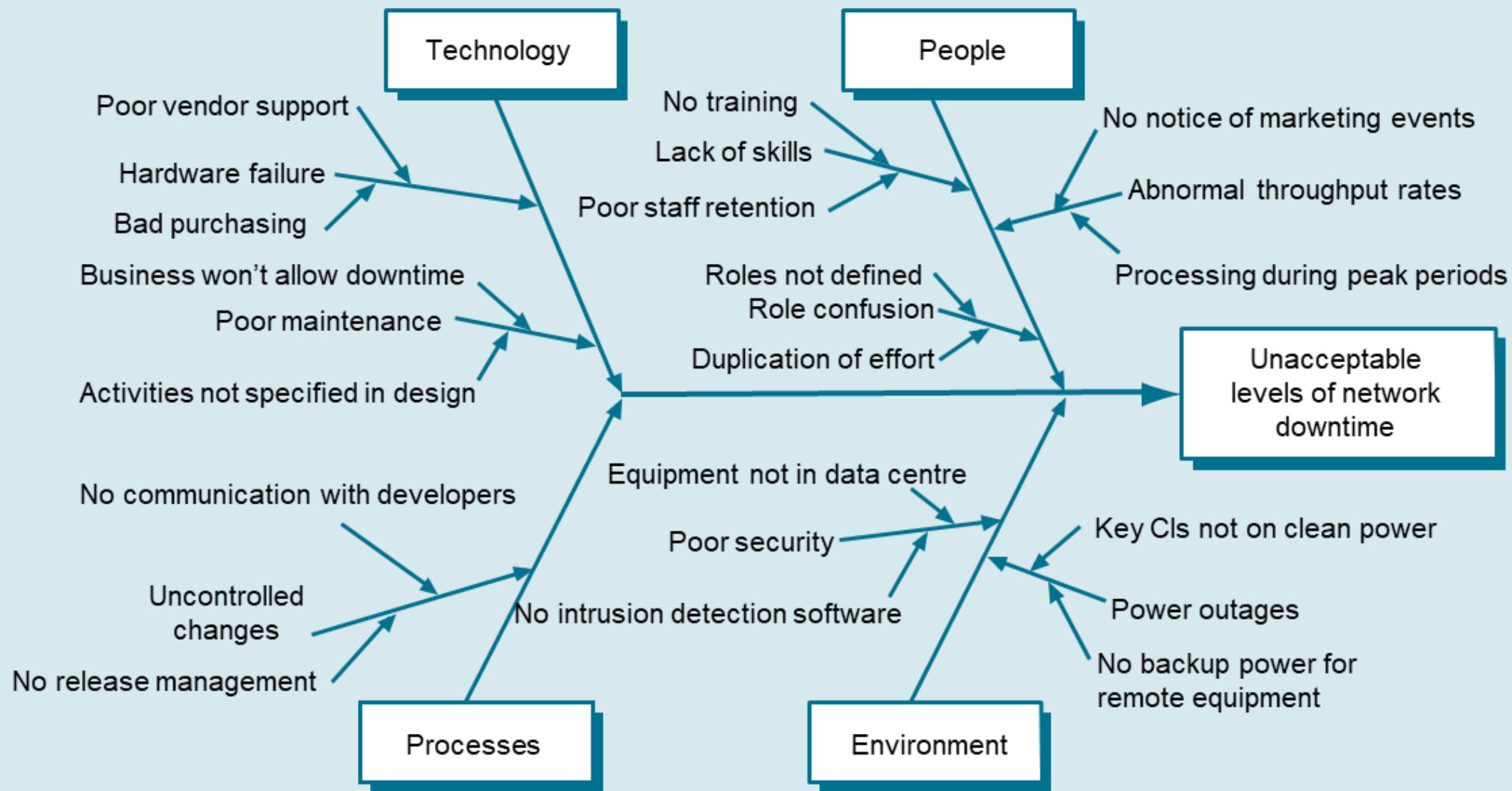


BRAINSTORM TECHNIQUES

Fishbone diagram or Ishikawa

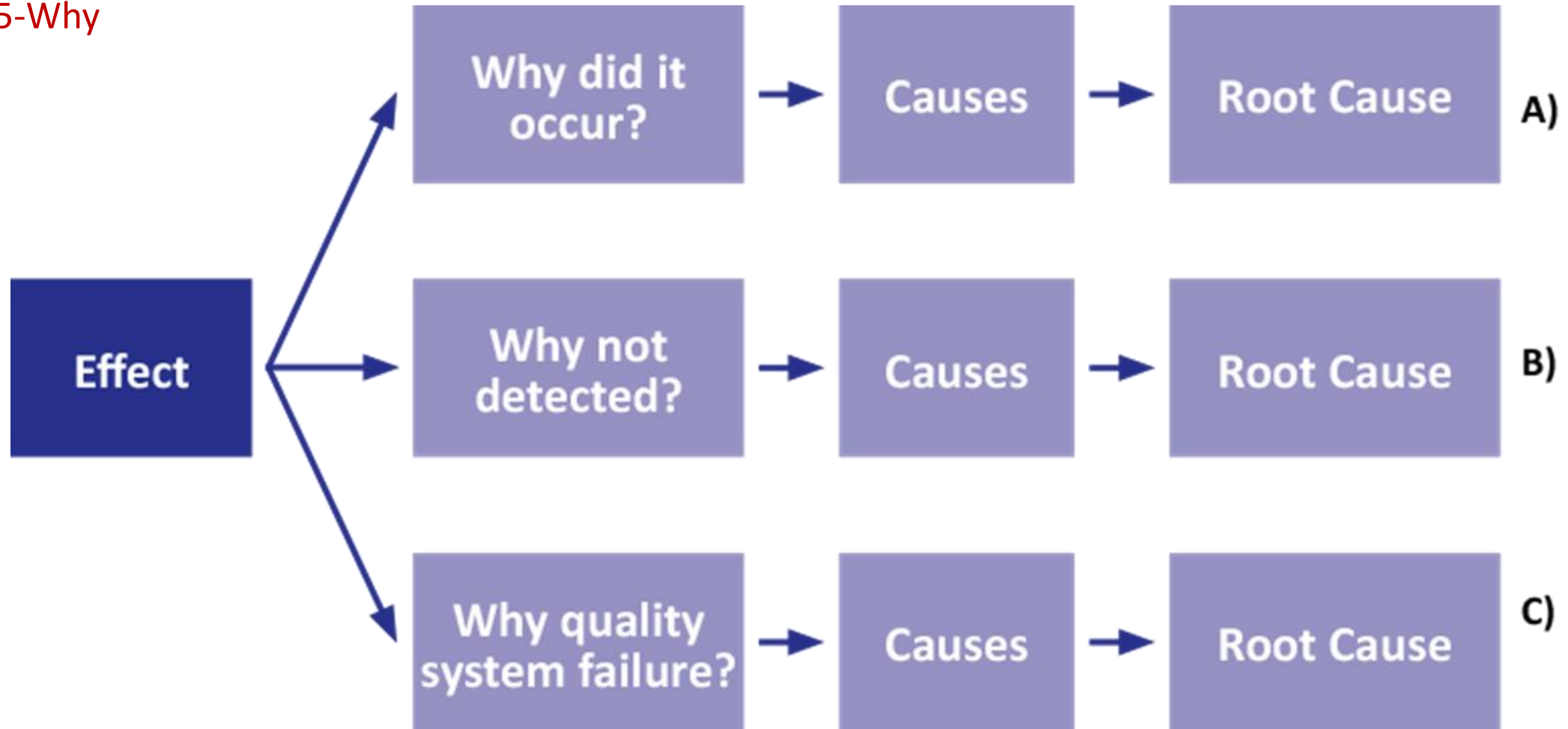


Ishikawa diagram showing possible causes



BRAINSTORM TECHNIQUES

5-Why



Why Can't I Save Money?

I Have No Money To Save

Why Don't I Have Money To Save?

I Spend Too Much

I Don't Earn Enough

Why Do I Spend Too Much?

Why Don't I Earn Enough?

I Fail To Budget
And Monitor Daily Spending

I Am Over-Leveraged

I Don't Maximize Commissioned
Opportunities?

Why Don't I Budget?

Why Am I Over-
Leveraged?

Why Don't I Maximize Commissioned
Opportunities?

I Never Learned How.

I Don't Understand
The Impact of Debt

I Lack Time Management Skills

Content

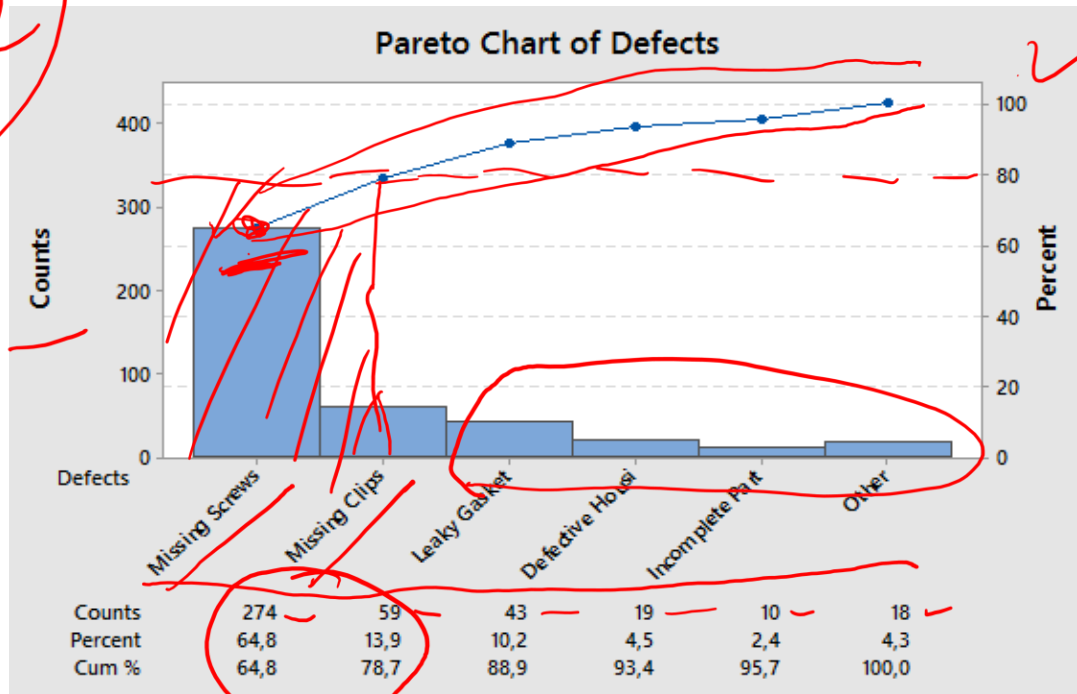
1. Pareto Chart
2. Scatter Plot ✓
3. Bar Chart
4. Pie Chart ✓
5. Time Series Plot
6. Histogram
7. Box Plot

1. Pareto

- Juran: "Focus on the vital few rather than the obvious many".
- 80-20 rule: 80% of the problems are caused by 20% of the factors.



O give
CF



J. Juran

	Counts	CF
A	2	2
B	4	6
C	7	13
D	10	23

Handwritten notes: Brooklyn, 7, 16, 10, 10, 10

Pareto – Explained

- Combines **bar graph** (individual values) and **line graph** (cumulative %).
- Based on the 80/20 rule: 80% of effects come from 20% of causes.
- Highlights the **most significant factors** in a dataset.

How It Works

- Bars are sorted in descending order of impact.
- **Left axis**: frequency, cost, or another metric.
- **Right axis**: cumulative percentage (up to 100%).
- Cumulative curve is **concave**, showing diminishing returns.

Best Used For

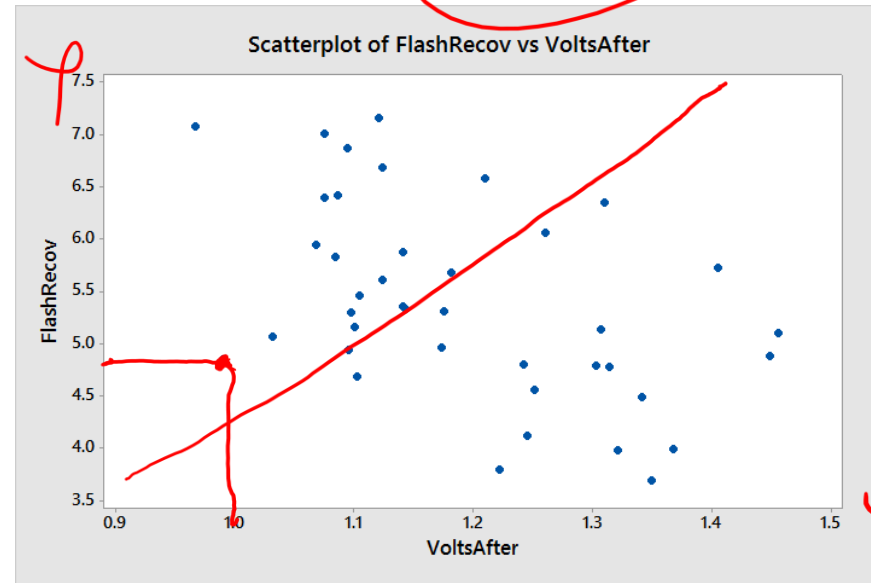
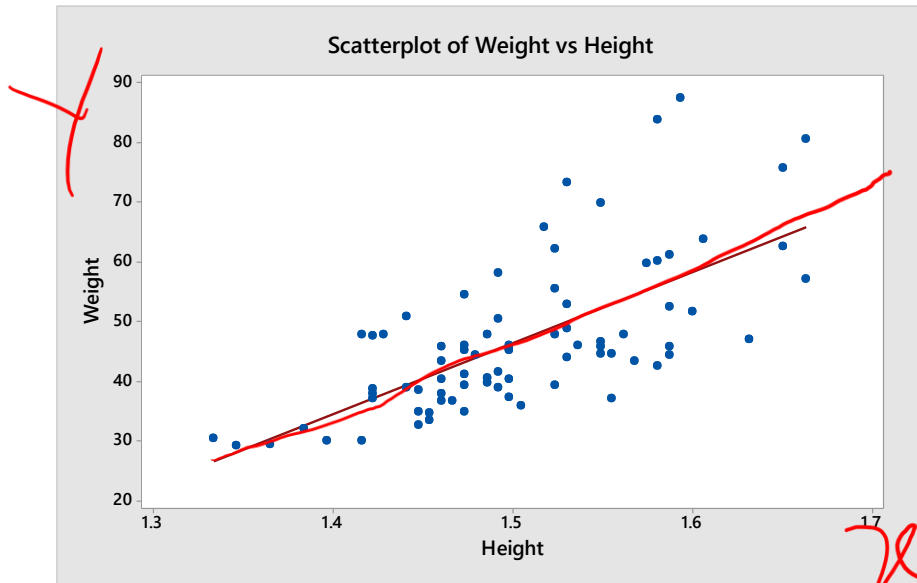
- **Quality control**, customer complaints, defect analysis. ✓
- Prioritizing issues and focusing improvement efforts. ✓
- Making **data-driven decisions** for maximum impact. ✓

Data Type ✓

- **Categorical data** (e.g., defect types, complaint reasons).
- Works with frequency counts, cost, or other impact measures.

2. Scatter Plot

- Used to examine the relationship between two continuous variables by drawing them on separate axes:
 - Weight vs. Height.
 - FlashRecov and VoltsAfter



100

A - 40
B - 30
C - 20
D - 10

Scatter Plot – Explained

What It Is

- A graph that shows the relationship between two continuous variables.
- Each point represents a pair of values plotted on X and Y axes.

How It Works

- Reveals patterns, trends, or correlations (e.g., water usage vs. electricity charges).
- If points form a cloud with no pattern, there's likely no relationship.
- Can also plot data over time, especially when entries are irregular or unordered.

regression analysis

Best Used For

- Exploring correlations between variables. ✓
- Visualizing trends or outliers in large datasets. ✓
- Analyzing non-sequential time-based data. ✓

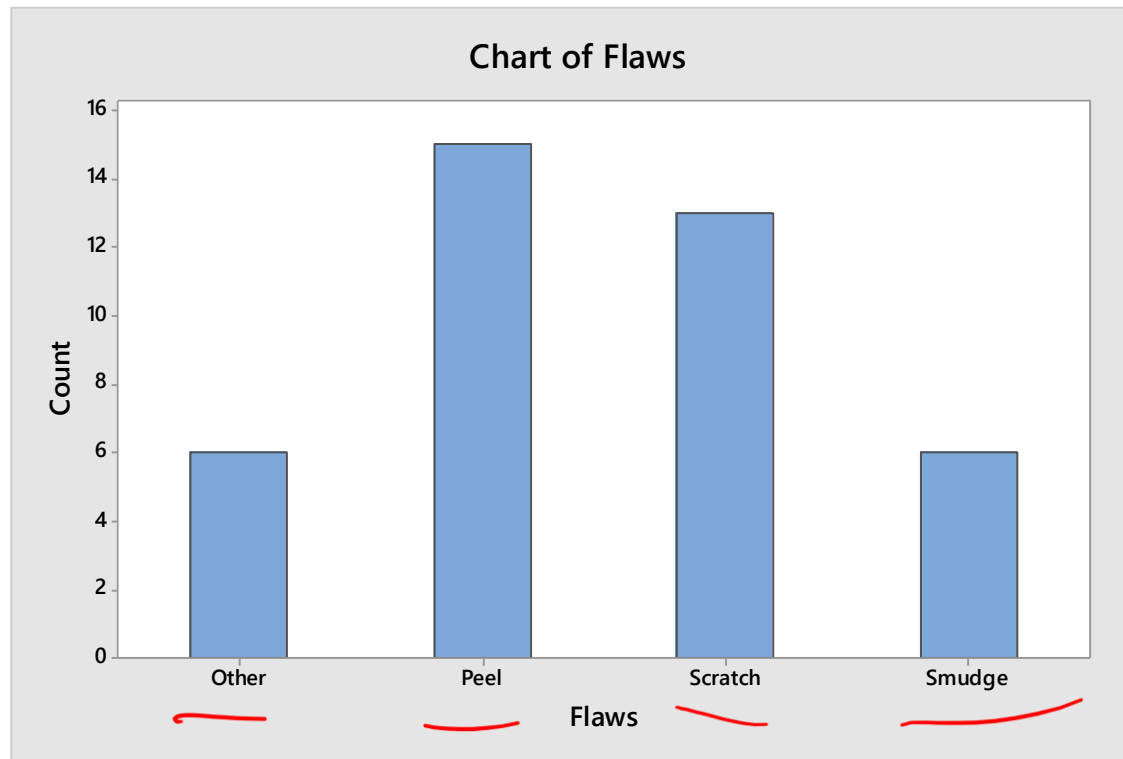
Data Type

- Continuous numerical data (e.g., temperature, income, usage). ✓
- Requires two variables — one for each axis. ✓



3. Count results by category - Bar Chart

- Use a Bar Chart or a Pie Chart to graphically compare count results or frequencies for two or more groups.



Bar Chart – Explained

- A chart that visually compares quantities or frequencies across categories or groups.
- Ideal for showing differences between two or more groups.

How It Works

- Each bar represents a category and its corresponding value (e.g., count or total).
- Bars can be vertical or horizontal, depending on the chart type.

Best Used For

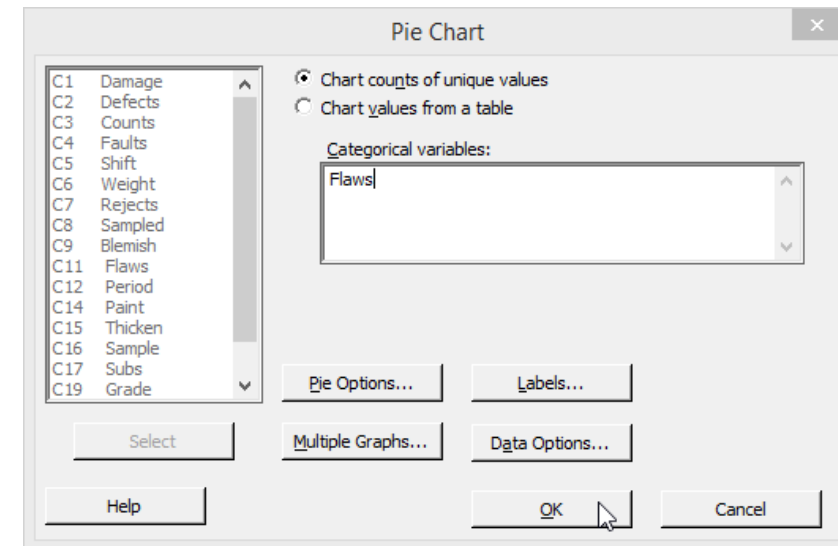
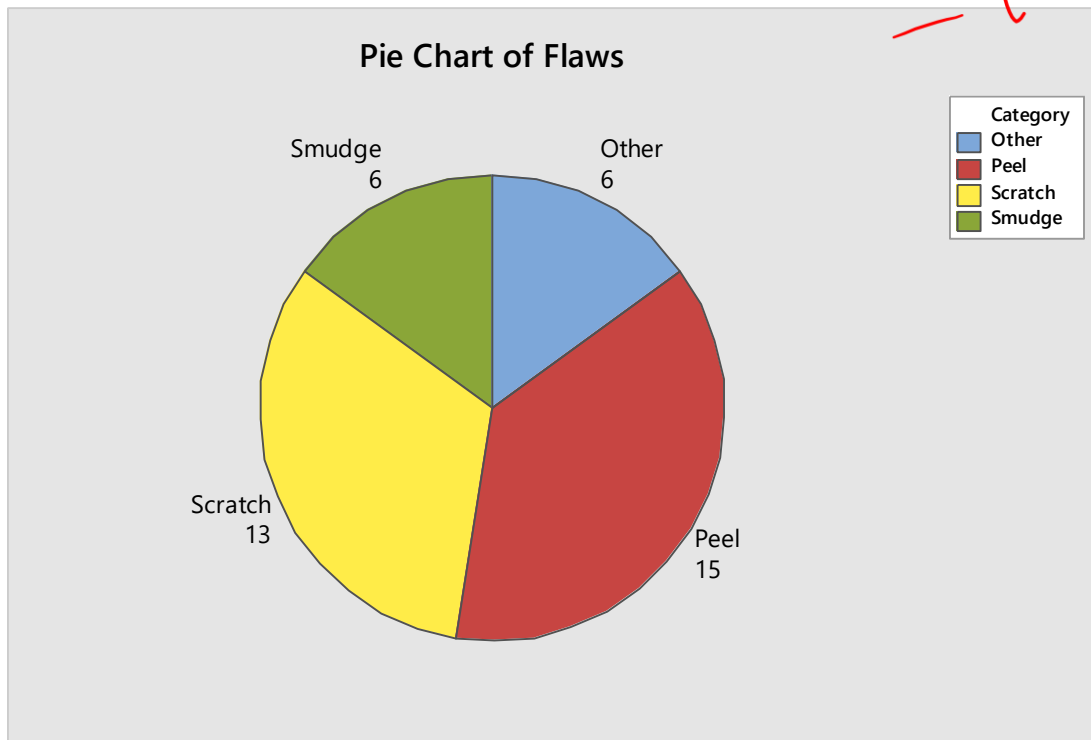
- Comparing grouped data side by side.
- Displaying counts of unique values in categorical columns.
- Highlighting distribution patterns across categories.

Data Type

- Categorical data (e.g., product types, regions, survey responses).
- Values can represent frequency, totals, or other measurable metrics.

4. Count results by category - Pie Chart

- Use a Bar Chart or a Pie Chart to graphically compare count results or frequencies for two or more groups.



Pie Chart – explained

- A circular chart that shows the proportion of categories as slices.
- Each slice represents a category's share of the total.

How It Works

- Slice size reflects the relative magnitude of each category.
- Useful for visual comparison of parts to a whole.
- Example: Hospital uses a pie chart to show top reasons for missed appointments.

Best Used For

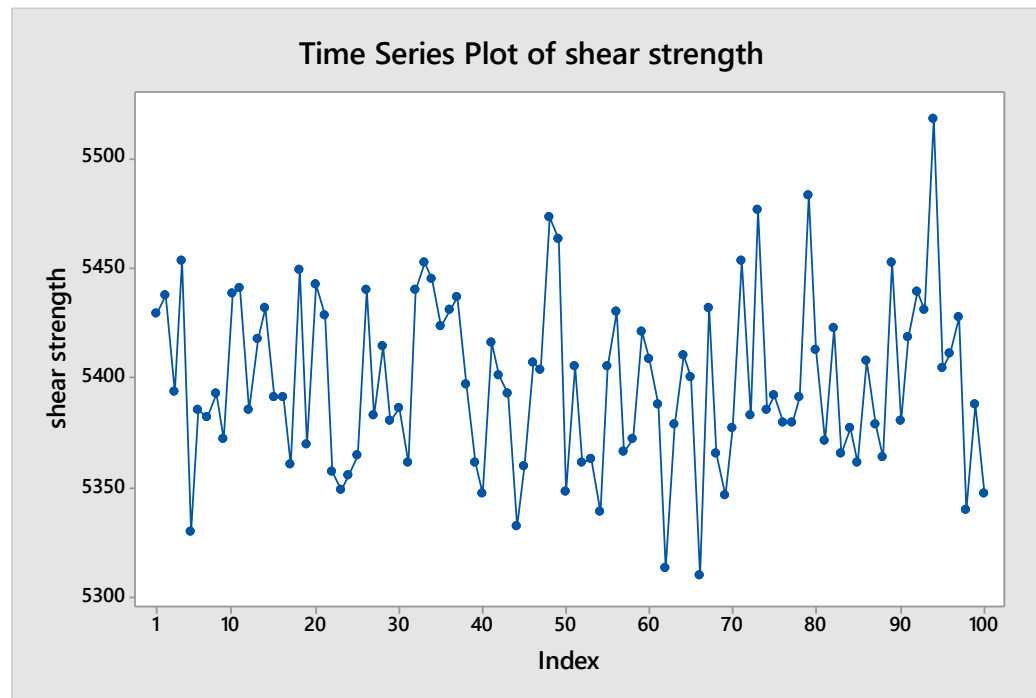
- Showing percentage breakdowns or distribution of categories.
- Highlighting dominant contributors in a dataset.
- Presenting simple, clear summaries of categorical data.

