CRITICAL THINKING AND PROBLEM SOLVING

November 2017

Version 1.4

LEARNING OUTCOME & RESOURCES

Learning Outcome

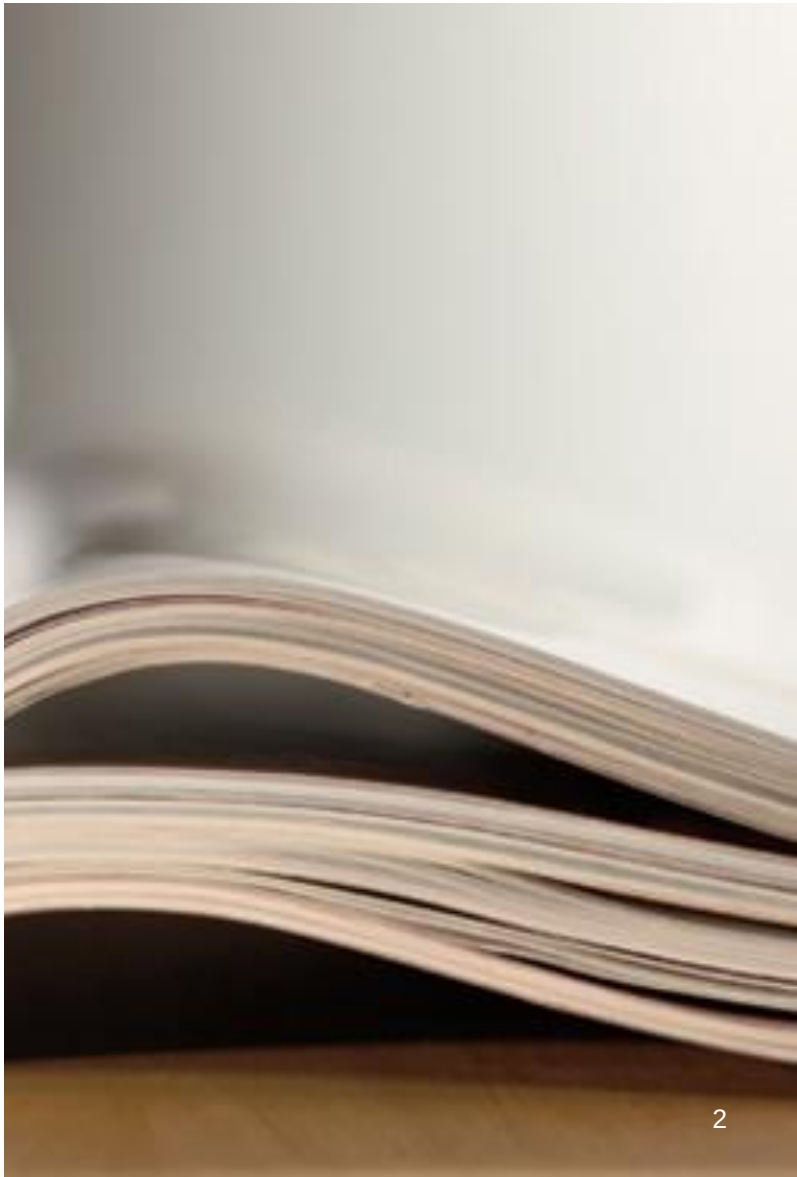
- Understanding the importance of critical thinking.
- Developing the skillset needed to conduct a root-cause analysis.
- Knowledge to apply different techniques to problem solving.

Resources

- REMC Company Handbook.

Workbook

Refer to complimentary excercises in your workbook.



THE PROBLEM

What might be the consequences of not understanding a problem in detail?

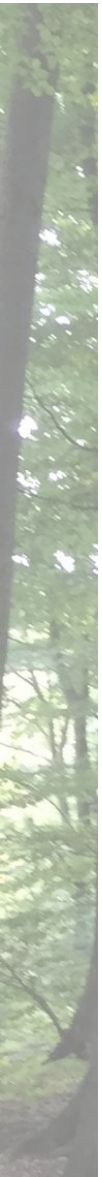
Discuss as a group and take notes in your workbook, exercise (16-1).