Data Type

- Categorical data with associated frequency or proportion values.
- Best when categories are limited in number (e.g., 3–7 slices).

5. Time Series Plot

- Used to visualise and/or discover patterns in time.
- Usually one of the first graphs made to see if the behaviour is stable.



Time Series Plot – Explained

- A graph that shows performance over time, with time on the X-axis and a measured variable on the Y-axis.
- A key tool in Six Sigma for tracking trends and changes.

How It Works

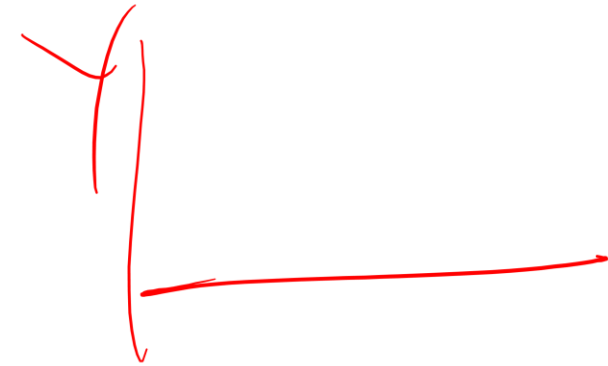
- Plots data points in chronological order to reveal patterns.
- Common measures: temperature, defects, lead time, dimensions.
- One of the first charts used in new projects to assess problem scope.

Best Used For

- Detecting trends, outliers, and sudden shifts.
- Comparing short-term vs long-term performance.
- Identifying cycles, variation, or structural issues.

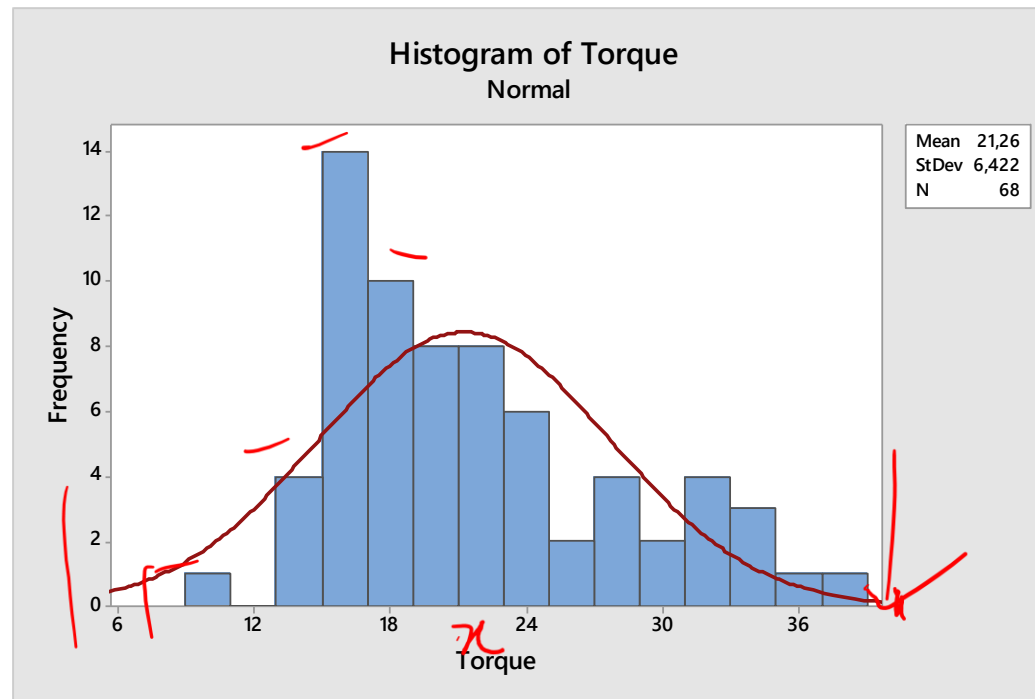
Data Type

- Continuous numerical data collected over time intervals.
- Ideal for irregular or non-sequential time entries.



6. Histogram

- Visualises the distribution/dispersion of data.
- Chosen widths (by Minitab) of the "bins" can be customised.



Histogram

- A chart that divides data into intervals called bins, shown as bars.
- Each bar represents the frequency of observations within a bin.

How It Works

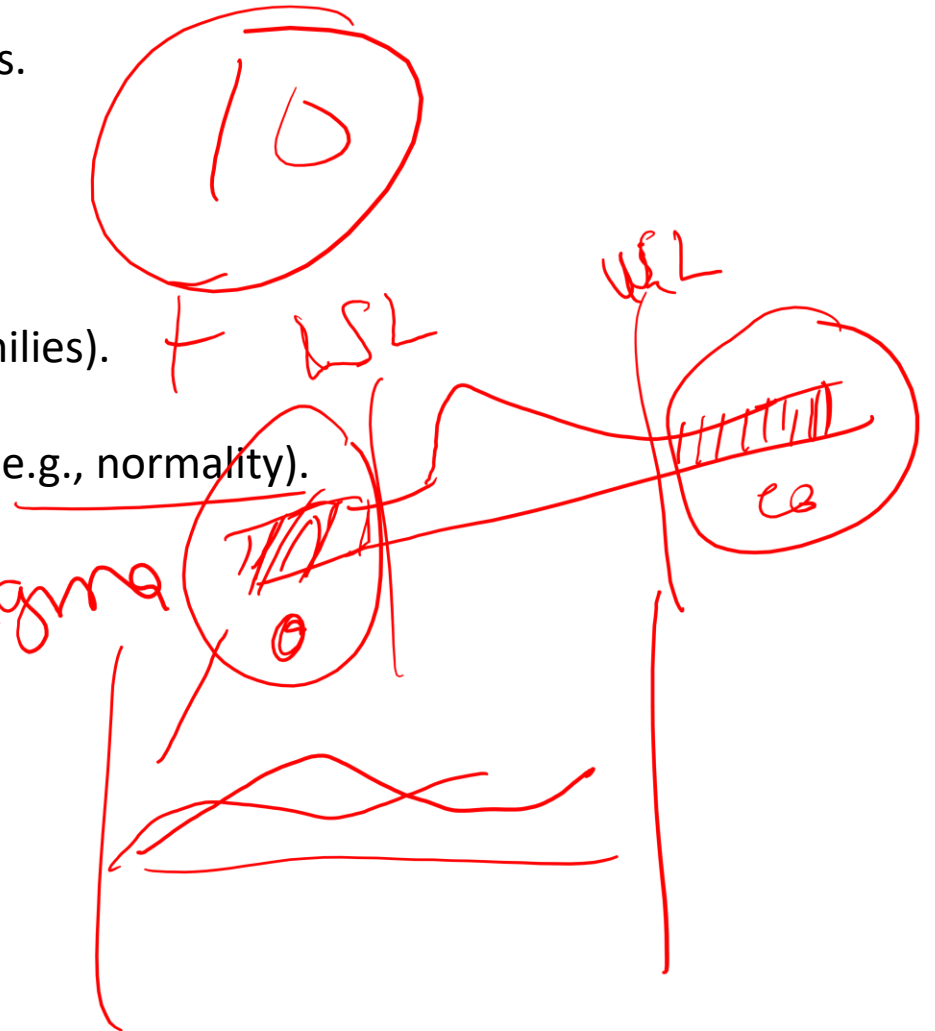
- X-axis: value intervals (e.g., water usage).
- Y-axis: number of observations per interval (e.g., number of families).
- Helps visualize the shape and spread of data.
- A probability density curve can be added to assess distribution (e.g., normality).

Best Used For

- Understanding data distribution and variation. — six sigma
- Detecting skewness, peaks, or outliers.
- Evaluating normality and guiding statistical analysis.

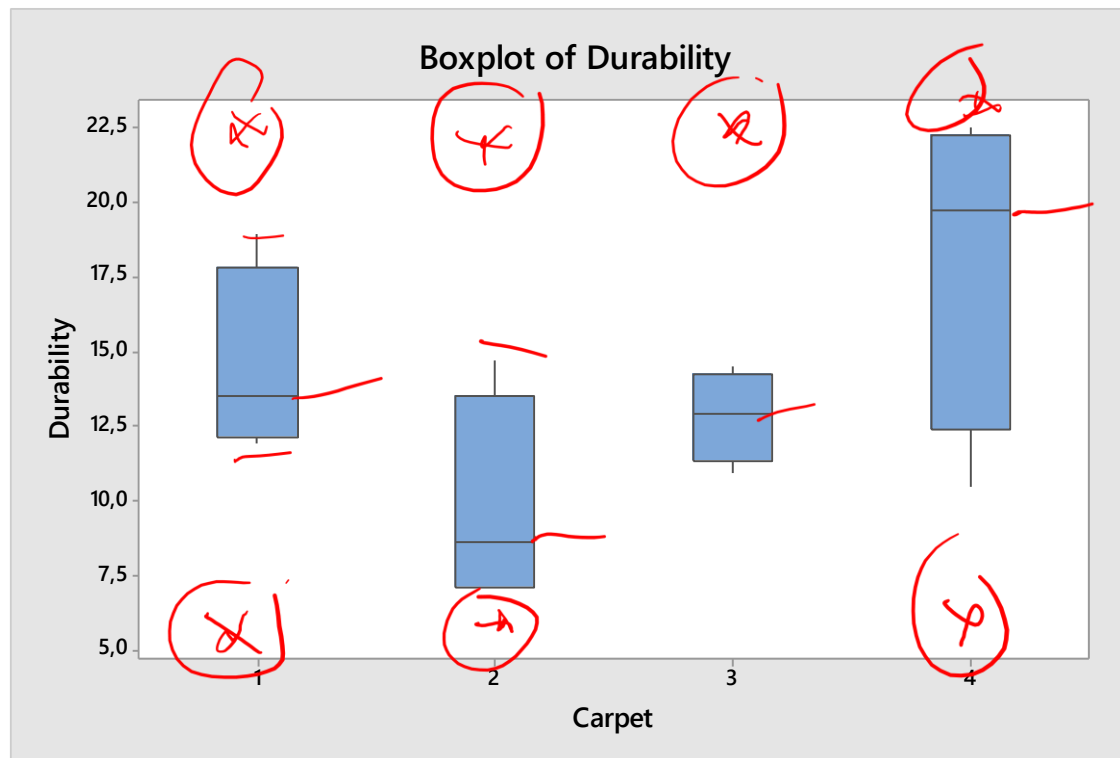
Data Type

- Continuous numerical data (e.g., usage, measurements).
- Requires a large sample size for meaningful insights.



7. Box Plot

- Use the Box Plot (box-and-whisker plots) to visualise and compare data distributions.



Box Plot – Explained

- A graphical summary of a dataset's distribution, central tendency, and variability.
- Shows the smallest value, the largest value, the median, and the quartiles (25%, 50%, 75%).

Q1 Q2 Q3

How It Works

- Box spans the Interquartile Range ($IQR = Q3 - Q1$), showing the middle 50% of data.
- Line inside box = Median (Q2).
- Whiskers extend to data within $1.5 \times IQR$ from Q1 and Q3.
- Outliers beyond whiskers are shown as individual points.

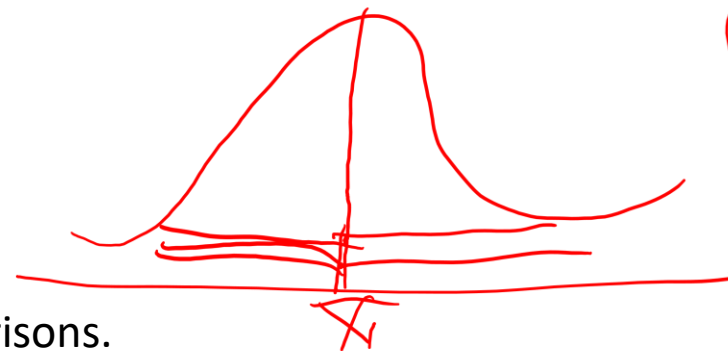
Best Used For

- Comparing distributions across multiple groups.
- Detecting outliers, spread, and skewness.
- Quickly assessing data symmetry and variability.

Data Type

- Continuous numerical data.
- Works well with large datasets and for group comparisons.

Mean
Median —
Mode



U6 – CREATING STABLE AND EFFICIENT PROCESSES (DEFINE)

E1 – PROCESS MAPPING

CONTINUOUS IMPROVEMENT MATURITY MODEL



D DEFINE

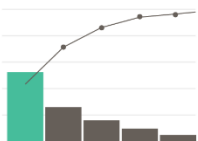
DEFINE AND SCOPE PROJECT
DEFINE DEFECT AND CTQ'S
PLAN AND DOCUMENT PROJECT



VOICE OF CUSTOMER



PROJECT CHARTER



PARETO

'OK FOR CUSTOMER'

VOC

CUSTOMER SPECIFICATION

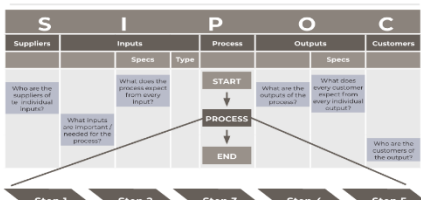
CTQ_{EXT}

INTERNAL SPECIFICATION

CTQ_{INT}



HARD AND SOFT BENEFITS



M MEASURE

EVALUATE MEASUREMENT SYSTEM
ESTABLISH BASELINE
SET IMPROVEMENT GOALS



TAKT TIME
VS
CYCLE TIME

$$OEE = \frac{B}{A} \times \frac{D}{C} \times \frac{F}{E}$$

AVAILABILITY RATE

PERFORMANCE RATE

QUALITY RATE



CURRENT PERFORMANCE



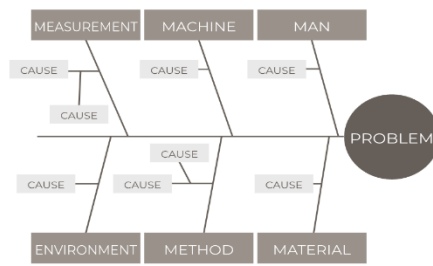
A ANALYZE

MAP PROCESS AND IDENTIFY INPUTS
ISOLATE KEY INPUTS
DEVELOP Y=F(X) FUNCTION



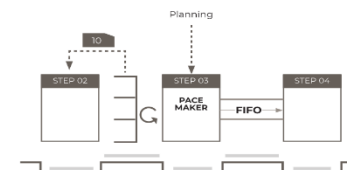
VSM CURRENT STATE

1. OVER PRODUCTION
2. WAITING
3. TRANSPORT
4. OVER PROCESSING
5. INVENTORY
6. MOVEMENT
7. DEFECTS
8. UNUSED EXPERTISE

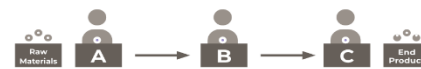
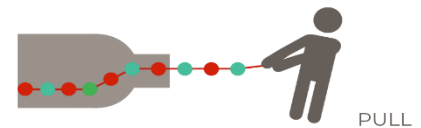
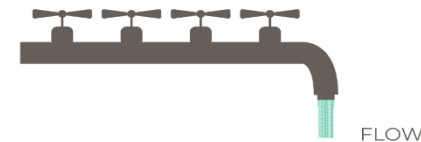


I IMPROVE

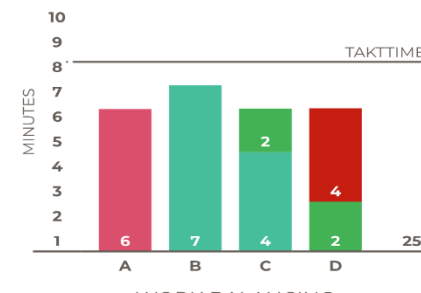
DETERMINE OPTIMUM SETTINGS
IMPLEMENT PROPOSED IMPROVEMENT
VALIDATE PROPOSED IMPROVEMENT



VSM FUTURE STATE



CONTROL WORK IN PROCESS

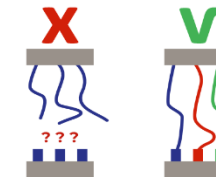


C CONTROL

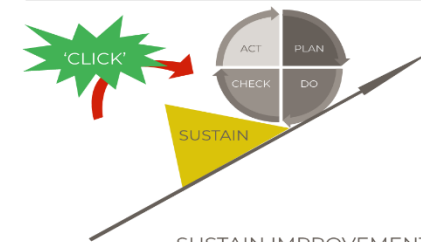
IMPLEMENT CONTROL STRATEGY
CLOSE OUT PROJECT
CELEBRATE RESULTS



FIRST TIME RIGHT



POKA YOKE



SUSTAIN IMPROVEMENTS



CONTROL PLAN/
CHECKLIST

LESSONS
LEARNED

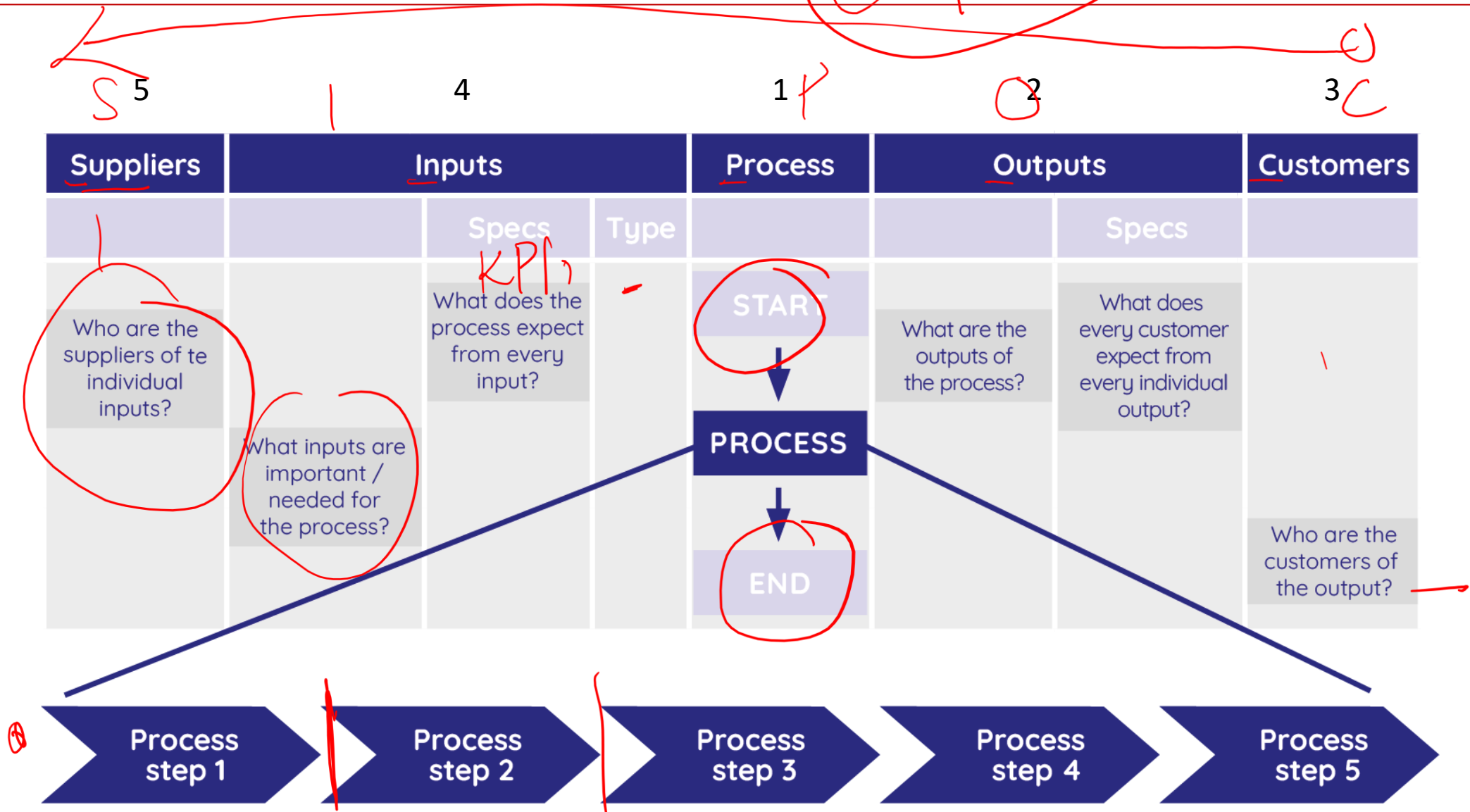


POSSIBLE TOOLS AT LEVEL III

Define	Measure	Analyze	Improve	Control
✓ Project Charter	Performance Metrics	VSM - Current State	VSM - Future State	Standardized Work
✓ Voice of Customer	Time Series Plot	Graphical Tools	Kaizen improvements	5S
✓ Costs of Poor Quality	OEE Analysis	Ishikawa	Reducing Muda (8 x Waste)	First Time Right, Poka Yoke
SIPOC —		Brainstorm Techniques	Reducing Muri (Overburden)	Jidoka
Process Mapping —		Affinity Diagram	Flow, Balancing, TOC	Visual Management
Swimlane —			Reducing Mura (Unevenness)	Performance Management
✓ Pareto			Pull, Kanban, FIFO, CONWIP	Short Interval Management
✓ CTQ Flowdown			Levelling	FMEA, Control Plan
✓ Stakeholder Analysis			SMED	Standard Operation Procedure
				Training (Skill development)
				Maintenance (TPM)
				Statistical Process Control
				Auditing

HIGH-LEVEL PROCESS DESCRIPTION AND SIPOC

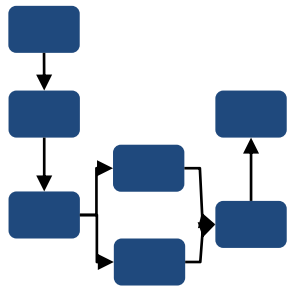
COPIS



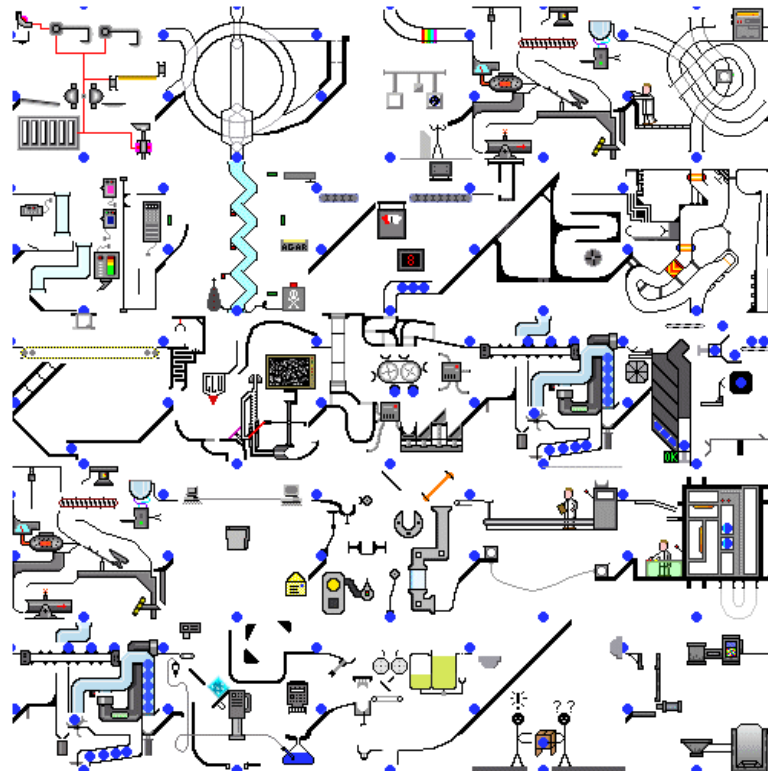


Process interpretations

How you think it is



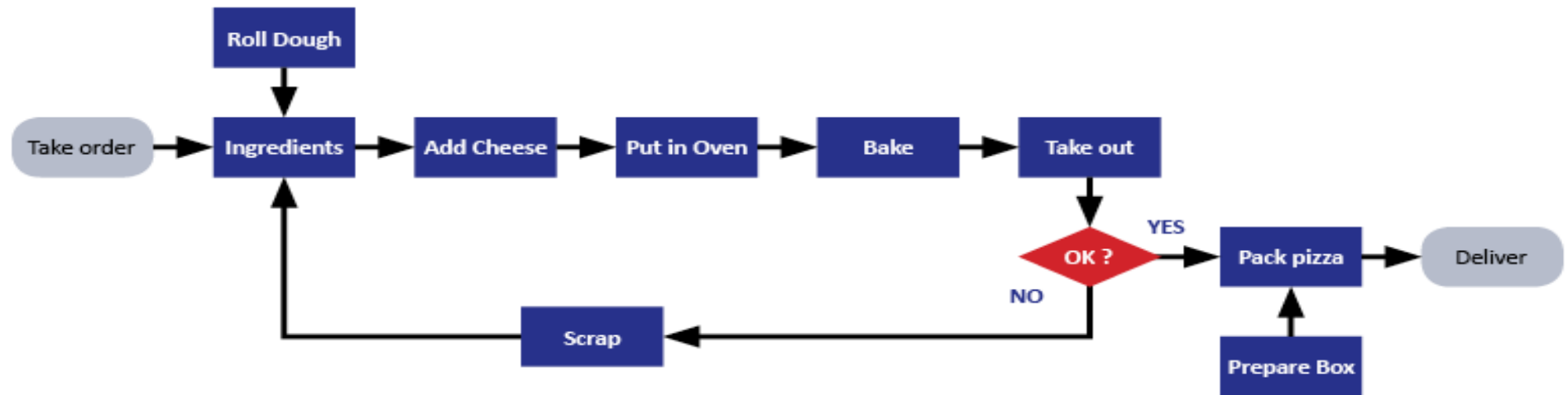
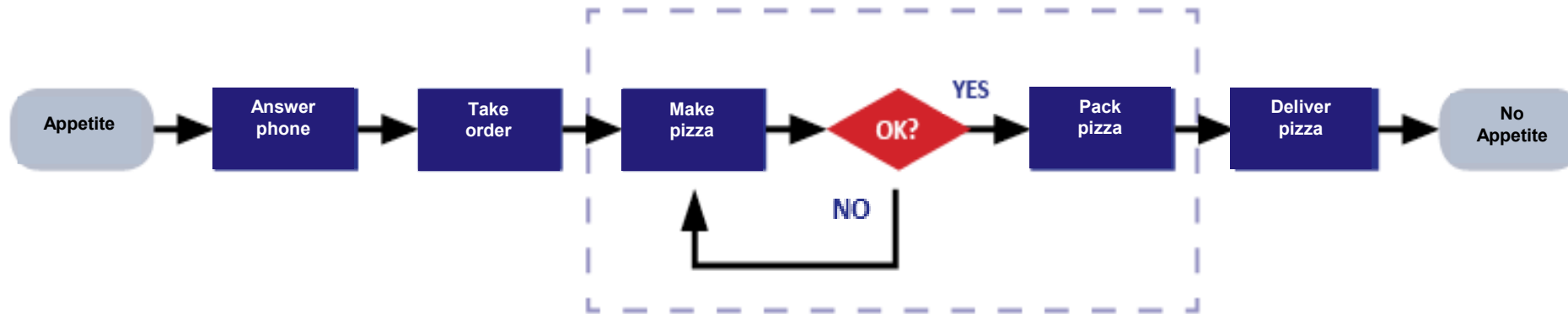
How it really is!