Critical Thinking

CRITICAL THINKING

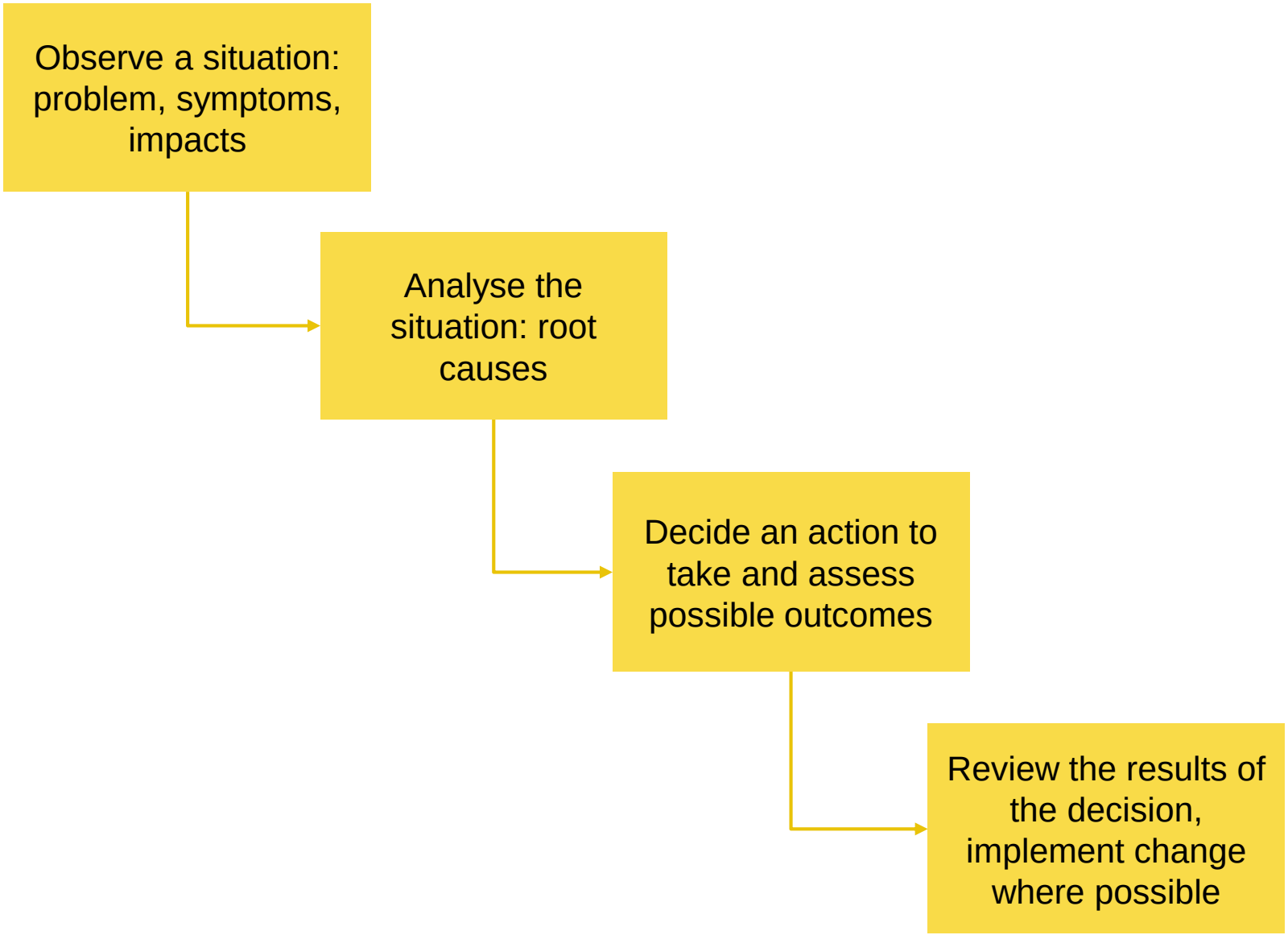
- Critical thinking is the **objective analysis of facts** to form a judgment.
- It is **aimed at achieving the best possible outcome** in any situation. It must involve gathering and evaluating information from as many different sources as possible.
- It **is based in the analysis of facts** rather than opinions.
  - **Facts** are information that is usually not debateable.
  - **Opinions** are subjective, value judgements based on isolated items (e.g. own experience, history) and can be debateable.