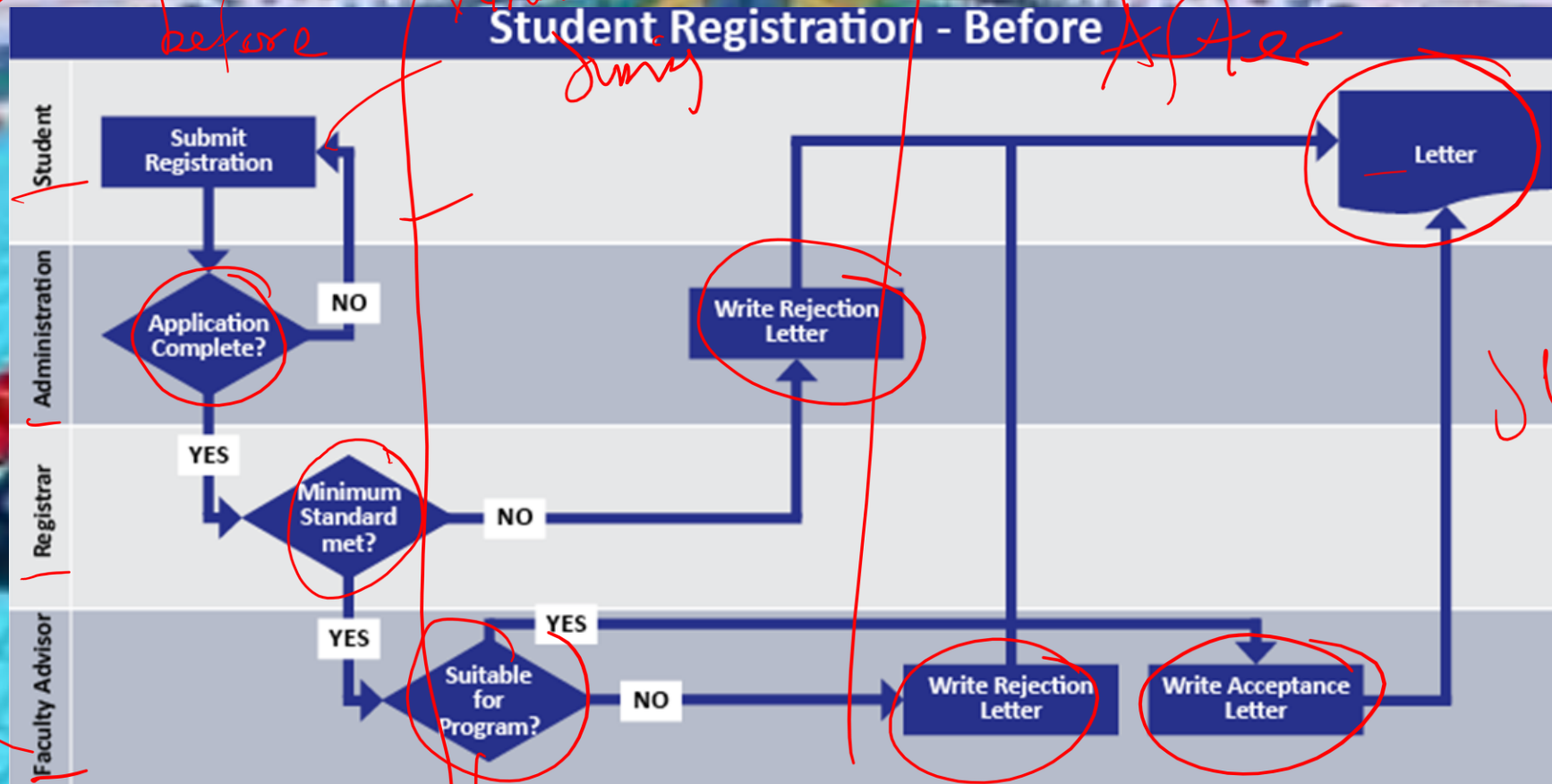
How you would like it



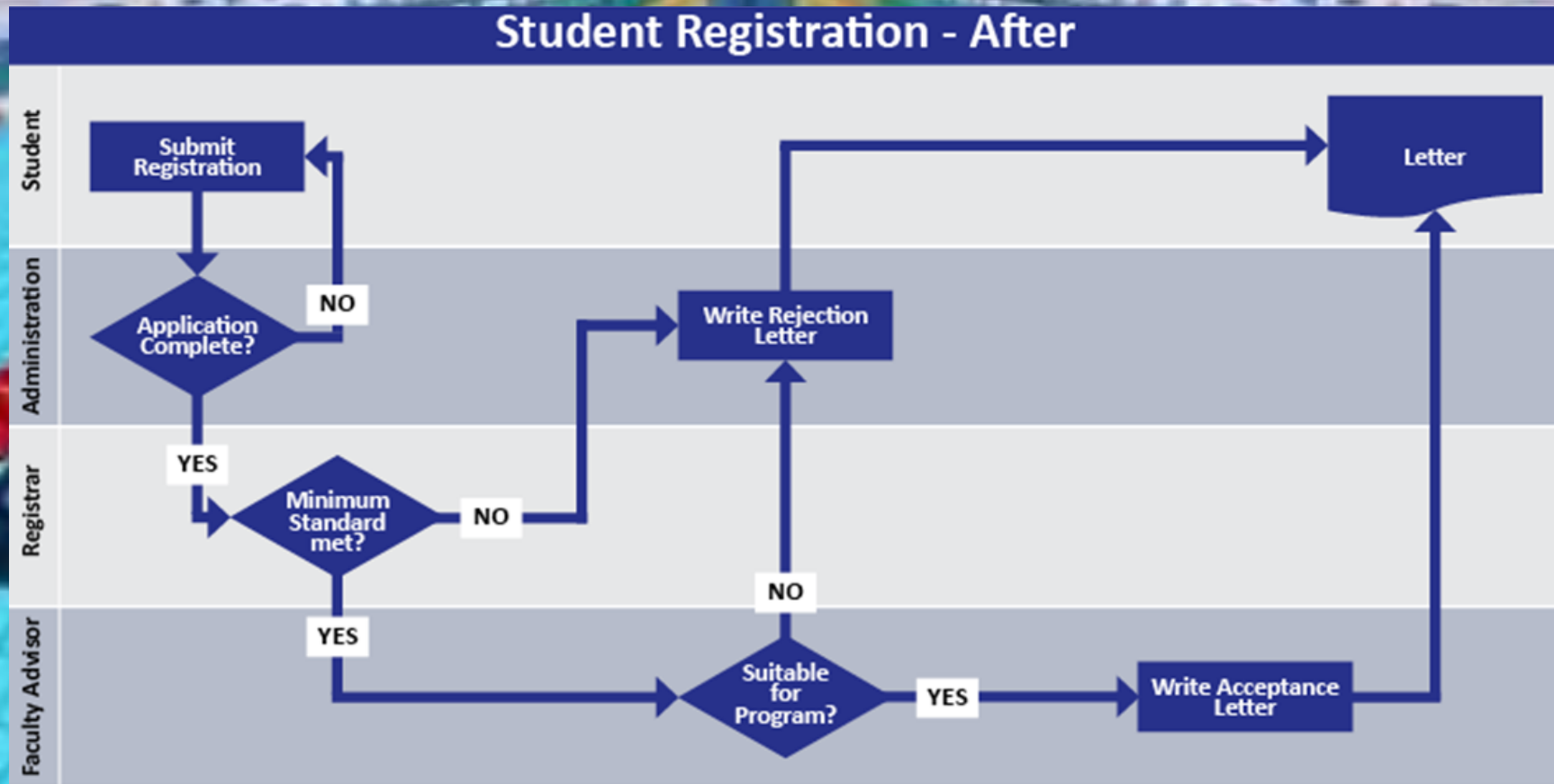
PROCESS FLOW DIAGRAM



PROCESS FLOW DIAGRAM



PROCESS FLOW DIAGRAM



U6 – CREATING STABLE AND EFFICIENT PROCESSES (MEASURE)

E2 – PERFORMANCE METRICS

Performance Metrics (Time)

Time / Quality

- Takt time ✓
- Process time ✓
- Cycle time ✓
- Waiting time ✓
- Lead time ✓

POSSIBLE TOOLS AT LEVEL III

Time-related
Quality-related

Define	Measure	Analyze	Improve	Control
✓ Project Charter	Performance Metrics	VSM - Current State	VSM - Future State	Standardized Work
✓ Voice of Customer	✓ Time Series Plot	Graphical Tools	Kaizen improvements	5S
✓ Costs of Poor Quality	OEE Analysis	Ishikawa	Reducing Muda (8 x Waste)	First Time Right, Poka Yoke
✓ SIPOC		Brainstorm Techniques	Reducing Muri (Overburden)	Jidoka
✓ Process Mapping		Affinity Diagram	Flow, Balancing, TOC	Visual Management
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✓ Stakeholder Analysis			SMED	Standard Operation Procedure
				Training (Skill development)
				Maintenance (TPM)
				Statistical Process Control
				Auditing

U6 – CREATING STABLE AND EFFICIENT PROCESSES (MEASURE)

E2 – PERFORMANCE METRICS



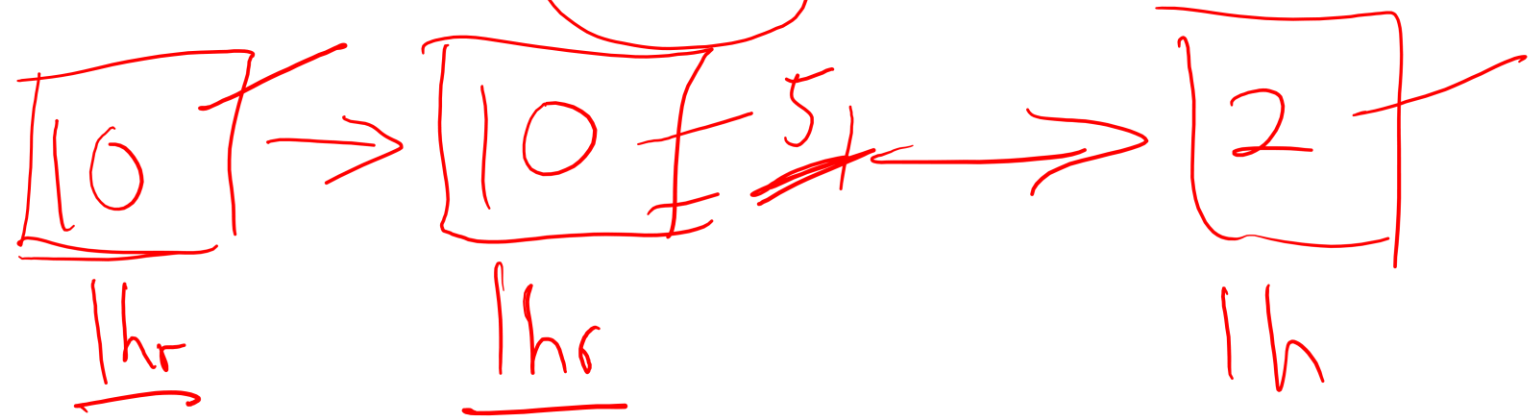
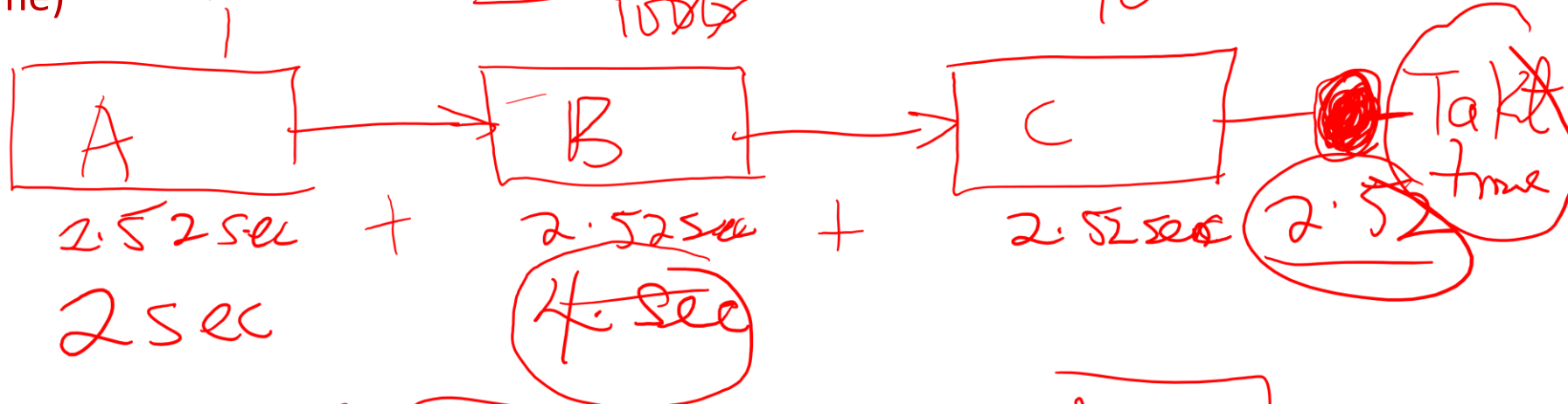
PERFORMANCE METRICS (TIME)

Available time / Customer demand ; 8 hrs / day, 1 hr of break
 1000

$$Takt = \frac{7 \text{ (hrs)} \times 60 \times 60}{1000} = \frac{7 \times 6 \times 6}{10} = 2.52$$

Performance Metrics (Time)

- Takt time
- Process time
- Cycle time
- Waiting time
- Lead time



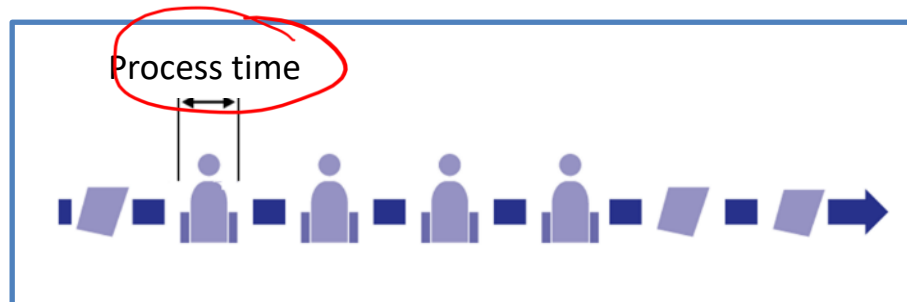
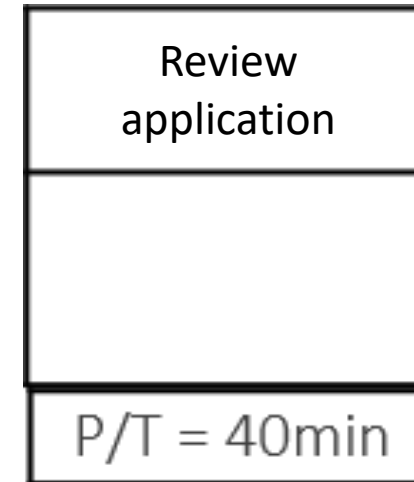
PERFORMANCE METRICS (TIME)


$$\text{Takt time} = \frac{\text{Available process time}}{\text{Customer demand}}$$

Production pace that delivers precisely the number of products that the customer wants

PERFORMANCE METRICS (TIME)

Process time

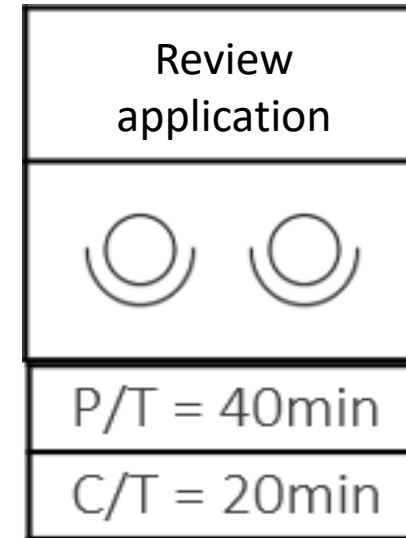


Process time = P/T
 necessary time for finishing all activities in an individual process step. It is **pure work time**. It excludes any waiting, transport, or setup delays.



PERFORMANCE METRICS (TIME)

Cycle time



$$C/T = \frac{P/T}{\# \text{ FTE}}$$

Cycle time = C/T

The average time between the finishing of two successive orders or across an operation. Unlike process time, it includes brief stops, changeovers, and small delays inherent in production. *For instance, if you run a 480-minute shift and finish 60 units at one station, your cycle time is 8 minutes per unit.*

$$\frac{480}{60} = 8 \text{ minutes/unit}$$

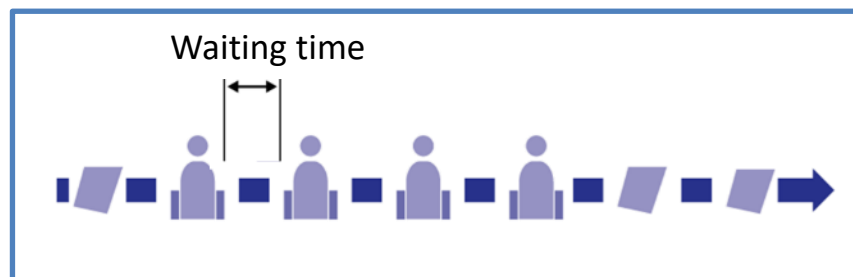


PERFORMANCE METRICS (TIME)

Waiting time

I
246

Review application
P/T = 40min
C/T = 20min



Waiting time

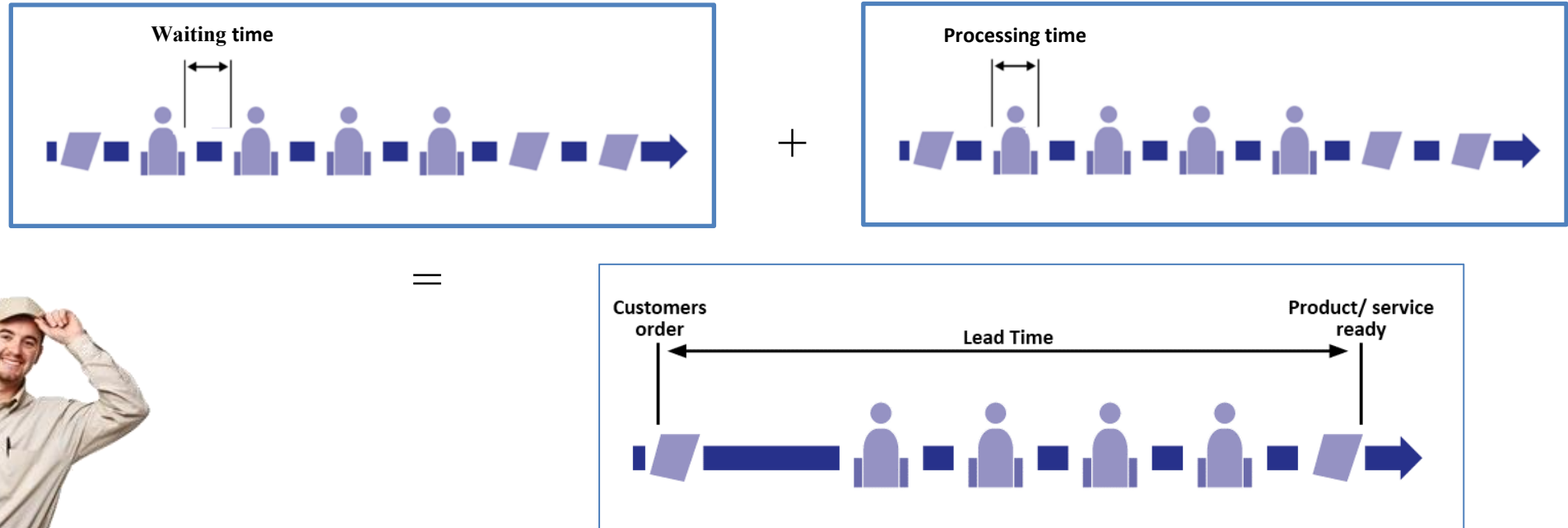
Captures all non-value-added intervals during which a unit sits idle—either waiting for the next operation, queued in a buffer, or simply paused.

It does not add value; it represents wasted time you want to minimize.



PERFORMANCE METRICS (TIME)

Lead time



Lead time = total of all processing and waiting times

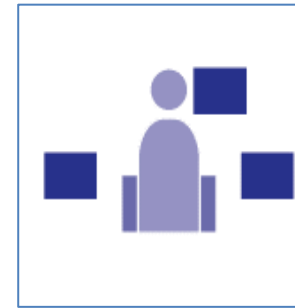
Lead time is the total elapsed time from when a customer places an order until it's delivered, covering every process and waiting interval in the value stream. It inherently includes processing, transport, buffering, and any external delays. If processing takes 2 hours, waiting adds 1 hour, and shipping requires another hour, the lead time totals 4 hours.