BENEFITS OF CRITICAL THINKING



- It helps with **effective communication** and **problem-solving abilities**.
- It helps **to reflect in one's own beliefs**. Provides the **tools for the process of self-evaluatio**n.
- It helps to **evaluate new ideas**, **selecting the best ones** and **modifying them** if necessary.
- It promotes the **ability to deal with changes quickly and effectively.**

HOW TO APPLY CRITICAL THINKING



TAKING ACTIONS APPLYING CRITICAL THINKING

Challenge: Detection of lead in wastewater after treatment discharge.

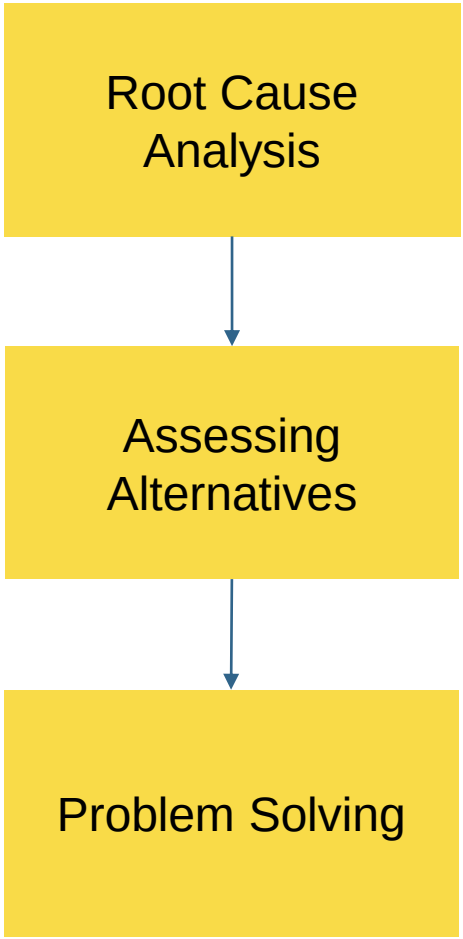
Observations:

- No Lead present in the incoming water to the facility.
- Mill did not use any dyestuffs/pigments/auxiliaries/chemicals during processing of material which might result in lead residues in wastewater before treatment.
- During treatment of wastewater mill uses ferrous sulphate as a ETP chemical.
- The ferrous sulphate is a by-product from another industry, containing a high amount of lead as an impurity.

Action to take:

- Inform procurement about the chemical specifications required.
- Conduct a quality control of incoming chemicals, including chemical testing.
- Substitute ferrous sulphate with an appropriate alternative.