PERFORMANCE METRICS (TIME)

(Handwritten red scribble)

Work in Process (Progress)



Work In Process = WIP

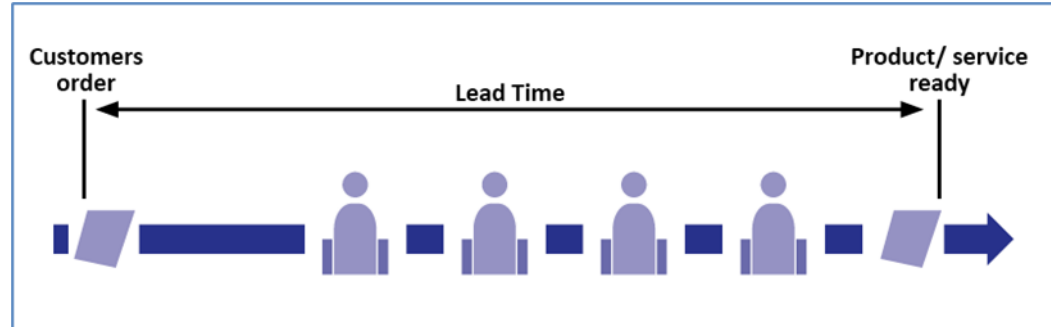
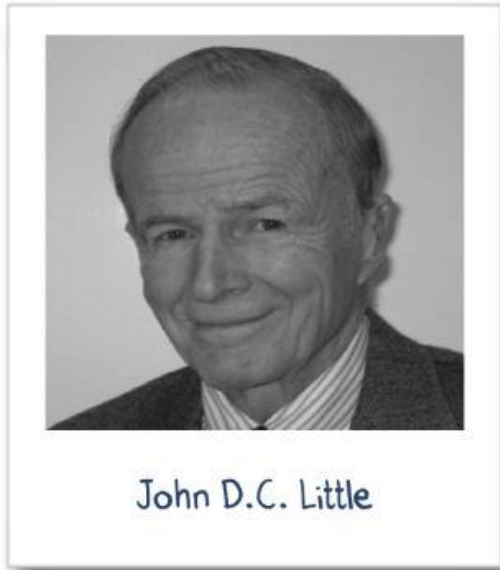
Denotes the number of units or materials currently between the start and finish points in your system. It includes everything actively being processed, queued, or in transit within the value stream.

If you have 30 units on machines and 20 units waiting in buffers, your WIP is 50 units.



PERFORMANCE METRICS (TIME)

Little's Law



Throughput is the rate at which a system completes work over a defined period. It answers the question:

“How many finished units (or services) leave the process per unit of time?”

Little's Law links WIP, throughput, and lead time in a simple relationship:

$$\underline{WIP} = \underline{\text{Throughput}} \times \text{Lead Time}$$

This applies to an entire system or any sub-flow and assumes a stable average flow.

For example, if you average 5 units per hour in throughput and maintain a 4-hour lead time, you can expect around 20 units in process at any given moment.

(WIP)

Little's law:

$$\text{Lead Time} = \frac{\text{Work in Progress}}{\text{Throughput}}$$



PERFORMANCE METRICS (QUALITY)

(99.9557%)

Performance Metrics (Quality)

- ppm: Parts per Million
- DPU: Defects per Unit
- DPMO: Defects per Million Opportunities
- Process Yield
- RTY: Rolled Throughput Yield

3.4 defects are allowed in a million

PERFORMANCE METRICS (QUALITY)

ppm: Parts per Million

- In high volume operations with high demand for quality, the ppm measure is used to indicate the quality performance of a production process.

Example:

- If the quality level is very important, for example in medical diagnoses, the number of errors can be indicated in ppm.



350 / million

350 ppm

350 incorrect diagnoses per million diagnoses or
3.5 incorrect diagnoses per ten thousand diagnoses.

PERFORMANCE METRICS (QUALITY)

DPU: Defects per Unit

- DPU is the number of defects per unit
- DPU can be greater than 1 because a unit can have several defects.
For instance: a hood can be dented and/or scratched.

Measures average number of defects each unit carries, regardless of severity or location.

Use when you expect multiple defects per item and want an overall quality burden.

Example

- Number of Units = 30 number of inspected hoods. ✓
- Number of Defects = 53 number of dents + number of scratches.

$$\text{DPU} = \frac{\text{number of defects}}{\text{number of units}} = \frac{53}{30} = 1.77$$

1.77 DPU

On each hood there are on average 1.77 defects.



PERFORMANCE METRICS (QUALITY)

DPMO: Defects per Million Opportunities

- Opportunities = 2 possible defects per unit (dents and scratches).
- Number of Units = 30.000 number of hoods.
- Number of Defects = 53 number of dents + scratches.

$$\text{DPMO} = \frac{1.000.000 \times \text{Number of Defects}}{\text{Opportunities} \times \text{Number of Units}} = \frac{53 \times 10^6}{2 \times 30.000} = 883$$

883 DPMO

If we produce 500,000 hoods, we can expect that there will be 883 defects (dents and scratches).

PERFORMANCE METRICS (QUALITY)

VOP

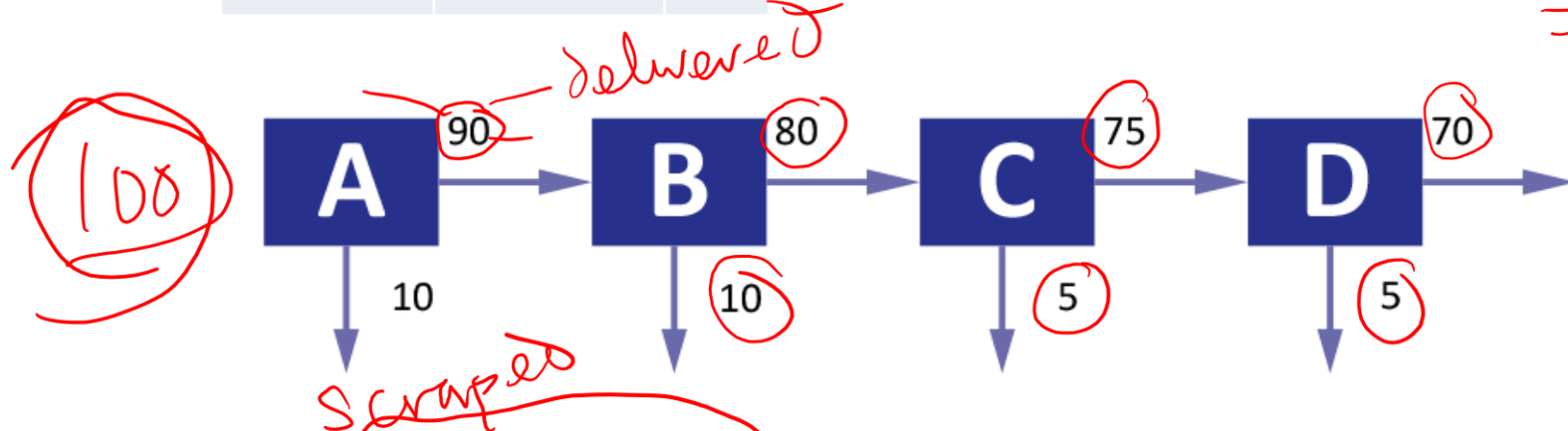
Process Yield

All time

What came out
What came in

Process	Scrap	Out	Process Yield	
A	10	90	$90 / (90+10)$	$= 90 / 100 = 90\%$
B	10	80	-	-
C	5	75	-	-
D	5	70	-	-

x
x
x



$$\frac{70}{100} = 70\%$$

Total Process Yield =

~~xxxx~~



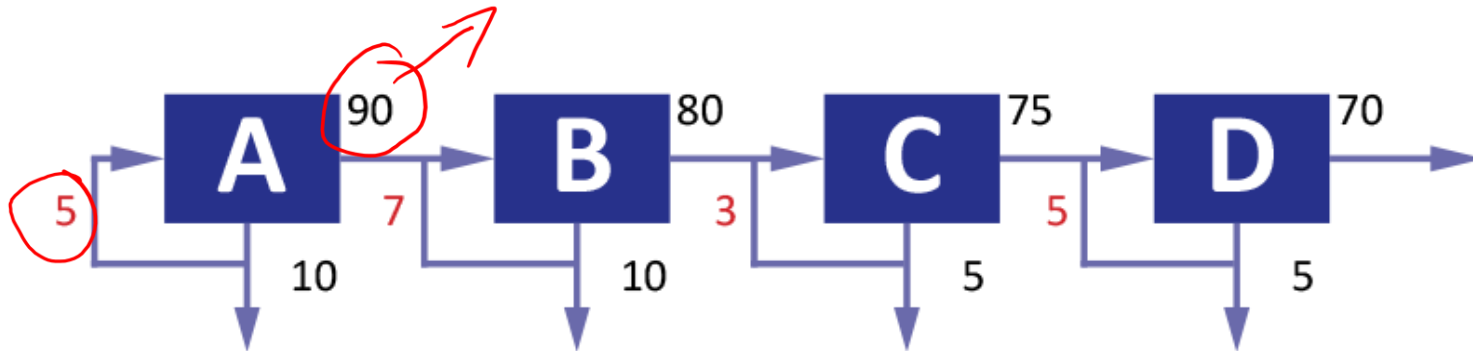
PERFORMANCE METRICS (QUALITY)



RTY: Rolled Throughput Yield

Process	Scrap	Rework	Out	First Time Right Yield		
A	10	5	90	$(90-5) / (90+10)$	= 85 / 100	= 85%
B	10	7	80	---	---	---
C	5	3	75	---	---	---
D	5	5	70	---	---	---

Input



Rolled Throughput Yield =



U6 – CREATING STABLE AND EFFICIENT PROCESSES (MEASURE)

E3 – BASIC STATISTICS

GROUP WORK

Nominal

- Objects have no natural order. (Just names or labels, no order.)
- Example: Gender (man/woman).

Ordinal

- Has an order, but gaps between values don't mean anything.
- Example: Ranking in a race (1st, 2nd, 3rd).

Interval

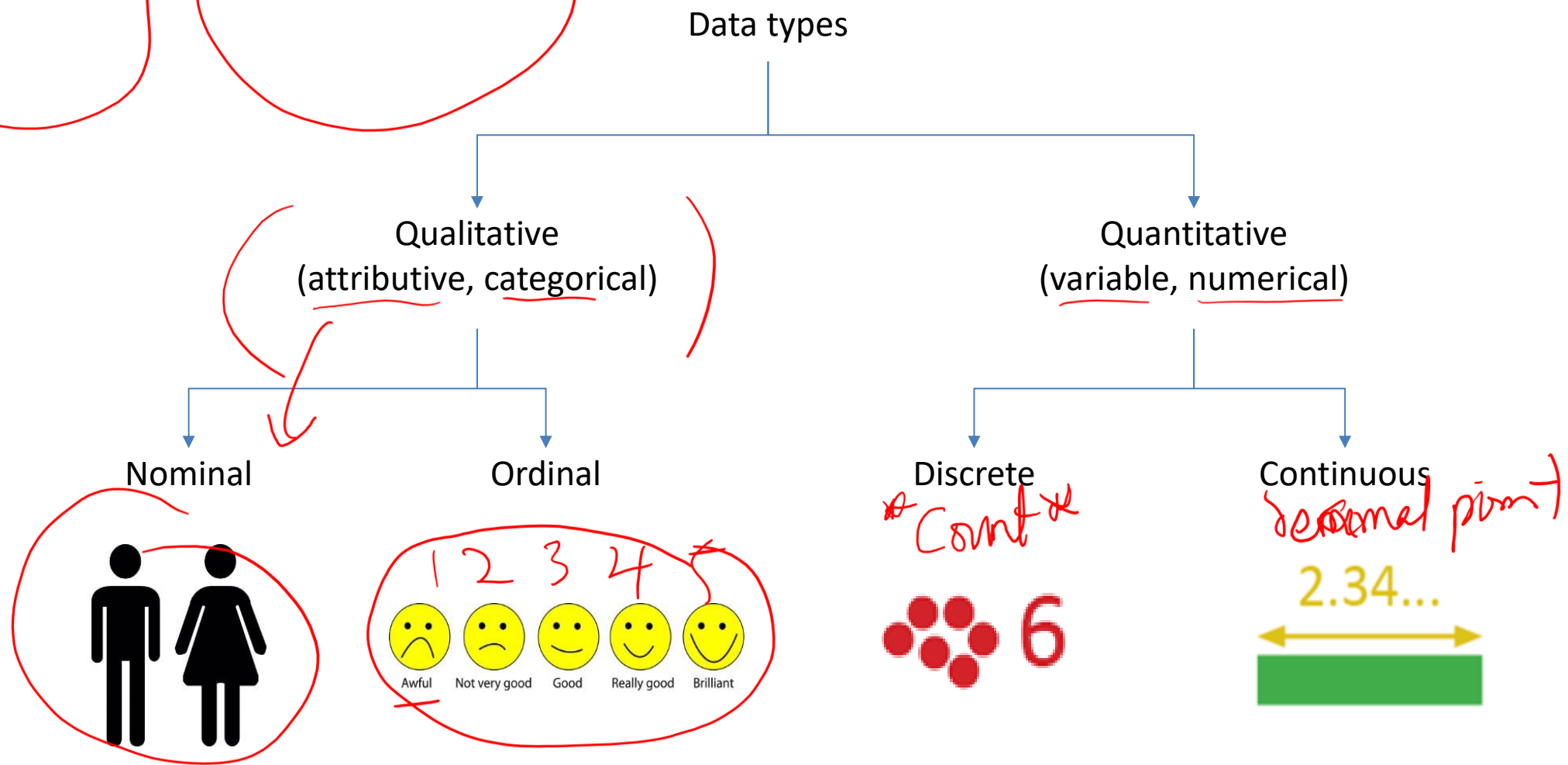
- Has order and equal gaps, but no true zero. *Zero does not mean "none of the thing exists." Example: 0°C doesn't mean "no temperature," it just means a point on the Celsius scale.*

Ratio

- **Has order** → The values can be arranged from low to high. *Example: 10 kg is less than 20 kg.*
- **Equal gaps** → The difference between values is consistent and meaningful. *Example: The gap between 10 kg and 20 kg is the same size as the gap between 20 kg and 30 kg (both are 10 kg apart).*
- **True zero** → Zero means the complete absence of what's being measured. *Example: 0 kg means no weight at all; 0 meters means no length.*
- **Ratios make sense** → Because there's a true zero, you can compare values as multiples. *Example: 20 kg is twice as heavy as 10 kg; 100 m is four times longer than 25 m.*

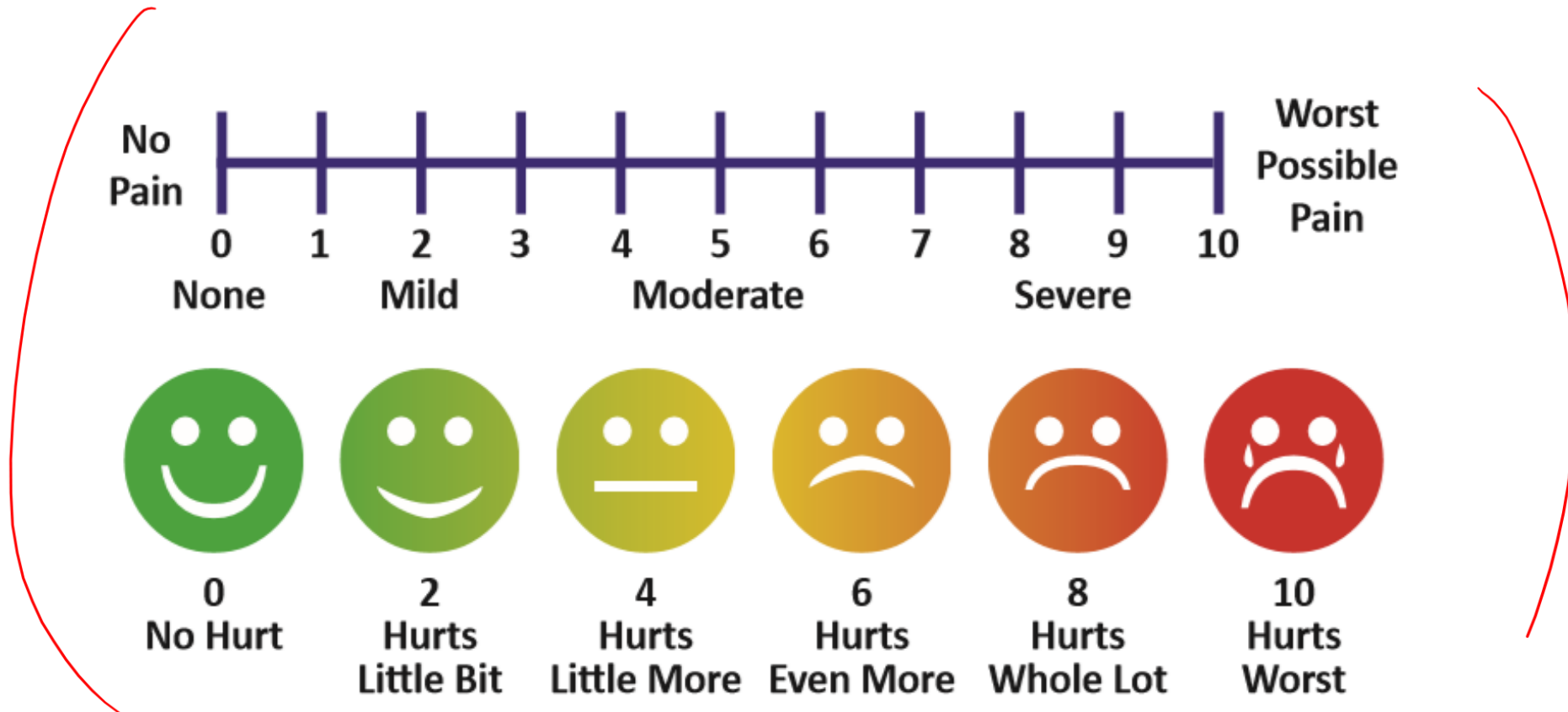


Qualitative data vs. Quantitative data



Data type	Scale type	Natural order	Quantifiable differences	Meaningful zero exists	Example
<u>Qualitative</u>	<u>Nominal</u>	-	-	-	Blood type: (A+, A-, B+, B-, AB+, AB-, O+)
	Ordinal	X	-	-	Performance rating (scale 1 to 5)
Quantitative	<u>Interval</u>	X	X	-	Temp. in an oven is higher than room temperature
	Ratio	X	X	X	<u>Height of tower; number of inhabitants</u>

Likert Scale



1. Data sheet

Worksheet 3 ***

↓	C1	C2-T	C3	C4	C5	C6
	Nr	Material	Force	Speed	Length	Diameter
1	1	A	100	1,0		
2	2	B	100	1,0		
3	3	A	150	1,0		
4	4	B	150	1,0		
5	5	A	100	2,0		
6	6	B	100	2,0		
7	7	A	150	2,0		
8	8	B	150	2,0		
9	9	A	125	1,5		
10	10	B	125	1,5		

2. Check sheet

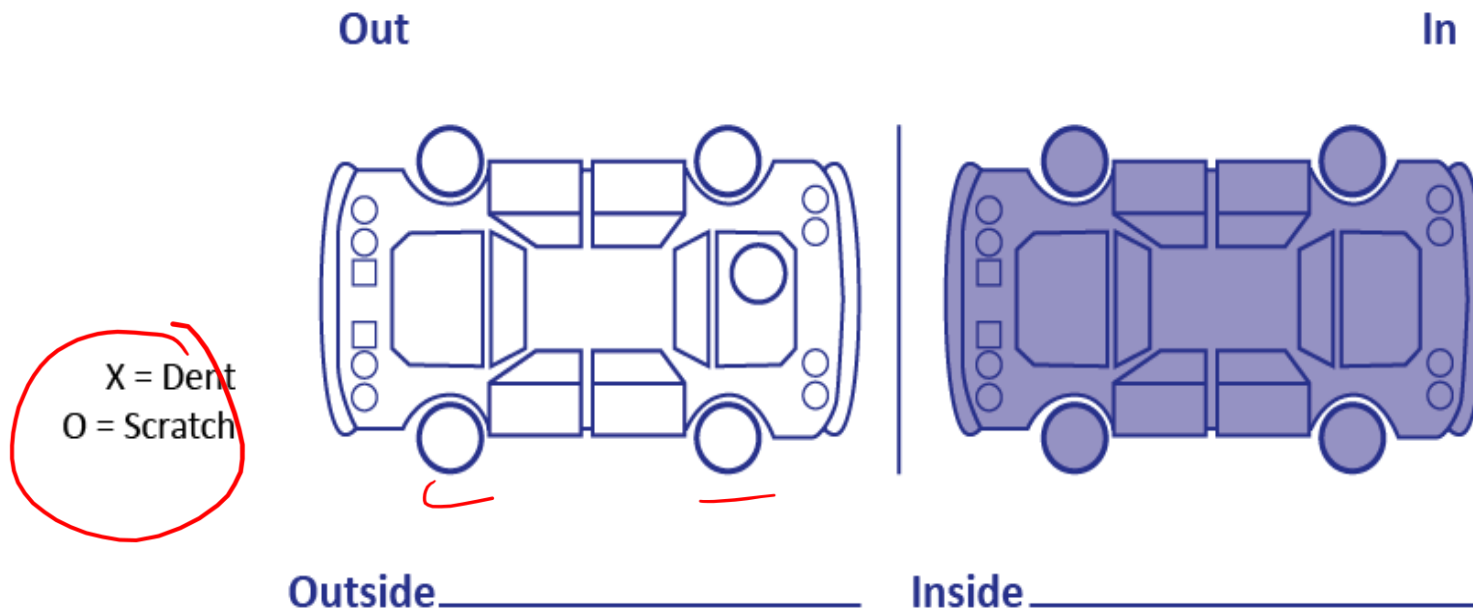
	Tally sheet				
Lamp defect					
Illegible code	###	###			
Empty battery	###	###	###		
Scratch on lens					
Broken ring	###				
Missing cord	###				

3. Frequency plot Check sheet

Age	Tally	Frequency
0 - 9		8
10 - 19		12
20 - 29		24
30 - 39		43
40 - 49		41
50 - 59		27
60 - 69		23
70 - 79		18
80 - 89		3
90 - 99		1

4. Concentration diagram

Damage Diagram



5. Questionnaire or Survey

Training survey

General information

Company name

Your name

Job title

Please rate the following statements.

	1. Strongly disagree	2.	3.	4.	5. Strongly agree
The trainer is very competent in translating theory into practice.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is a good balance between theory, practice, and interaction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The trainer has an advanced level of knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How likely is it that you would recommend this training to a friend or colleague?

Not at all likely
Extremely likely

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Possible tools at Level III

Define	Measure	Analyze	Improve	Control
✓ Project Charter	✓ Performance Metrics	VSM - Current State	VSM - Future State ✓	Standardized Work
✓ Voice of Customer	✓ Time Series Plot	✓ Graphical Tools	Kaizen improvements	5S
✓ Costs of Poor Quality	OEE Analysis	✓ Ishikawa	Reducing Muda (8 x Waste)	First Time Right, Poka Yoke
✓ SIPOC		✓ Brainstorm Techniques	Reducing Muri (Overburden)	Jidoka
✓ Process Mapping		✓ Affinity Diagram	Flow, Balancing, TOC	Visual Management
✓ Swimlane			Reducing Mura (Unevenness)	Performance Management
✓ Pareto			Pull, Kanban, FIFO, CONWIP	Short Interval Management
✓ CTQ Flowdown			Levelling	FMEA, Control Plan
✓ Stakeholder Analysis			SMED	Standard Operation Procedure
				Training (Skill development)
				Maintenance (TPM)
				Statistical Process Control
				Auditing

Time-related
Quality-related

U6 – CREATING STABLE AND EFFICIENT PROCESSES (ANALYZE)

E4 – VALUE STREAM ANALYSIS (VSM)



Value Stream mapping
Identifying and eliminating Waste in a process



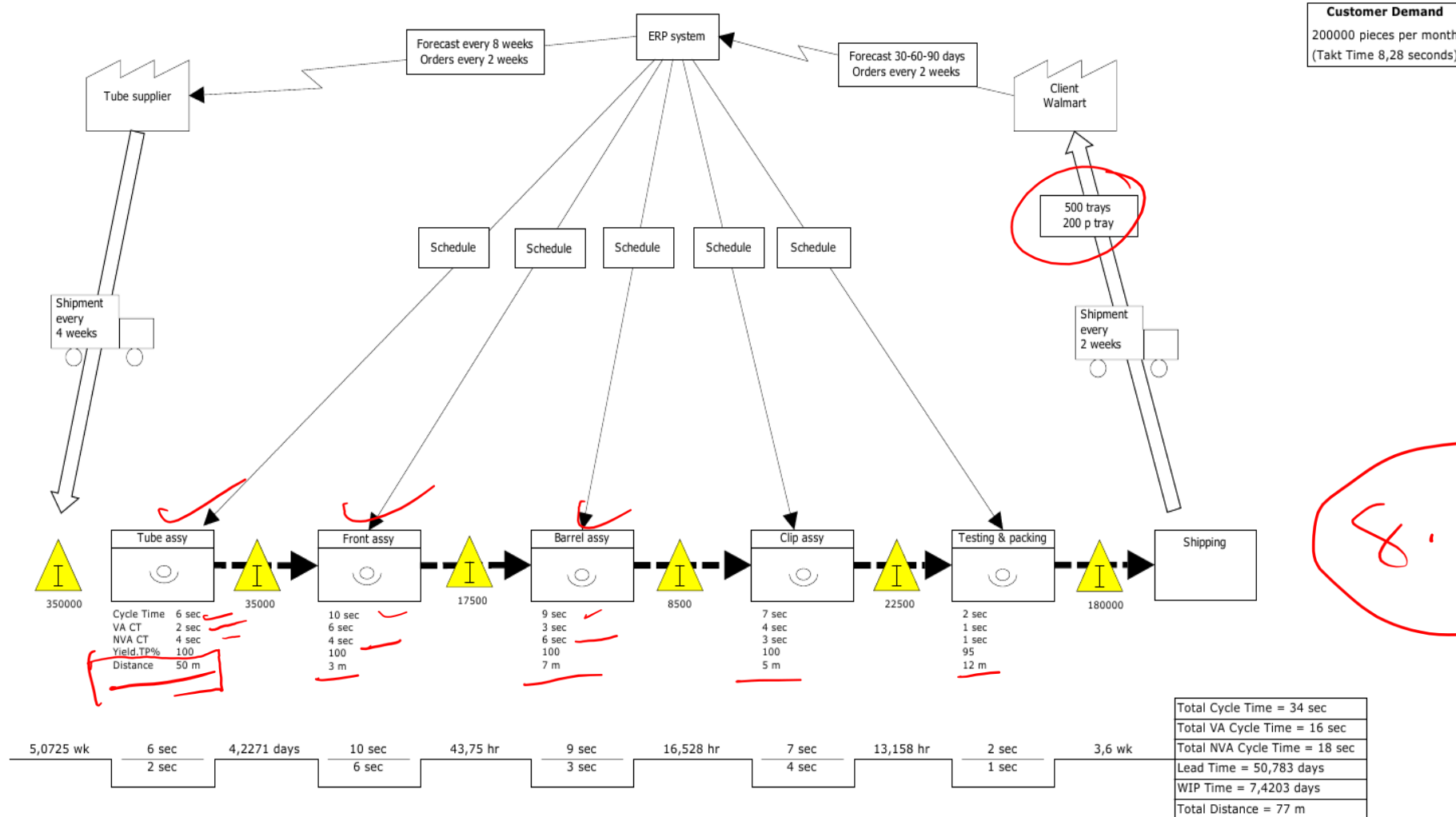
Shigeo Shingo



Taiichi Ohno

Value = Activities the customer is willing to pay for.
Activities that are important to the customer.