CRITICAL THINKING METHODOLOGIES



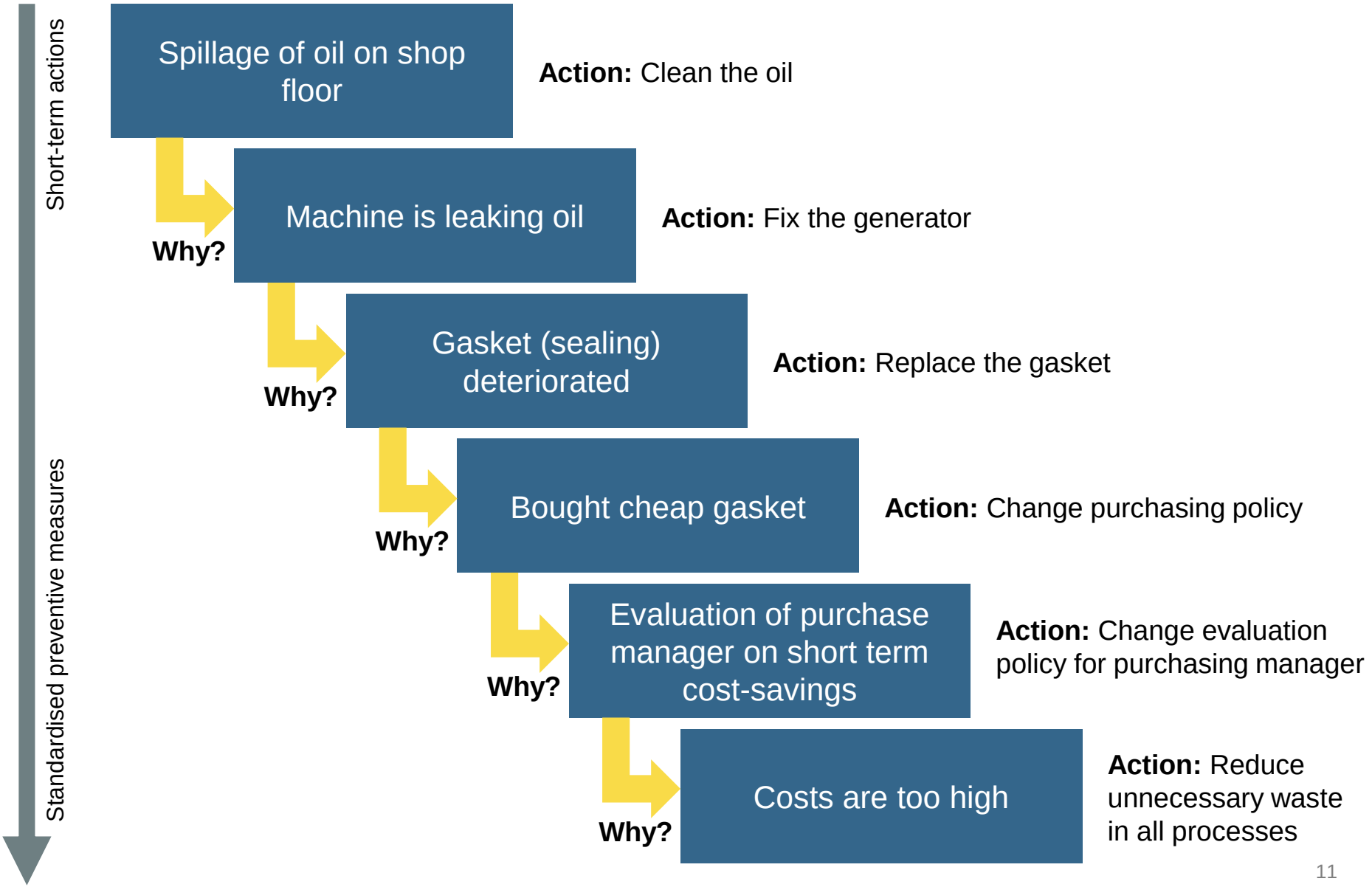
- 5 Why's
- Fishbone Diagram

- SWOT Analysis
- Decision Tree
- Cost Benefit Analysis

- MAIC Methodology

Root Cause Analysis

FINDING THE ROOT CAUSE: 5 WHYS



EXAMPLE OF APPLYING 5 WHYS: PRODUCT LISTED ON RAPEX (1/2)

1 of 1 photo

Share on

Alert number: A12/1204/17

Category: Clothing, textiles and fashion items

Product: Ladies' nightwear

Brand: Zeeman

Name: Unknown

Type / number of model: 28059

Batch number / Barcode: Unknown

Risk type: Chemical

The product contains the azo dye Disperse Yellow 23 (CI 26070) releasing an excessive amount of the aromatic amine 4-aminoazobenzene (measured value: 567 mg/kg). When the product is in direct and prolonged contact with the skin, the aromatic amine may be absorbed by the skin. Aromatic amines can cause cancer, cell mutations and affect reproduction.

The product does not comply with the REACH Regulation.