VALUE STREAM MAPPING (CURRENT STATE)



8.28

U6 – CREATING STABLE AND EFFICIENT PROCESSES (IMPROVE)

E5 – REDUCING MUDA (WASTE)



Muda: ①
Waste, uselessness, non-value added or idleness.











Muri: ②
Overburden, impossible, beyond one's power or expertise.



Mura: ③
Unevenness, irregularity or lack of uniformity.

Types of Waste (MUDA) *waste*

-  1. **Over-production** Producing more than asked by market
-  2. **Waiting** Goods or documents not being processed ✓
-  3. **Transport** Transporting materials or products ✓
-  4. **Over-processing** Taking unneeded steps to process parts ✓
-  5. **Inventory** Unnecessary supplies or stock ✓
-  6. **Movement** Searching and unnecessary movements ✓
-  7. **Defects** Faults, scrap or bad quality ✓
-  8. **Unused expertise** Not using existing expertise or knowledge

Cost saving

U6 – CREATING STABLE AND EFFICIENT PROCESSES (IMPROVE)

E6 – REDUCING MURI (OVERBURDEN)



REDUCING MURI (OVERBURDEN)



Muda:
Waste, uselessness, non-value added or idleness.



Muri:
Overburden, impossible, beyond one's power or expertise.



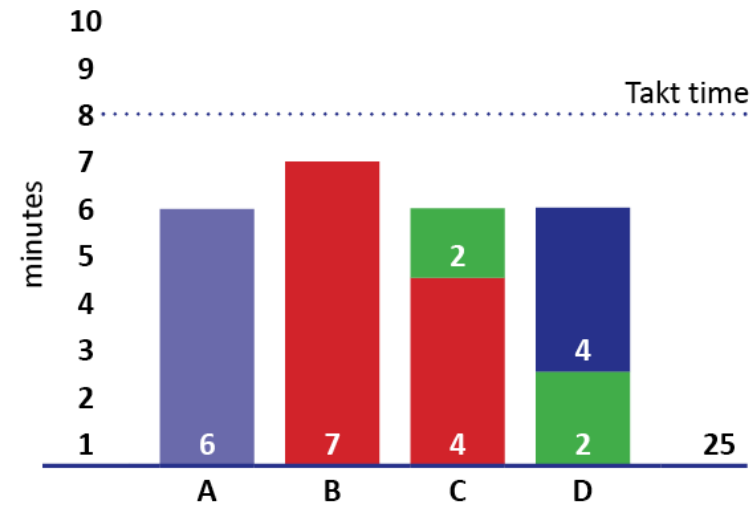
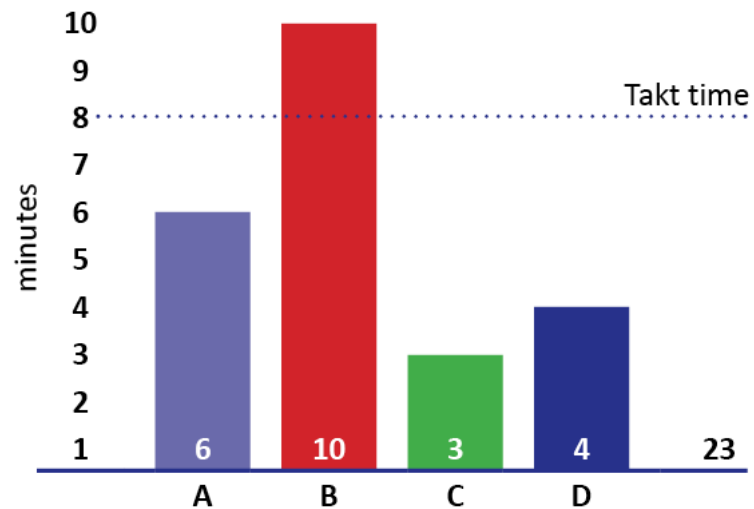
Mura:
Unevenness, irregularity or lack of uniformity.



Continuous Flow
Ensure an even flow of the process

Aim for a balanced workload:

- Set the Takt time as a metric for each workstation.
- Redesign the process so the work can be done within the Takt Time.
- Standardize procedures and work.



U6 – CREATING STABLE AND EFFICIENT PROCESSES (IMPROVE)

E7 – REDUCING MURA (UNEVENNESS)

REDUCING MURA (UNEVENNESS)



Muda:
Waste, uselessness, non-value added or idleness.



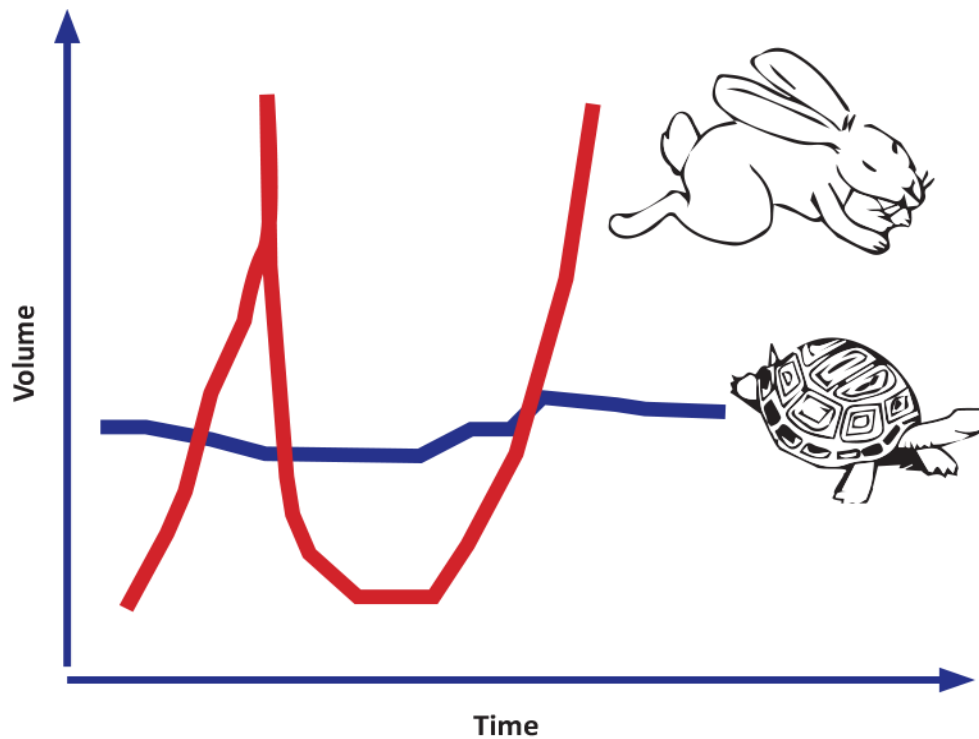
Muri:
Overburden, impossible, beyond one's power or expertise.



Mura:
Unevenness, irregularity or lack of uniformity.

Turtle vs. Hare

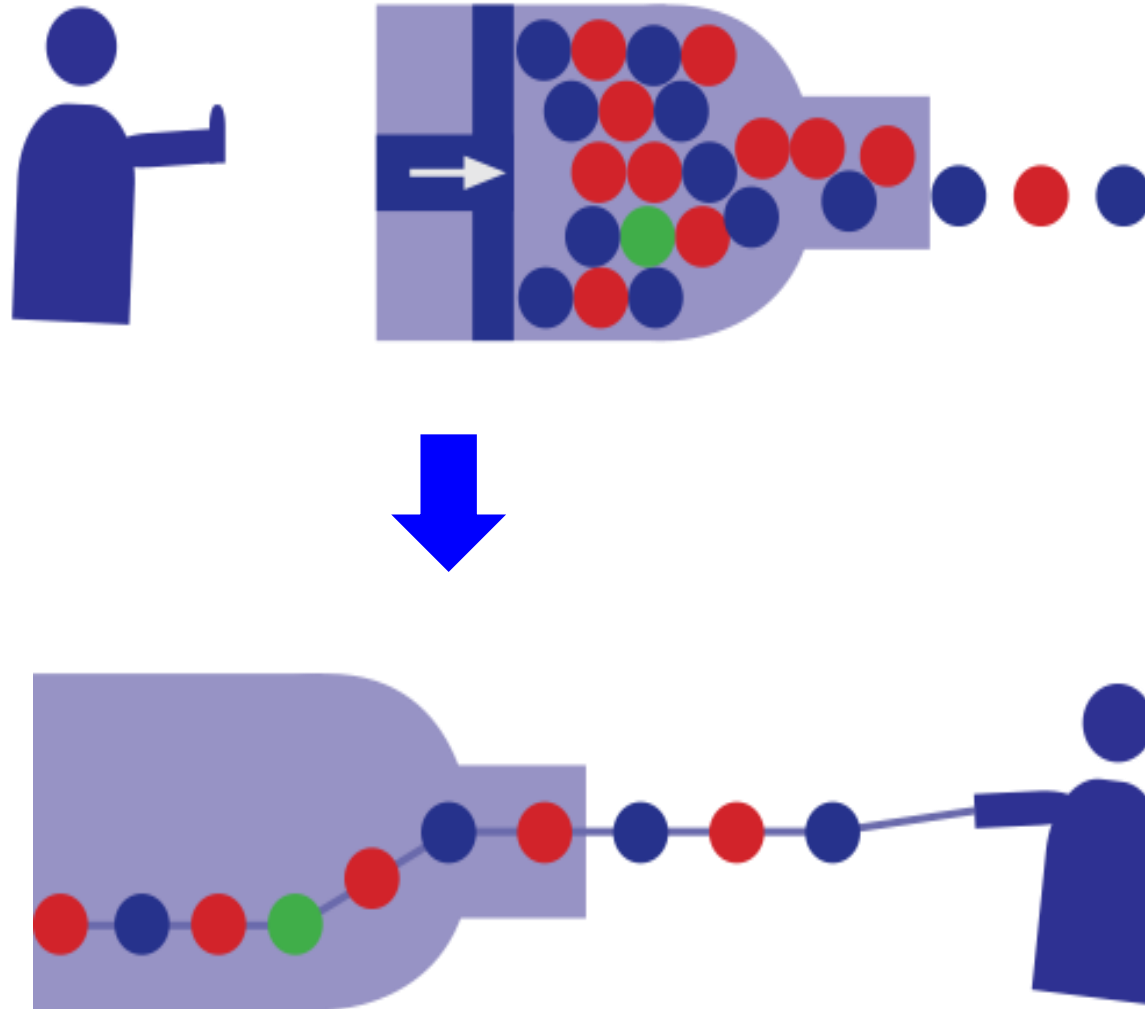
- “The slower but steady tortoise causes less waste and should be chosen over the fast hare that sometimes sprints and then stops to rest. The Toyota production system only works when all employees become turtles.” (Taiichi Ohno)



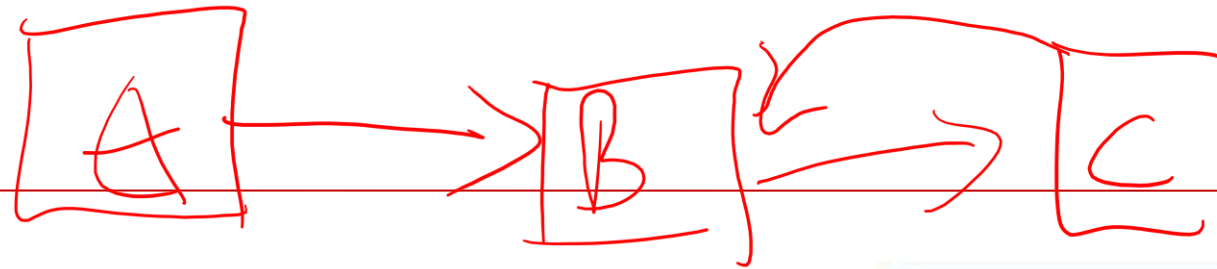
Taiichi Ohno

PULL



Push
vs.
Pull



PULL



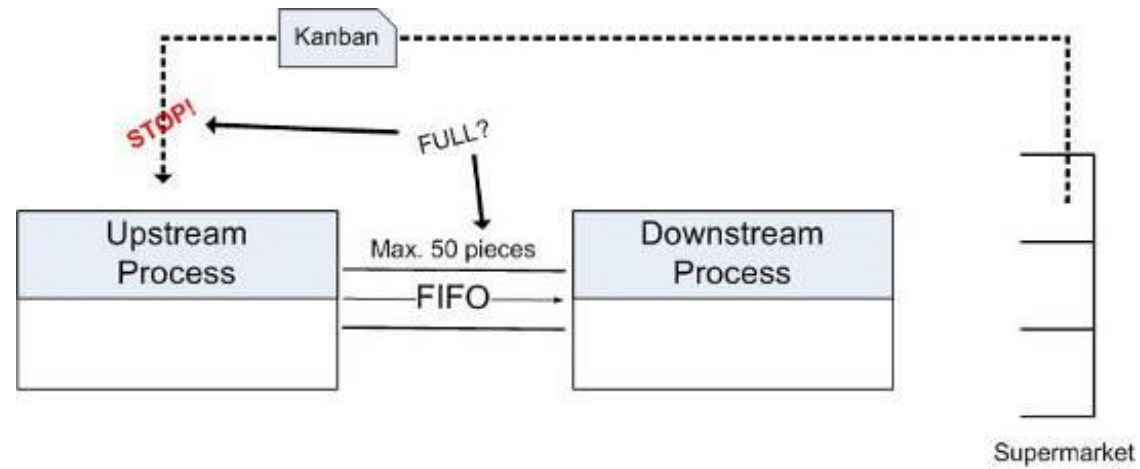
Kanban

	Kanban
Location	
Part #	
Description	
User info	
Price/unit	
Reorder volume	
Delivery time	
	 027393 000146

Kanban	WQnr: 0
Artikelnr:	1629482
Aantal:	1000
Hoofdlocatie:	GF-66-02-01
Deur: A	Kanbangebied: GC-KH-PR-ZA
Print datum: 04/12/2006	

- Developed at Toyota by *Taiichi Ohno*
- **Purpose:** Align production with actual demand
- **How it works:**
 - Each step pulls only what it needs from upstream ✓
 - **Kanban signal** (card/digital) authorizes production or withdrawal ✓
 - No Kanban = no production → prevents overproduction
- **Supermarket Analogy:** Stock only what will be consumed soon
- **Example:**
 - Demand = 100 parts/day ✓
 - Box = 20 parts → 5 boxes/day ✓
 - For 2 days = 200 parts → **10 Kanban cards** ✓

First-In-First-Out (FIFO)

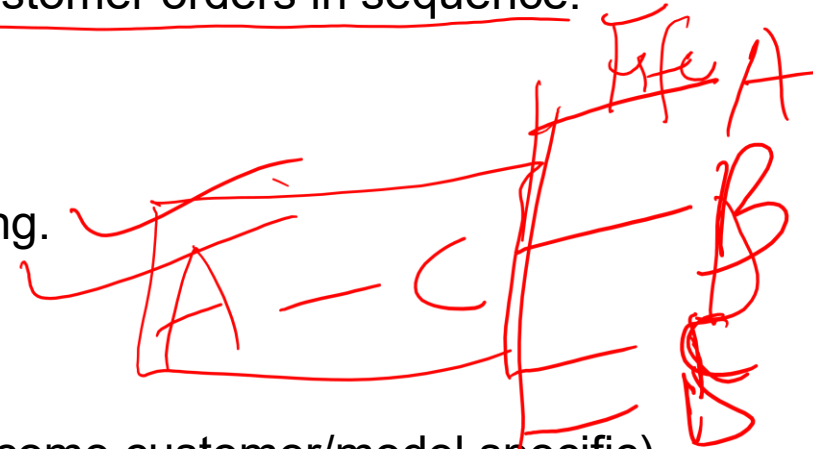


- **Definition:** Products move in the same order they enter the process — no overtaking.

- **Purpose:** Controls inventory between steps and keeps customer orders in sequence.

- **How it works:**

- Planning sets the order based on demand. ✓
- Operations complete in that order without re-prioritizing. ✓
- If the FIFO lane is full, upstream production pauses. ✓



- **Application:**

- Used **after the decoupling point** (when products become customer/model specific).
- Ensures smooth flow with minimal inventory.

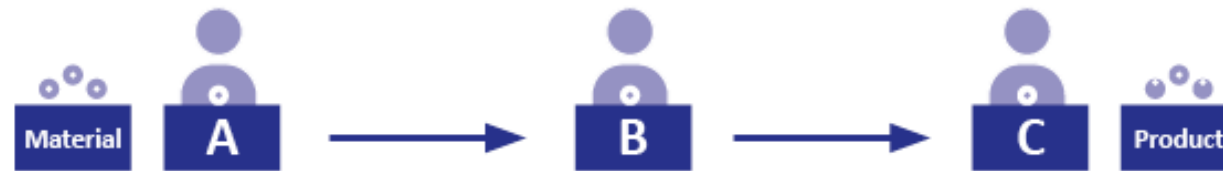
- **Example:** Headphones A–D → once the model is chosen, orders flow through FIFO lanes until finished.

In short: FIFO lanes keep production flowing in the right order, prevent excess inventory, and ensure customer-specific products are delivered as planned.

Batch versus One Piece Flow production



①



*fashion
100 pieces
of dress*

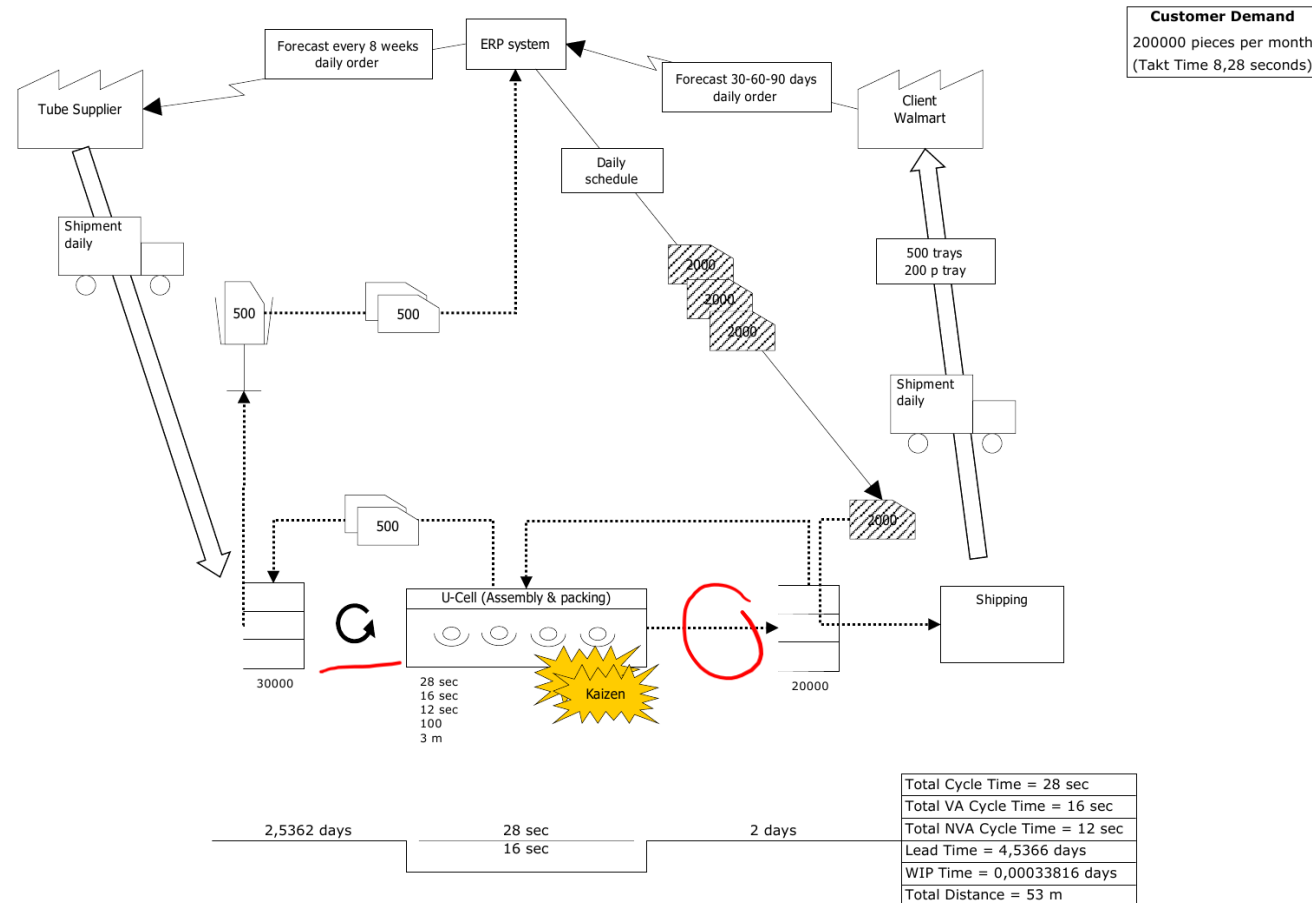
U6 – CREATING STABLE AND EFFICIENT PROCESSES (IMPROVE)

E8 – VALUE STREAM IMPROVEMENT

- Define product family
- Map VSM Current State
- Map VSM Future State
- Determine the Gap
- Define implementation plan

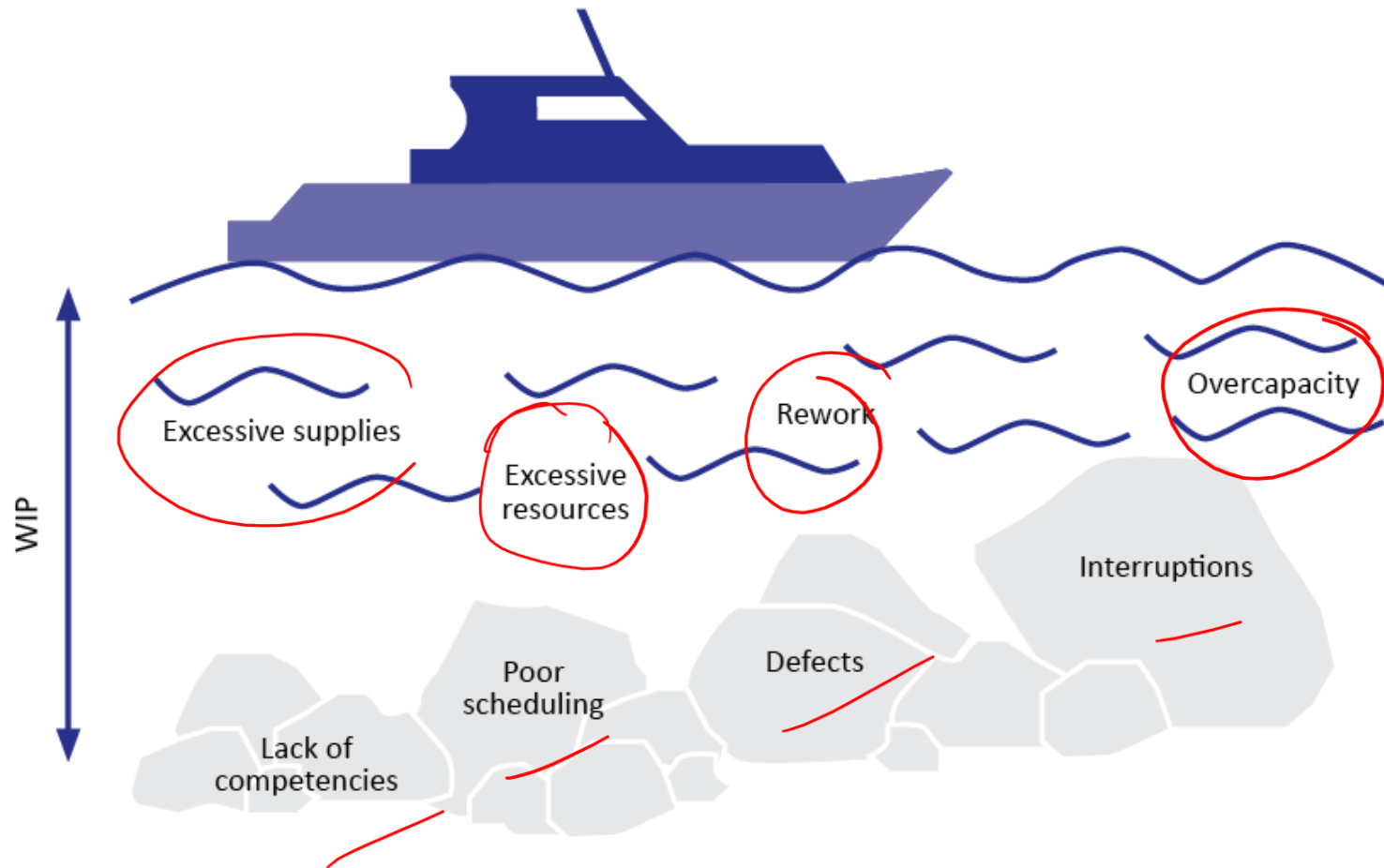
From Current State to Future State: bridging the gap