Measures taken by economic operators: Recall of the product from end users (By: Importer)

Measures ordered by public authorities (to: Importer): Ban on the marketing of the product and any accompanying measures

Reference: https://ec.europa.eu/consumers/consumers_safety/safety_products/rapex/alerts/?event=main.listNotifications

EXAMPLE OF APPLYING 5 WHYS: PRODUCT LISTED ON RAPEX (2/2)

Short-term actions

Standardised preventive measures

Product recall due to aromatic amine 4-aminoazobenzene

Action: Take product back

Why?

Use of restricted Azo disperse dye for dyeing

Action: Avoid use of products containing restricted substances

Why?

No risk management performed for the dyestuff in the facility

Action: Perform risk assessment of all chemicals added to the chemical inventory

Why?

Dyeing manager not aware of the RSL requirement

Action: Train responsible employees on requirements

Why?

Procurement person not aware of the RSL requirement

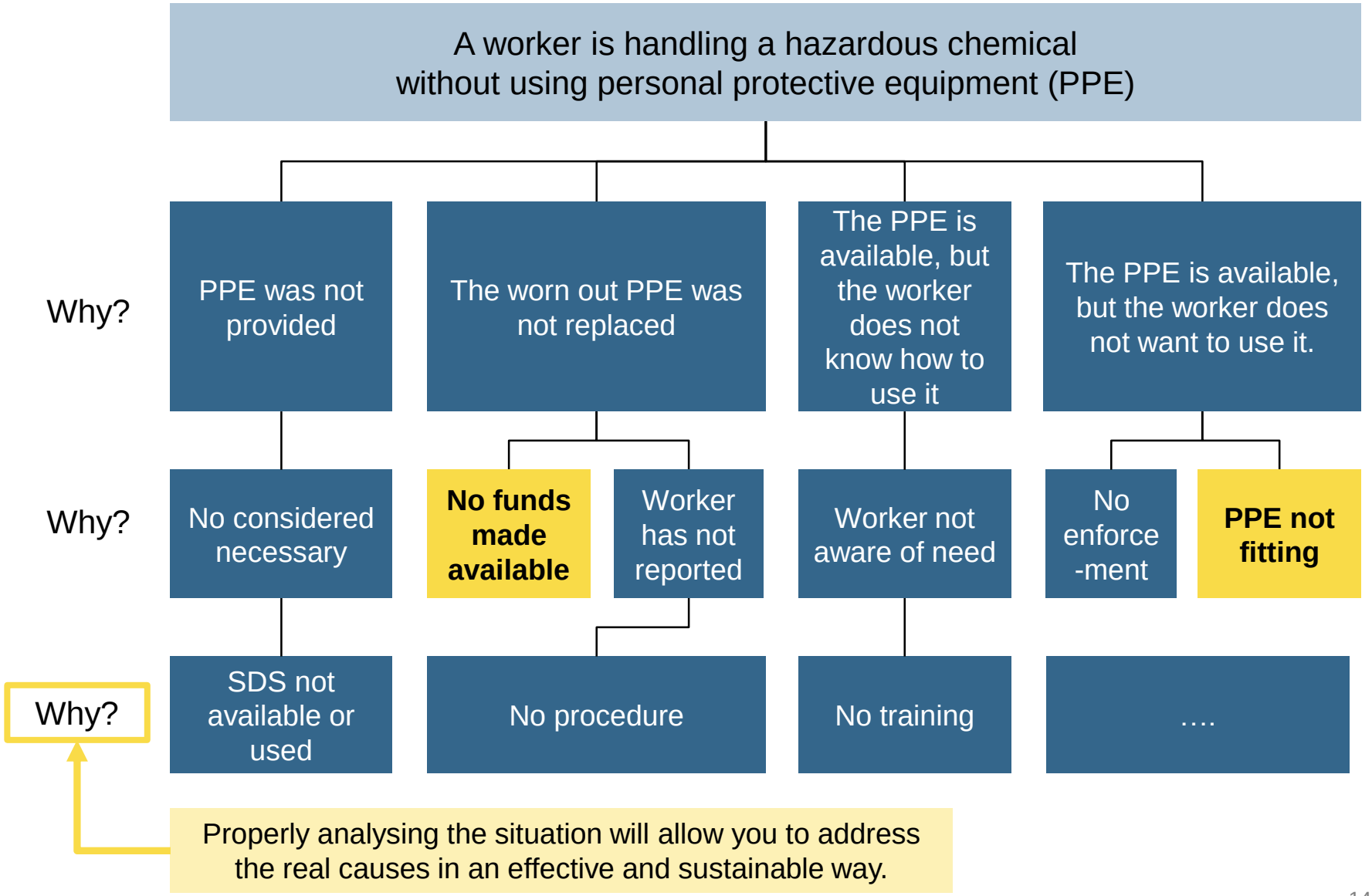
Action: Improve internal communications

Why?

Brand requirement & RSL policy not communicated properly internally

Action: Set-up an internal process to reflect brand requirements

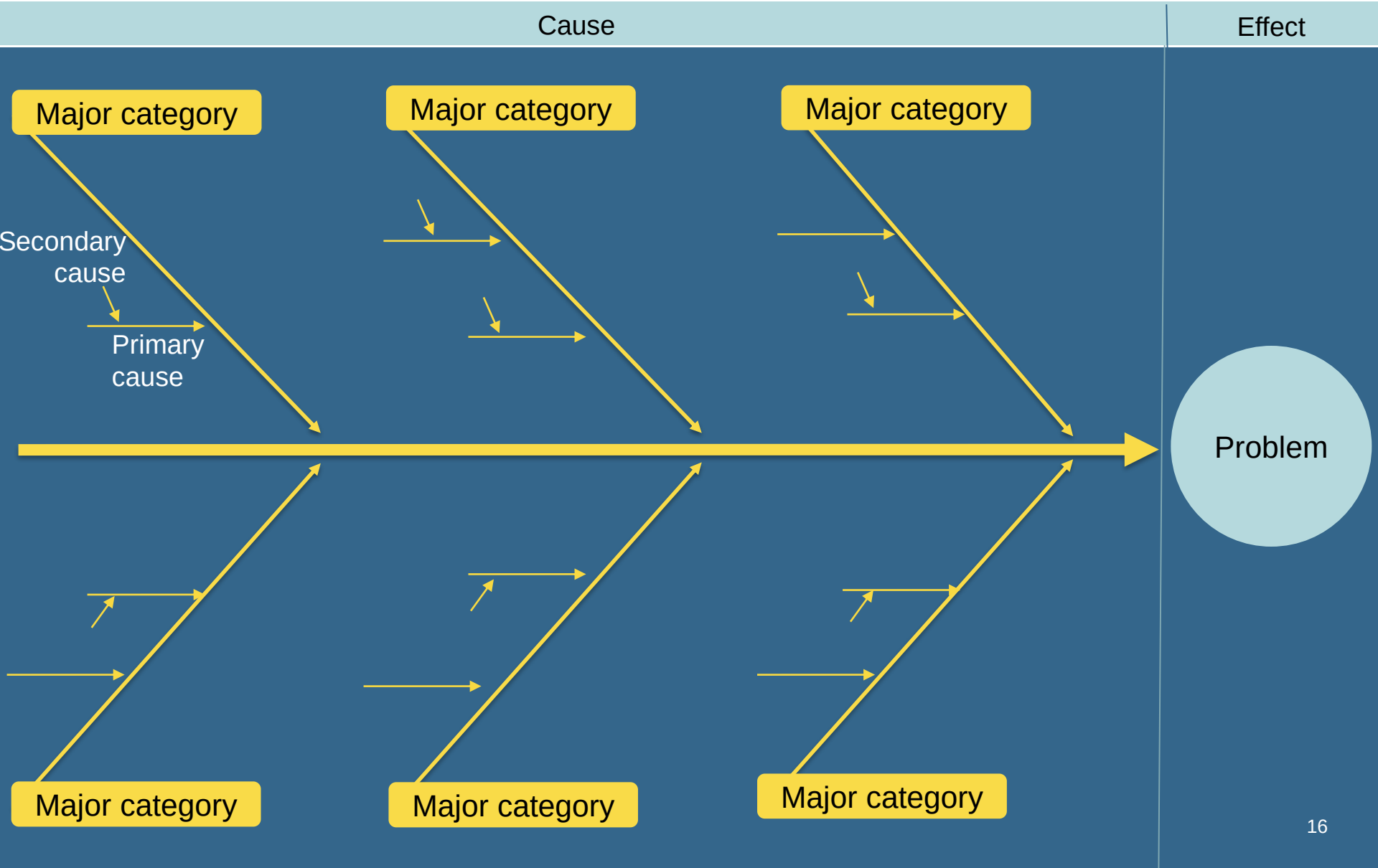
ADRESSING ROOT-CAUSE



SUMMARY OF THE 5 WHYS

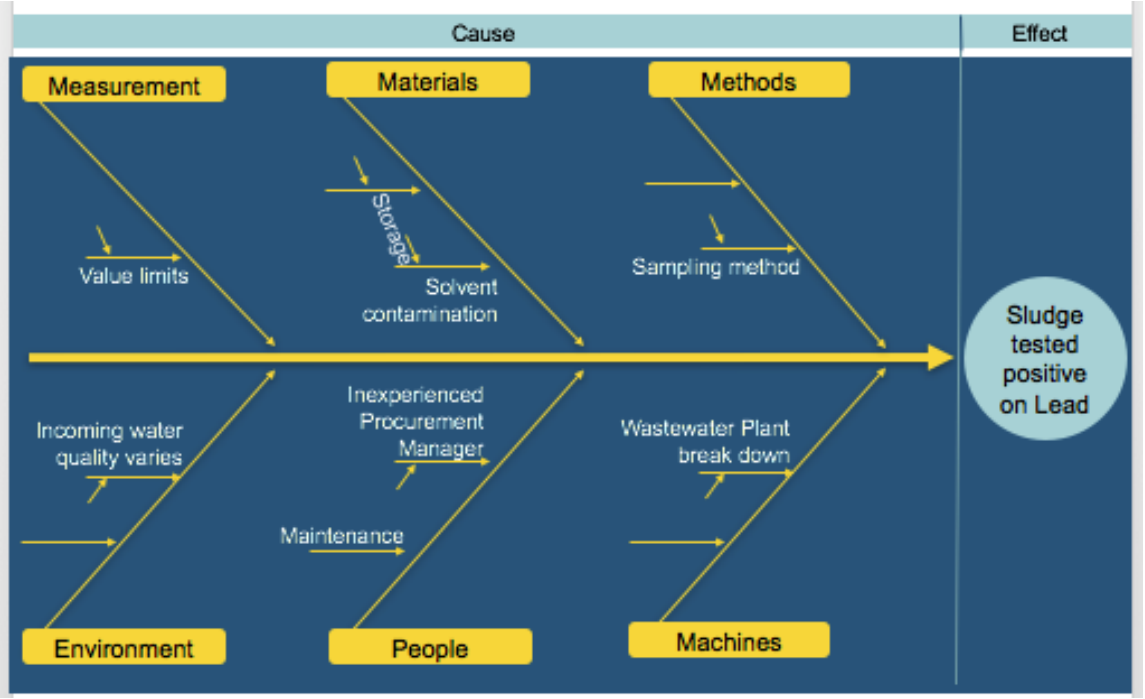
Advantages	Disadvantages
• It helps to quickly identify the root cause of a problem. • It helps determine the relationship between the different root causes of a problem. • It can be learned quickly and doesn't require statistical analysis to be used.	• If the cause is unknown to the person doing the problem solving it may not lead to any meaningful answers. • If even one WHY has a meaningless answer, the whole procedure can be thrown off. • It assumes that each symptom has only one sufficient cause. It may not reveal jointly sufficient causes that explain a symptom. • The method isn’t necessarily repeatable; three different people applying 5 Whys to the same problem may come up with three totally different answers.