Example Future State

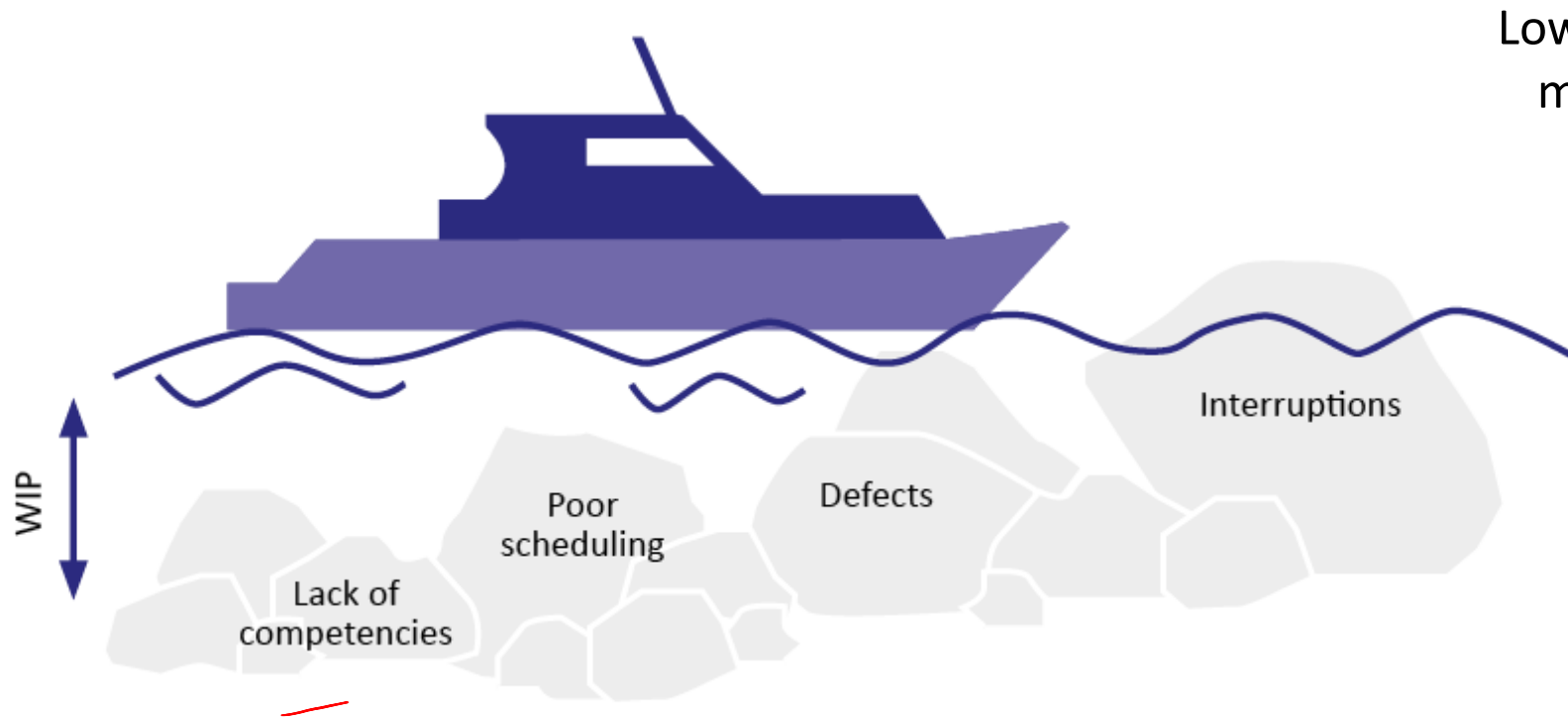


If the organization is not Lean

Problems are hidden in an ocean of inventories



The organization that is in the process of becoming Lean



Lowering the "Water level"
makes problems visible

U6 – CREATING STABLE AND EFFICIENT PROCESSES (CONTROL)

E9 – PROCESS AND QUALITY CONTROL



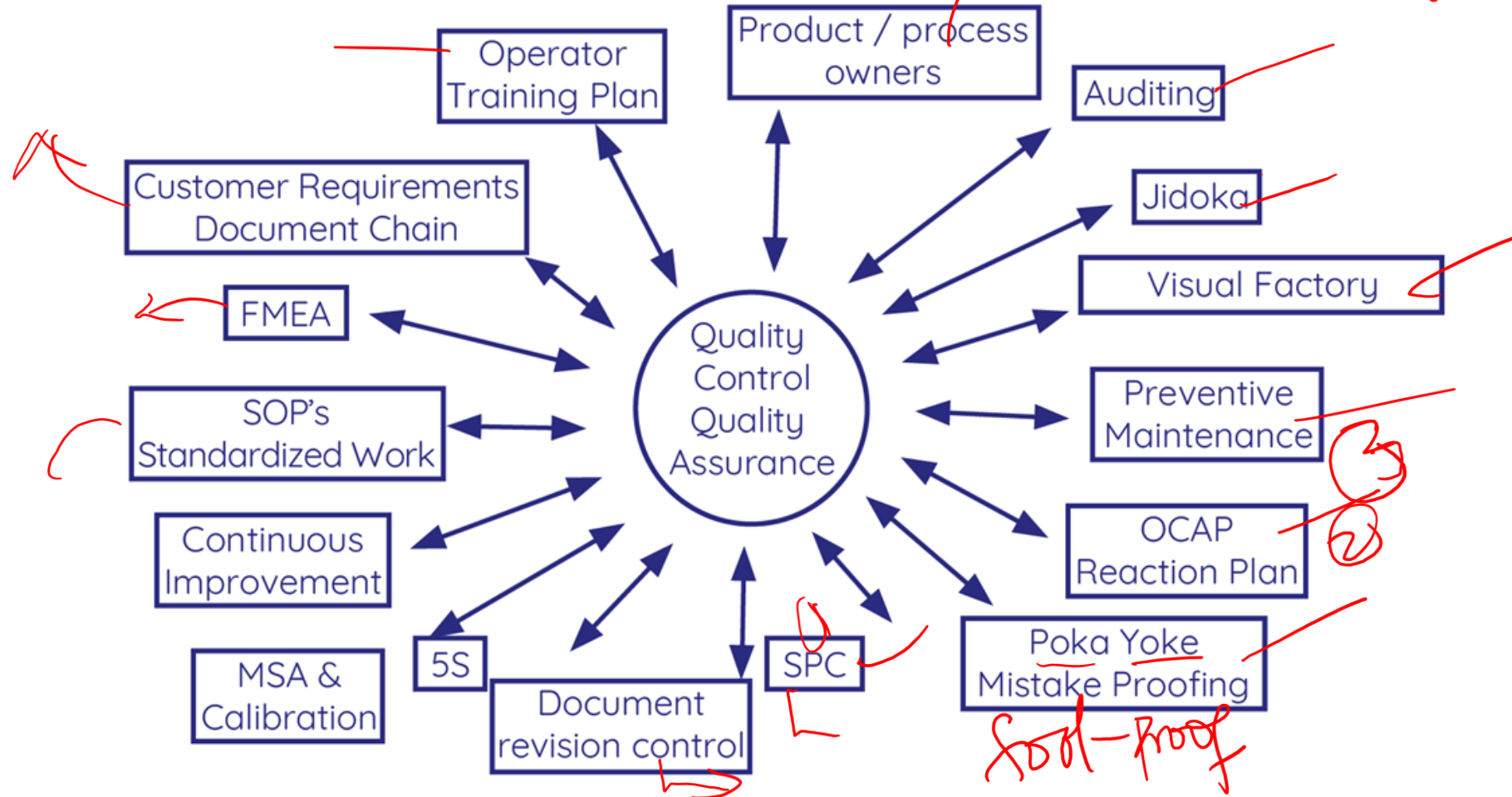
A mistake proof process

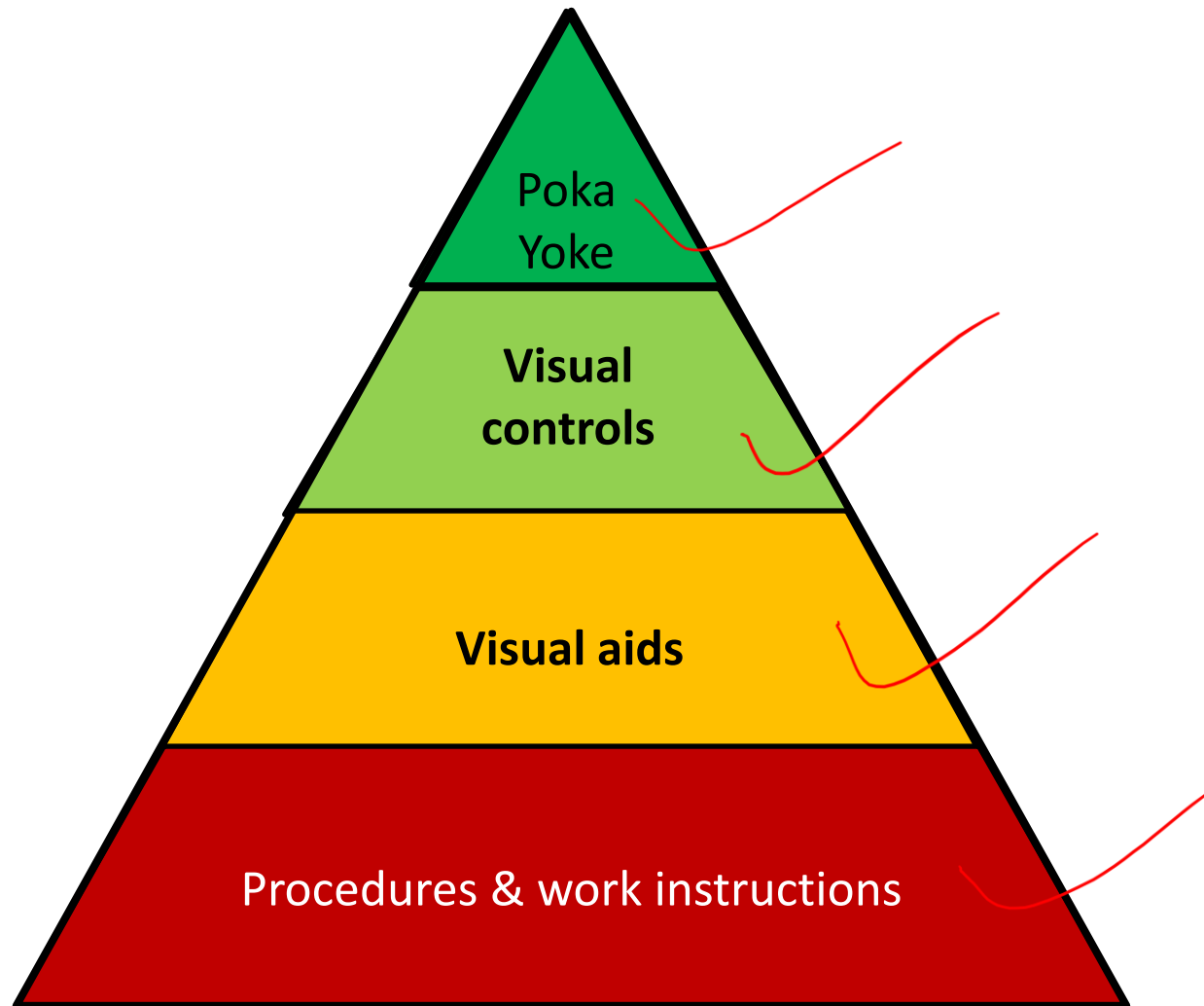
↔ fool-proof

Polka toke



Quality Control & Quality Assurance measures





Avoid

- Poka Yoke

Warning

- Signal in case of error

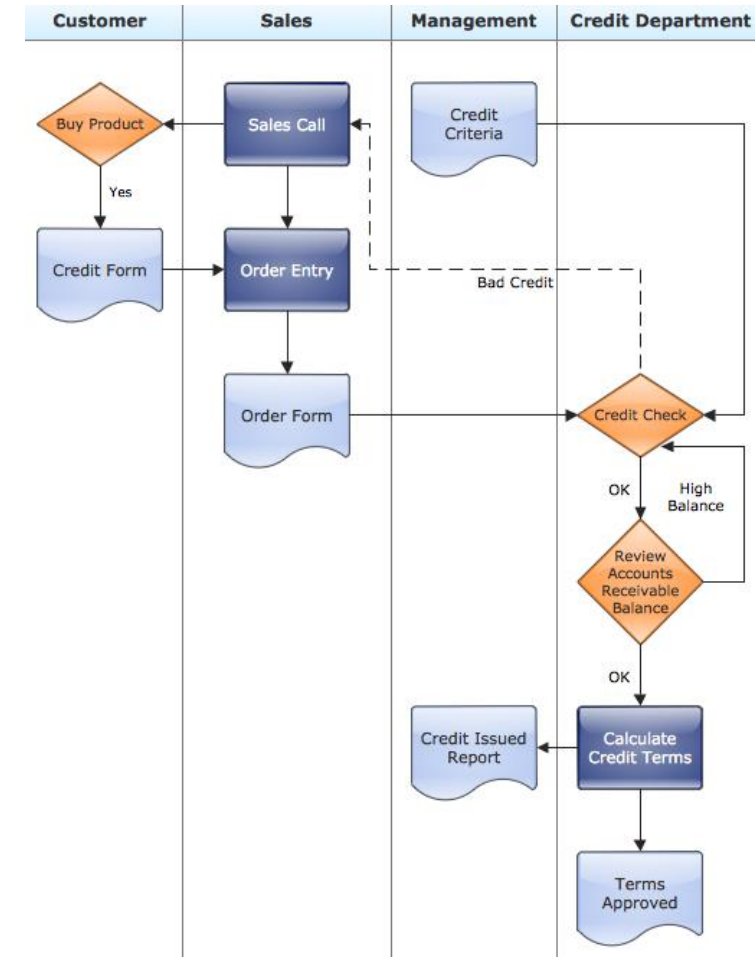
Visualize

- One Point Lesson ✓
- Visual information ✓

Standardize

- Procedures/protocols
- Manuals
- Work instructions

Procedures and Work instructions (Standardize)



Visualization tools (Visualize)

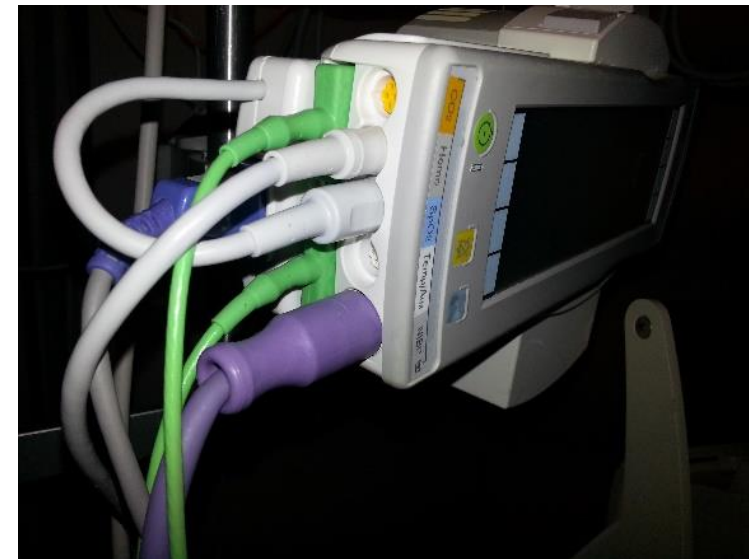
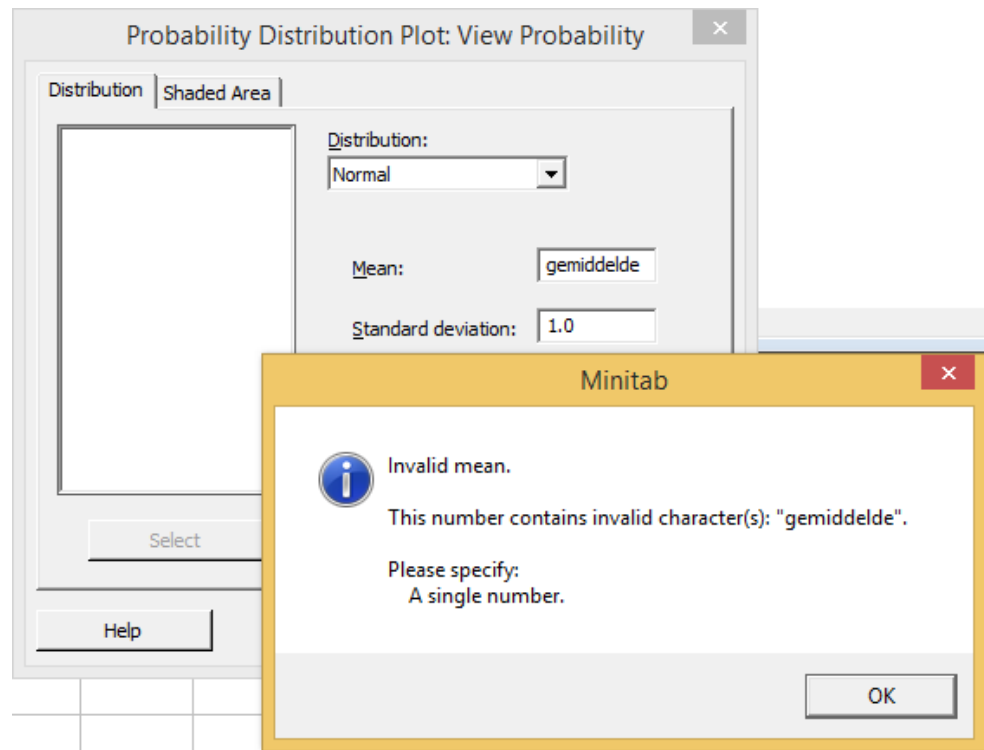


Signal in case of error (Warning)



Poka Yoke (Avoid)

- Input validation
- Fool proofing



Intervene in case of errors

- Autonomation
- Stop operations when a problem occurs



Andon cord



Emergency stop

U7 – CREATING CAPABLE PROCESSES (MEASURE)

E1 – STATISTICAL TECHNIQUES

CONTINUOUS IMPROVEMENT MATURITY MODEL



D DEFINE

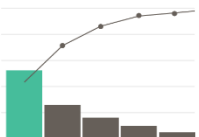
DEFINE AND SCOPE PROJECT
 DEFINE DEFECT AND CTQ'S
 PLAN AND DOCUMENT PROJECT



VOICE OF CUSTOMER



PROJECT CHARTER



PARETO

'OK FOR CUSTOMER'

VOC

CUSTOMER SPECIFICATION

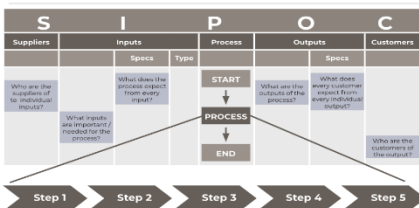
CTQ_{EXT}

INTERNAL SPECIFICATION

CTQ_{INT}

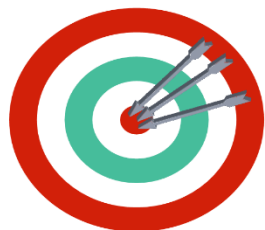


HARD AND SOFT BENEFITS

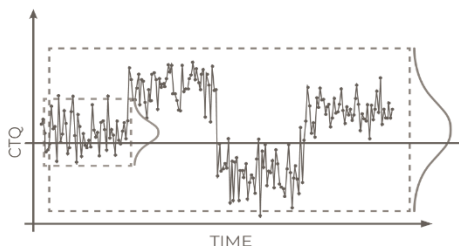


M MEASURE

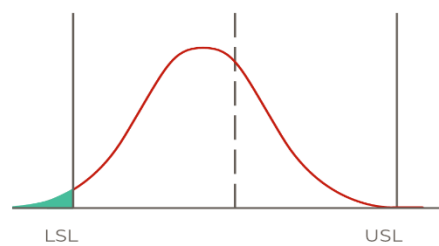
EVALUATE MEASUREMENT SYSTEM
 ESTABLISH BASELINE
 SET IMPROVEMENT GOALS



MEASUREMENT SYSTEM ANALYSIS



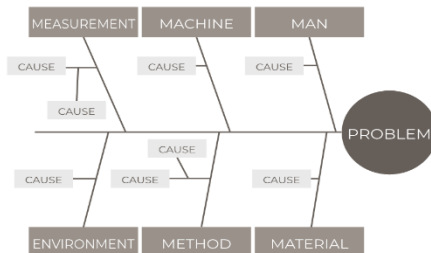
CTQ OVER TIME



CURRENT CAPABILITY CTQ

A ANALYZE

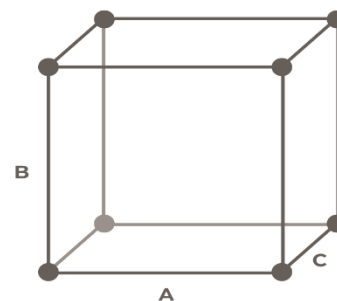
MAP PROCESS AND IDENTIFY INPUTS
 ISOLATE KEY INPUTS
 DEVELOP Y=F(X) FUNCTION



Y DATA	X DATA	
	DISCRETE	CONTINUOUS
DISCRETE	CROSS TABULATION & CHI-SQUARE	LOGISTIC REGRESSION
CONTINUOUS	HYPOTHESIS TESTING & ANOVA	CORRELATION & REGRESSION

I IMPROVE

DETERMINE OPTIMUM SETTINGS
 IMPLEMENT PROPOSED IMPROVEMENT
 VALIDATE PROPOSED IMPROVEMENT



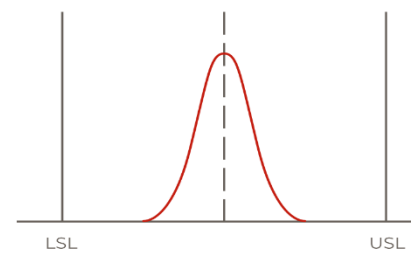
EXPERIMENT



OPTIMIZE



IMPLEMENT



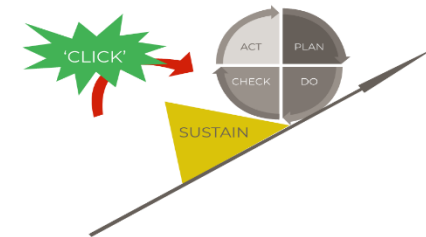
IMPROVED CAPABILITY CTQ

C CONTROL

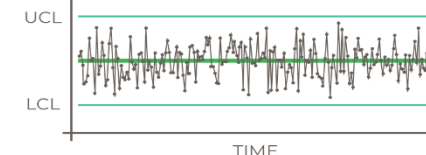
IMPLEMENT CONTROL STRATEGY
 CLOSE OUT PROJECT
 CELEBRATE RESULTS



FIRST TIME RIGHT



SUSTAIN IMPROVEMENTS



STATISTICAL PROCESS CONTROL (SPC)

LESSONS LEARNED

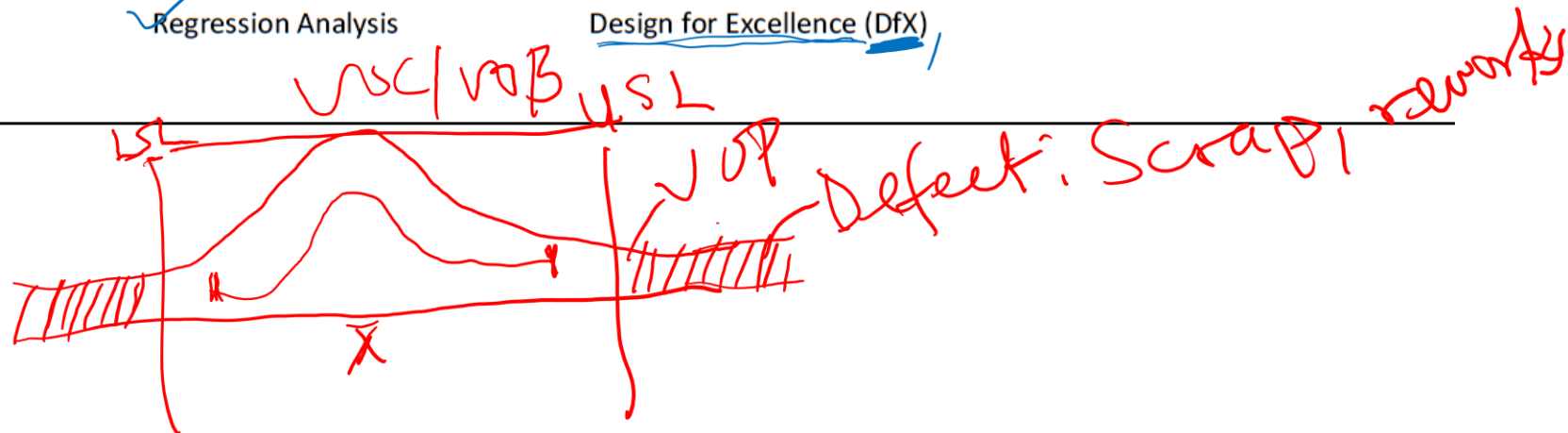


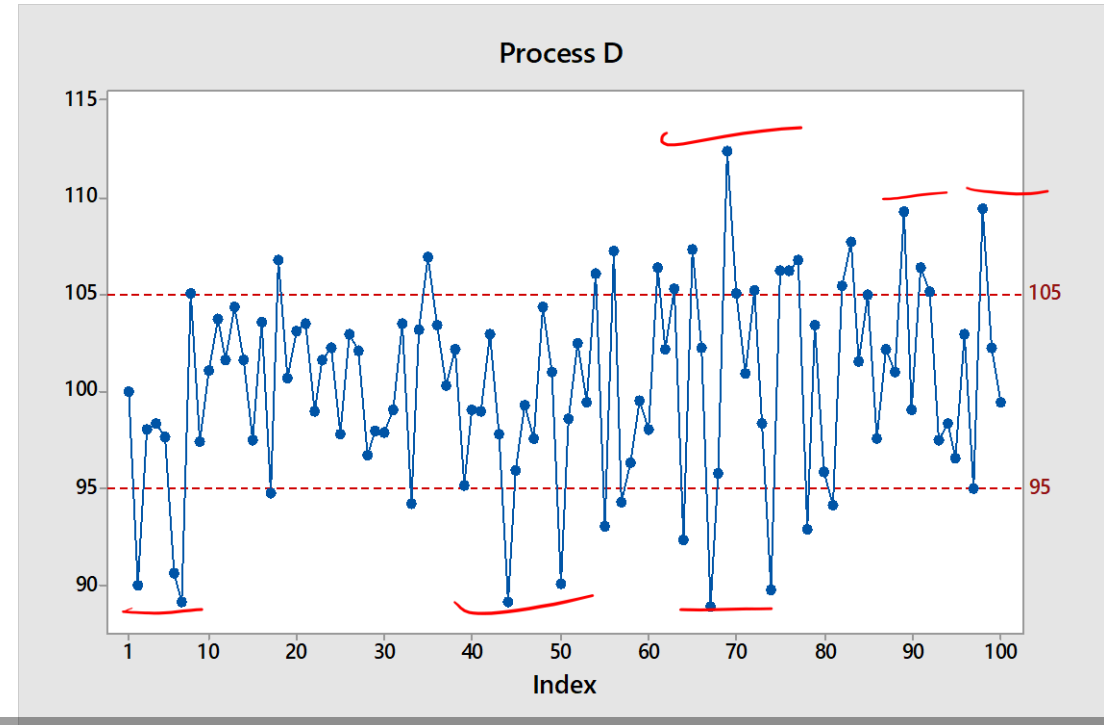
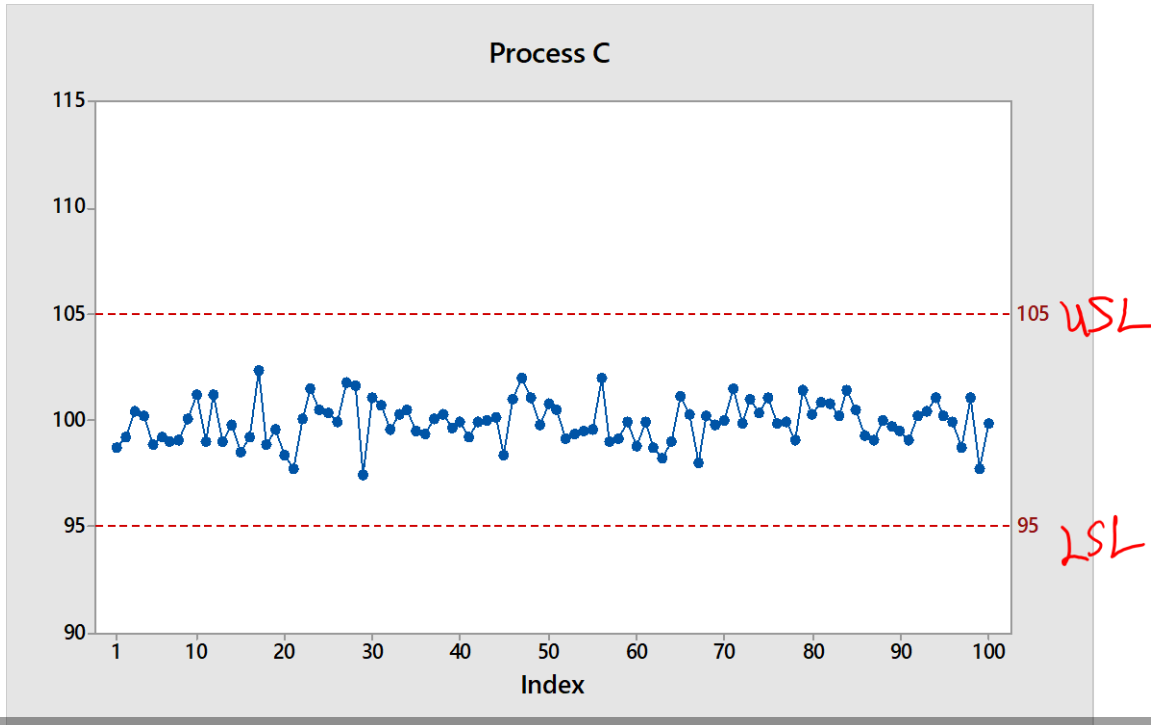
CELEBRATE RESULTS

* Quality Metrics) - PPM, DPU, DPMO, PY, RTY, P_p , P_k , C_p , C_k

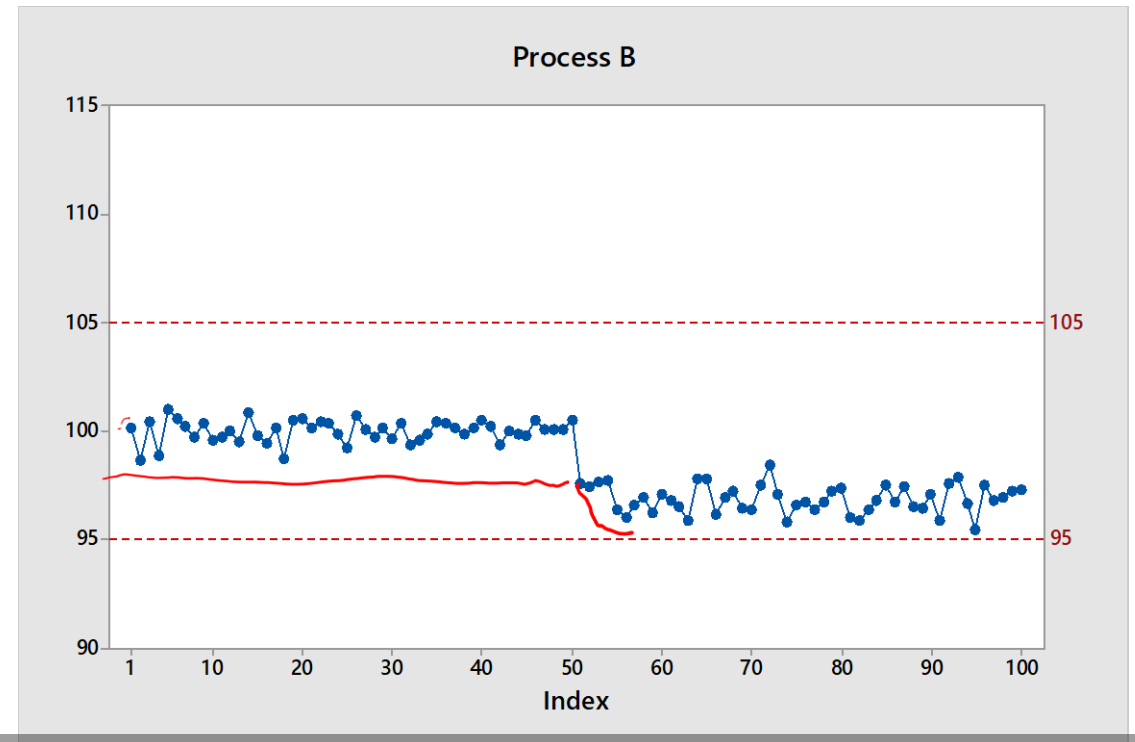
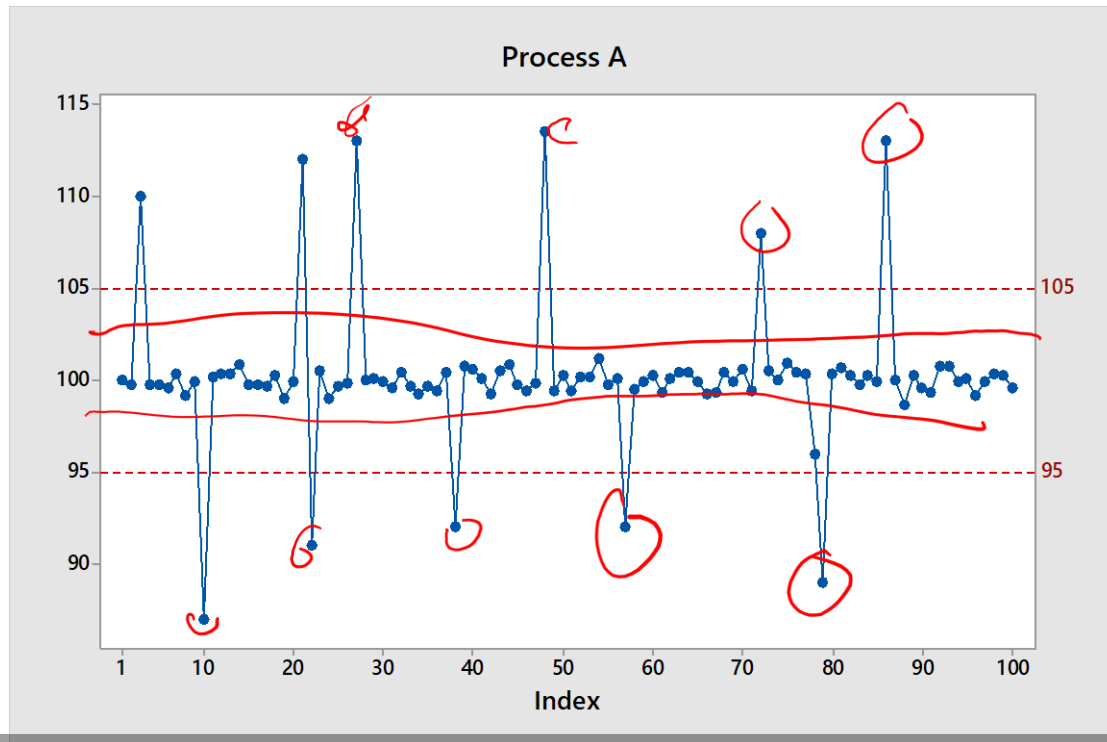
Table 7.1. Optional tools Level IV

Define	Measure	Analyze	Improve	Control
✓ Project Charter	✓ Performance Metrics	✓ Graphical Tools	✓ Design of Experiments	✓ First Time Right, Poka Yoke
✓ Voice of Customer	✓ Time Series Plot	✓ Ishikawa	✓ Reducing variation CTQ	✓ FMEA, Control Plan
✓ Costs of Poor Quality	✓ Measurement System Analysis	✓ Brainstorm Techniques	✓ Reducing Muda (8 x Waste)	✓ Training (Skill development)
✓ SIPOC	✓ Attribute Agreement Analysis	✓ Hypothesis testing	✓ Reducing Muri (Overburden)	✓ Statistical Process Control (SPC)
✓ Pareto		✓ Process Capability Analysis C_p	✓ Reducing Mura (Unevenness)	✓ Auditing
✓ CTQ Flowdown		✓ Regression Analysis	✓ Design for Excellence (DfX)	
✓ Stakeholder Analysis				





Common Cause variation
is produced by the process itself

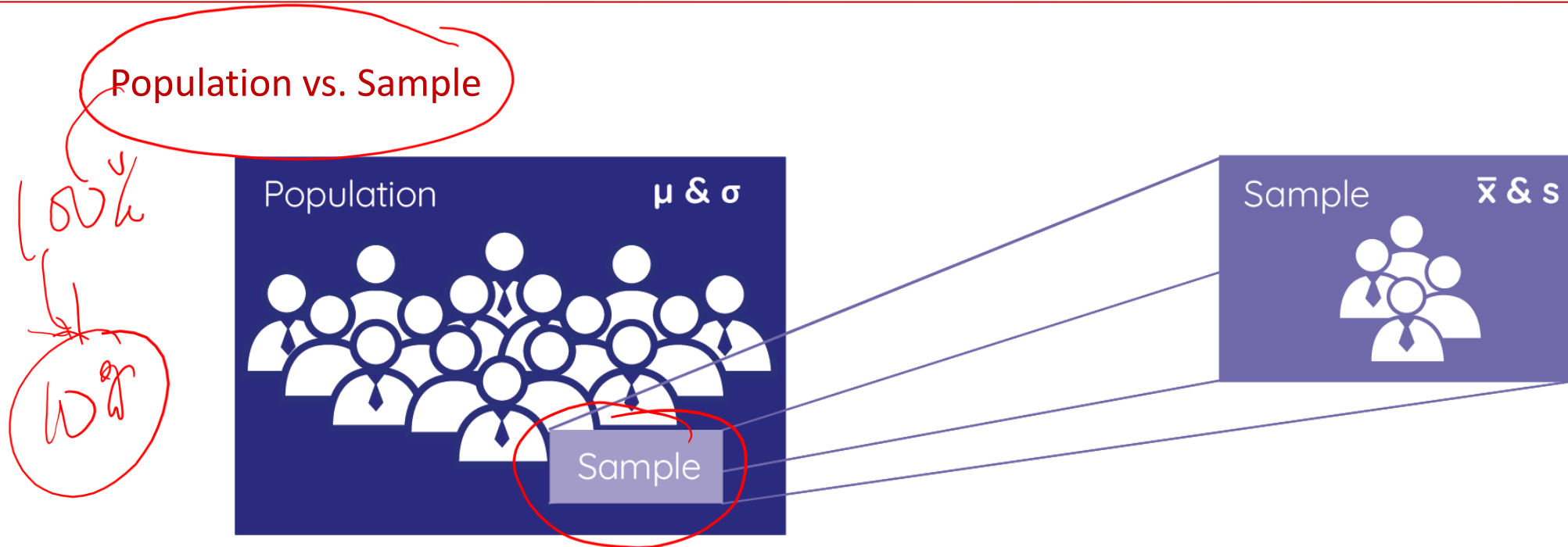


(Special Cause Variation)

is non-random variation, caused by a special event or action

7.3 Statistics

Statistics is the study of the collection, organization, analysis, interpretation and presentation of data. Statistics deals with all aspects of data including the planning and execution of experiments, the collection of data and the analysis of the data. In this section we will review the aspects of special cause variation and common cause variation. We will also review the basic terms of sample and descriptive statistics.



- Generally, there is insufficient knowledge regarding the population as a whole, this is why we use a sample.
- Based on this sample, we can use statistics to make estimates regarding the whole population.
- This is therefore always an estimate, however one with quantifiable confidence.

STATISTICS

(check sheet, excel, survey)
Data collection tool

Sample size?

Population / Sample

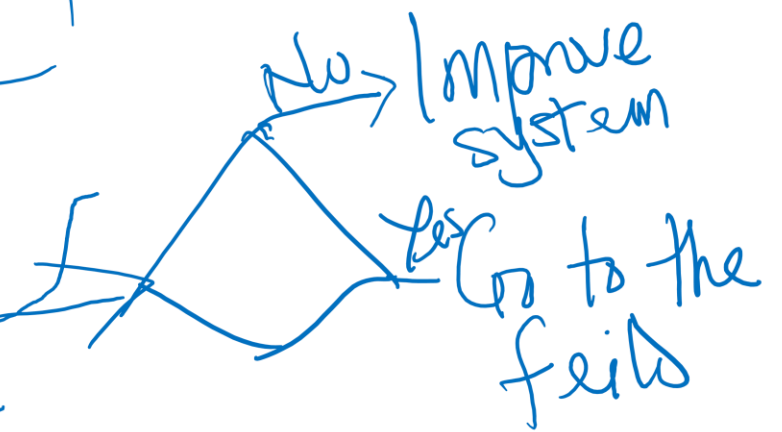
Sampling method
Random systematic, stratified

Data type

People, device, technique (how) → (Research)
Standard

Measurement system
Analysis +
Attribute agreement
Analysis

R107

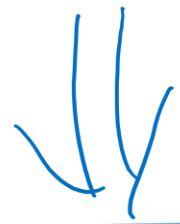


Collect Data from Gremba



Describe the data

Yield, RTY, PPM,
DPU, DPMO, C_p , C_{pk} , P_{pk}
Short Long
time



Analyse data

Centre: Mean, Meda & Mode
Spread: Range, variance, standard deviation, IQR, etc.

Distribution: Shape
↳ Normal distribution

Visualize data



Hypothesis testing

95%

5%

H_0 - Null
 H_1 -

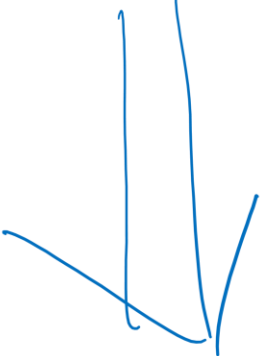


Correlation & Regression



Design of Experience

Improve



Control

↳ SPC

Four components of process variation

- Center:

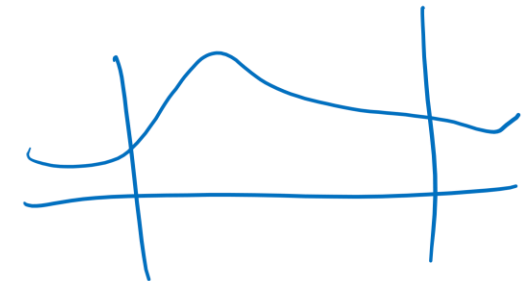
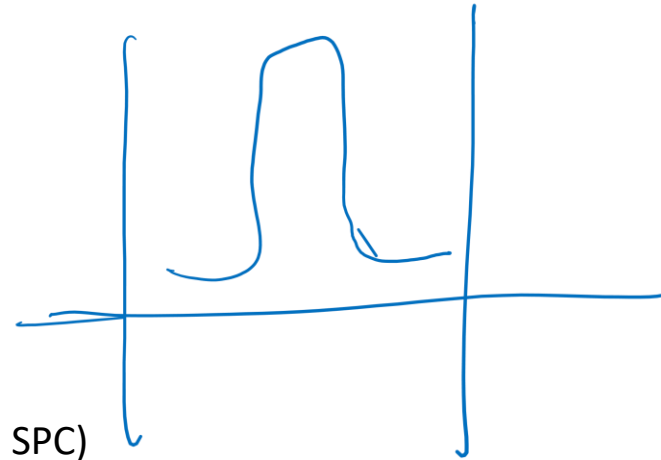
Central tendency.
Is the process 'on target'?

- Spread:

How much variation is in the data?

- Stability:

Does the process shift in time? (See SPC)



Measures for Central Tendency

Data : {3, 5, 4, 7, 5}

- Mean (Xbar):
Arithmetic mean of data

EXCEL : '= AVERAGE (...)'

$$\bar{X} = \frac{(3+5+4+7+5)}{5} = 4.8$$

$$1234 = \frac{2+3}{2} = 2.5$$

- Median (Me):
Middle value of sorted data

$$\text{Median}(3; 4; 5; 5; 7) = 5$$

Measures for Spread

- Range R:
Absolute difference between maximum and minimum value from the data set

EXCEL : '= MAX (...) - MIN (...)'

- Standard deviation(s):
Square root of the variance s^2

EXCEL : '= STDEV (...)'

$SD = \sqrt{2}$

↓ 2, 3, 4, 5

$$\bar{X} = \frac{1+2+3+4+5}{5} = 3$$

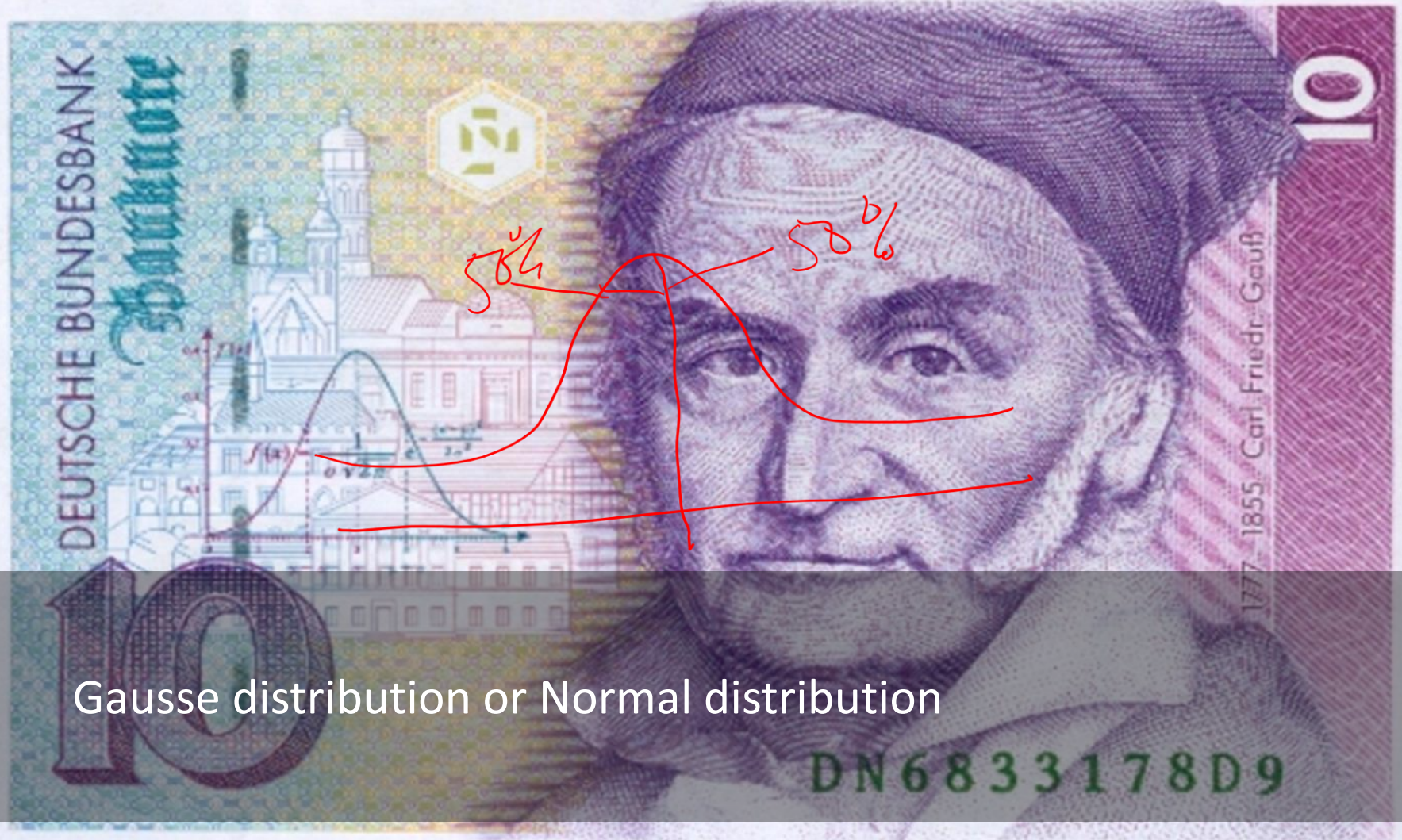
$$(1-3)^2 + (2-3)^2 + (3-3)^2 + (4-3)^2 + (5-3)^2$$

$$= \frac{4 + 1 + 0 + 1 + 4}{5} = \frac{10}{5} = 2$$

U7 – CREATING CAPABLE PROCESSES (MEASURE)

E2 – DISTRIBUTIONS

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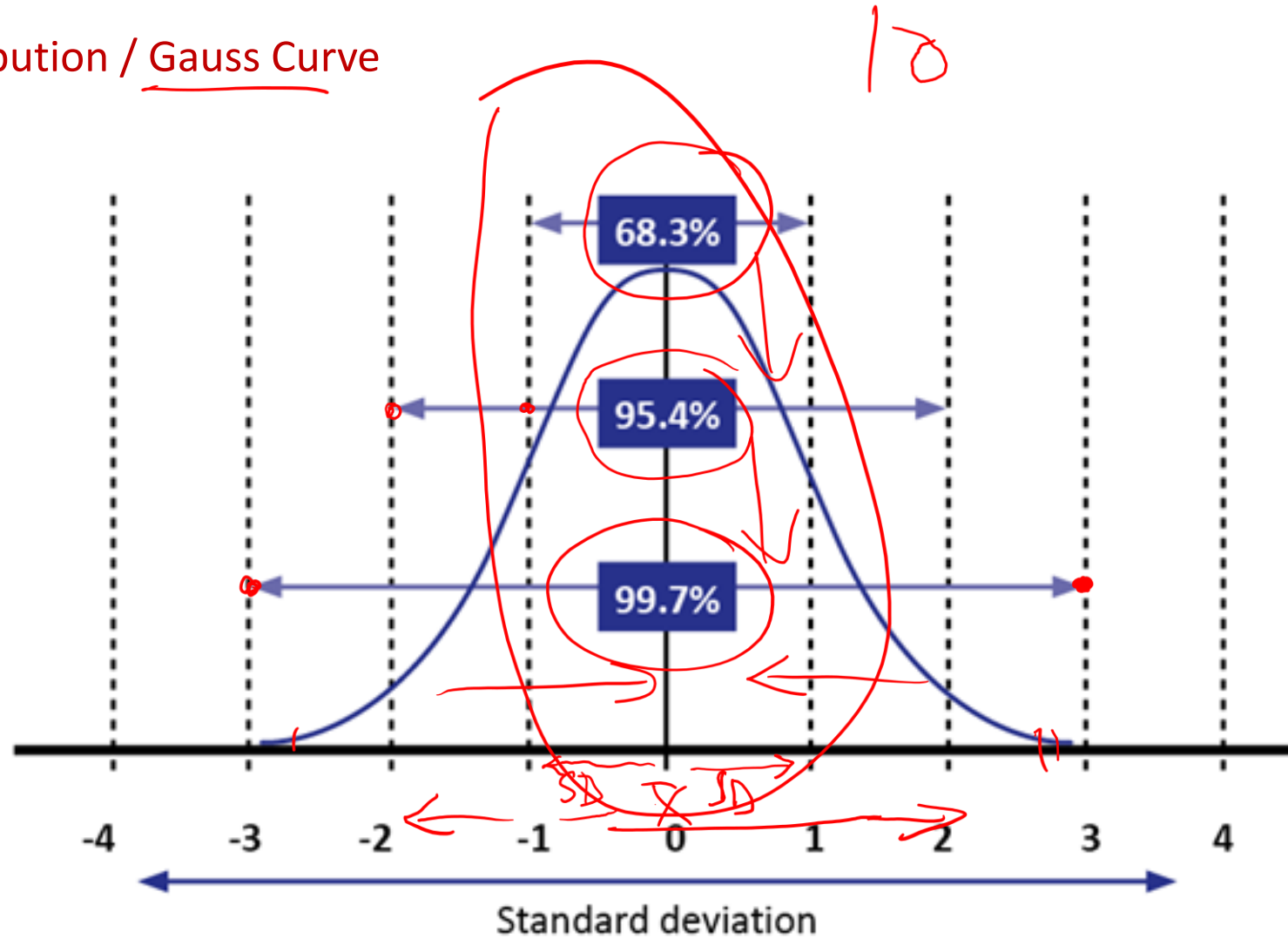


Gausse distribution or Normal distribution

Deutsche Bundesbank
Frankfurt am Main
1 Oktober 1993

DN6833178D9

Normal Distribution / Gauss Curve



U7 – CREATING CAPABLE PROCESSES (MEASURE)

E3 – MEASUREMENT SYSTEMS

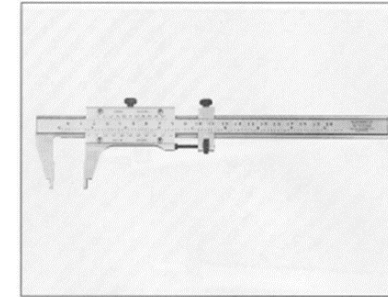
Measurement Instrument

- Device / instrument for measuring values
- Also includes go / no-go gages

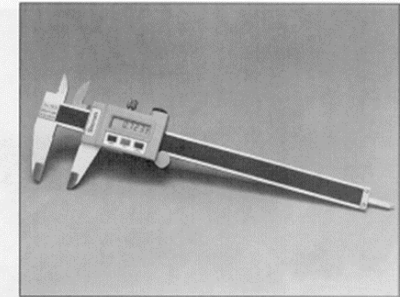
Measurement System

- The complete process of collecting gauge values:

The collection of procedures, measurement instruments, devices, software, employees etc. needed to assign a value to a characteristic



Vernier caliper



Digital caliper



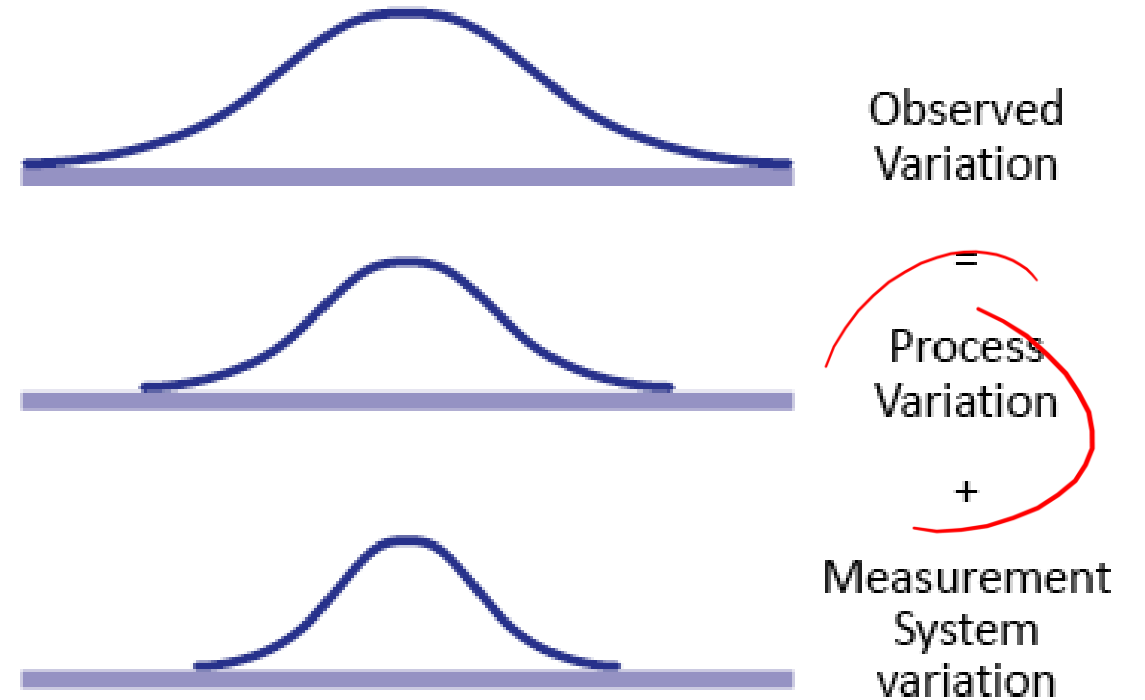
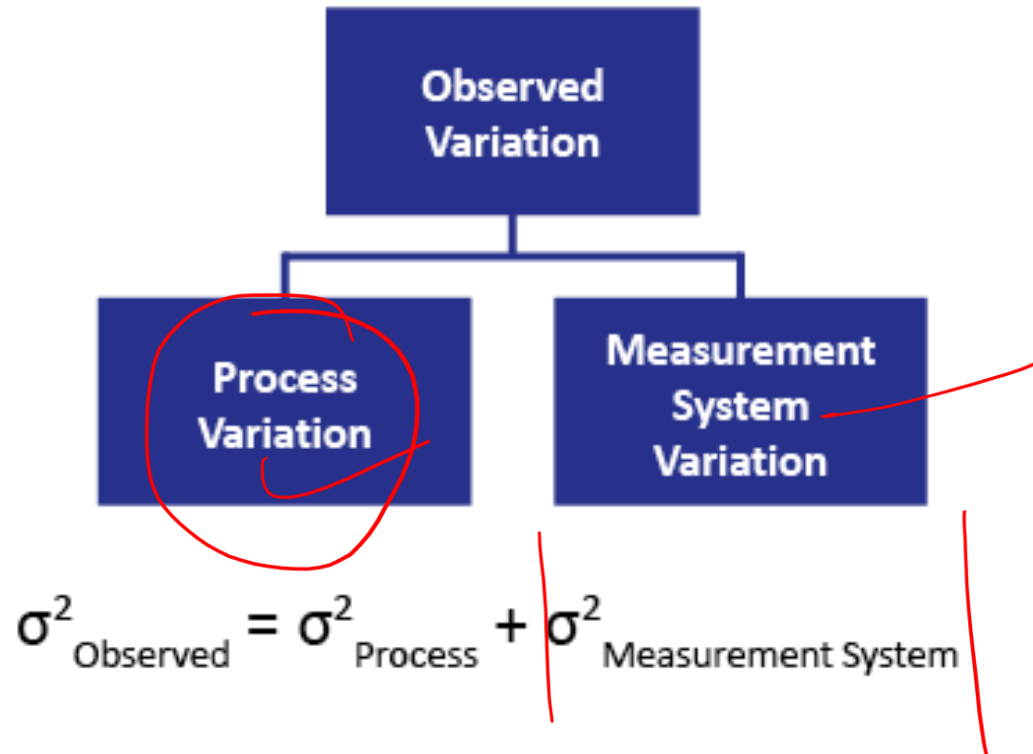
Micrometer



One-inch digital electronic micrometer

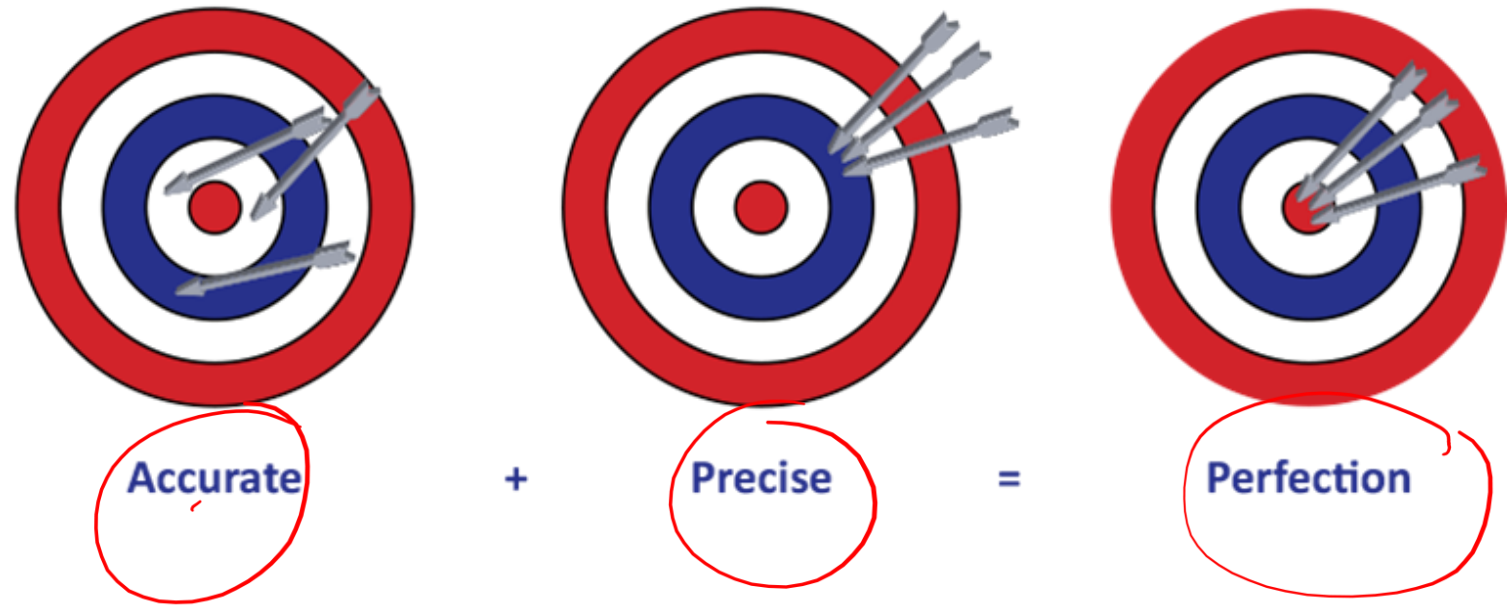
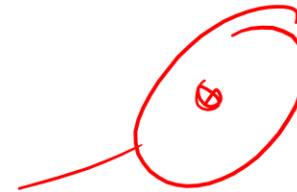


Observed variation and Measurement system variation



Measurement System Analysis

1. Accuracy
2. Precision
 - a) Repeatability
 - b) Reproducibility
3. Stability



U7 – CREATING CAPABLE PROCESSES (ANALYZE)

E4 – HYPOTHESIS TESTING & CONFIDENCE INTERVALS

Hypothesis Testing – Lawsuit

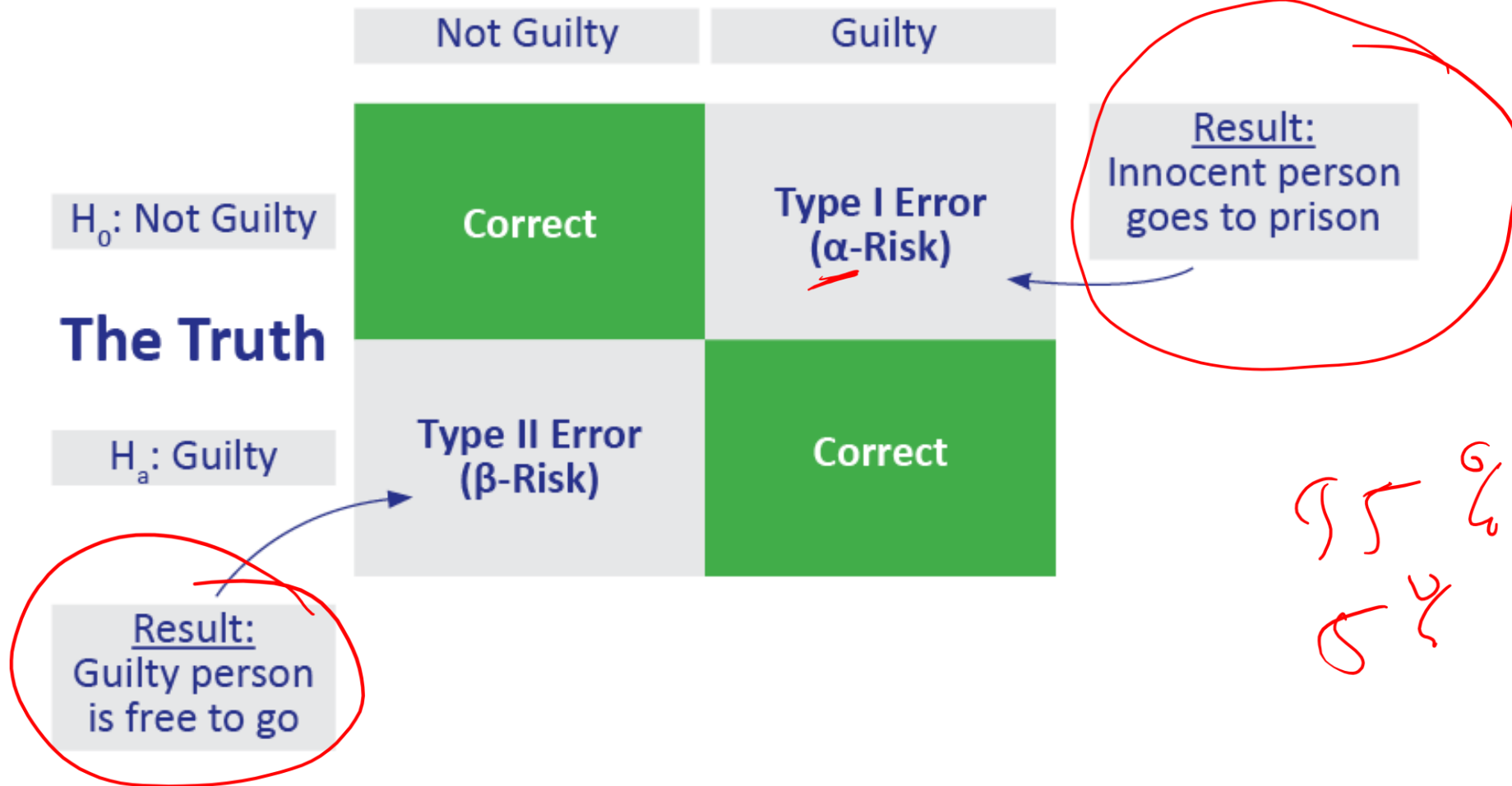
‘One is presumed innocent until proven guilty’



This also applies to Hypothesis testing:

- The null-hypothesis (H_0) always assumes there is no difference. Even when we suspect that there actually is a difference!
- The alternative hypothesis (H_a) describes the difference. This is an assumption that must be reviewed and proven.

Courts Judgment

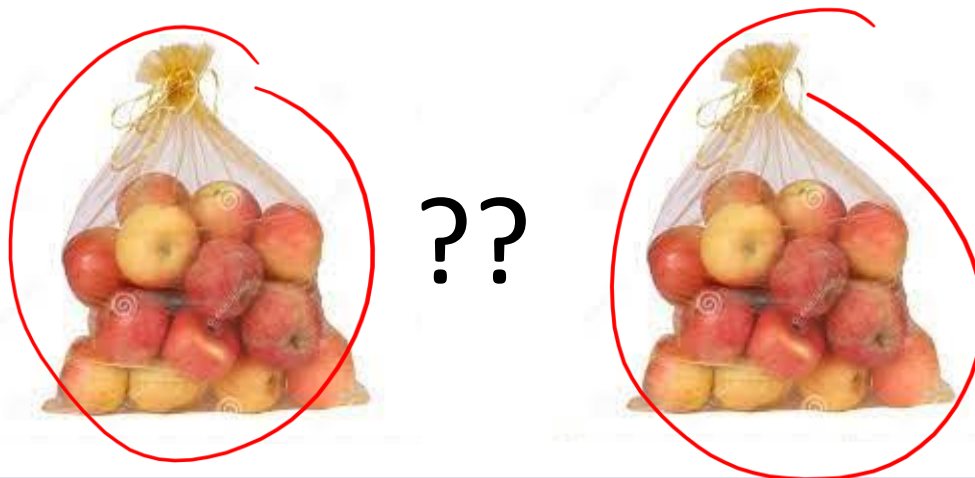


U7 – CREATING CAPABLE PROCESSES (ANALYZE)

E5 – TESTS FOR MEANS, VARIANCES AND PROPORTIONS

2-Sample T-Test - $H_0: \mu_1 = \mu_2$

- Suppose we want to investigate whether the average weight of apples sold at Walmart is lower than the average weight of apples sold at Carrefour. To investigate this, we buy a bag of 10 apples from both supermarkets. These are two samples. We then measure the weight of all apples in both samples (2 x 10). The question now is whether the apples from the Walmart are significantly lighter than the apples from Carrefour.
- To investigate this, the Green or Black Belt chooses the so-called '2-Sample t-test'.
- $H_0: \mu_{\text{Walmart}} = \mu_{\text{Carrefour}}$ (There is no difference between Walmart and Carrefour)
- $H_A: \mu_{\text{Walmart}} < \mu_{\text{Carrefour}}$ (The apples at Walmart are lighter than the apples at Carrefour)



P-value ← margin of error

U7 – CREATING CAPABLE PROCESSES (ANALYZE)

E6 – CORRELATION AND REGRESSION

Correlation Coefficient

Stat > Basic Statistics > Correlation

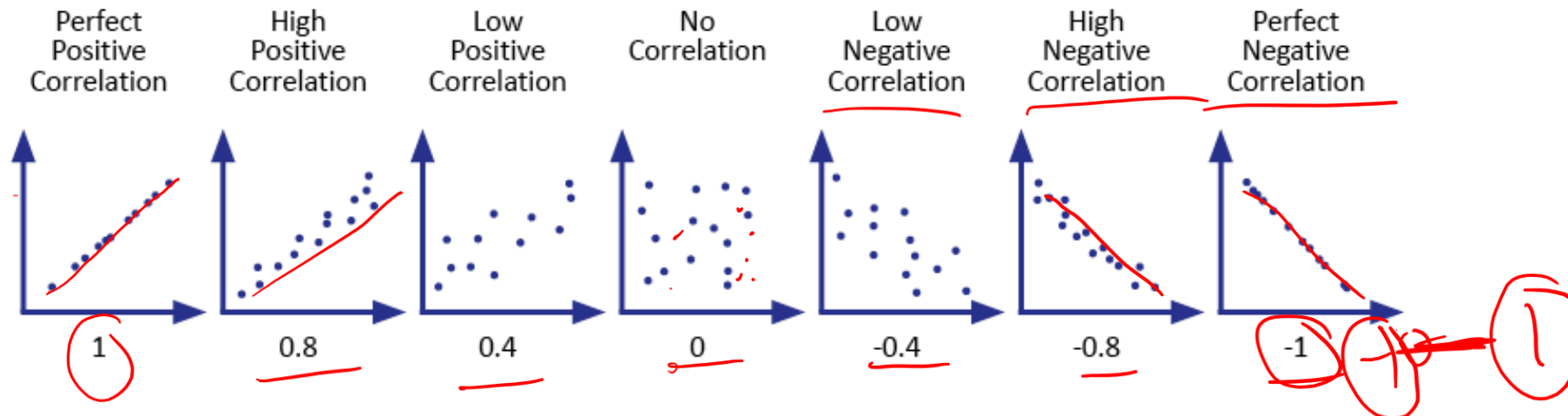
causation

- The Pearson Correlation Coefficient is used to measure the strength of the linear relationship between two variables.
- The correlation coefficient assumes a value between -1 and +1.

Strong $R \geq 0,8$

Weak $|R| \leq 0,5$

Strong $R \leq -0,8$



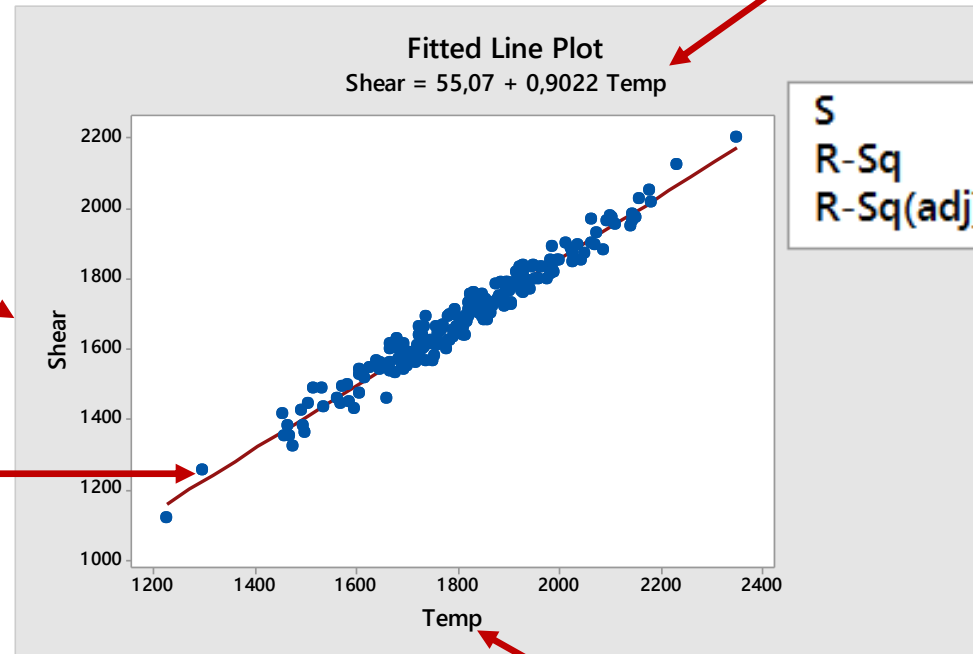
Fitted Line Plot

Stat > Regression > Fitted Line Plot

Regression Equation

Response Y (Effect)

Regression line $Y = aX + b$



Handwritten notes in red ink:

$$y = mx + c$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$y = f(x)$

$y = mx + c$

Predictor X (Cause)

Worksheet
REG-16 Shear versus Temperature.mtw

U8 – CREATING FUTURE-PROOF PROCESSES

CONTINUOUS IMPROVEMENT MATURITY MODEL



DMADV roadmap