UNDERSTANDING THE SITUATION: FISHBONE DIAGRAM



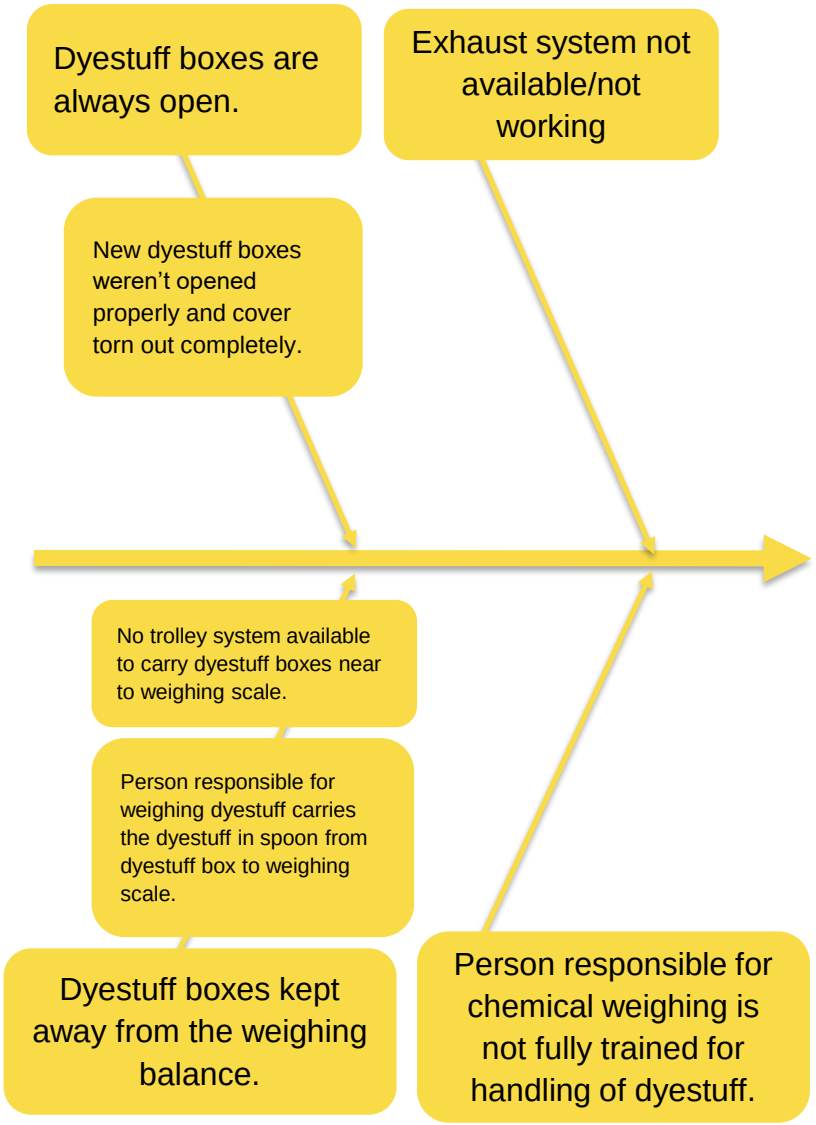
FISH BONE DIAGRAM PROCEDURE

- Define problem statement (effect).
- Brainstorm the major categories of causes of the problem.
- Brainstorm all the possible causes of the problem. Ask: “Why does this happen?”
- Again ask “why does this happen?” about each cause.
- Write sub–causes branching off the causes.
- Continue to ask “Why?” and generate deeper levels of causes. Layers of branches indicate causal relationships.



APPLYING THE FISHBONE DIAGRAM

Cause	Effect	Actions



Dyestuff dust in chemical weighing room

- Train the chemical store responsible person for how to open the dyestuff carton boxes, also, need to train on dyestuff handling and precaution to take care during weighing of dyestuff.
- Ensure proper exhaust system working in place.
- Ensure trolley system available in place to carry out boxes to weighing scale in case they are away.
- Keep the regularly used dyes near to weighing area to avoid frequent use of trolley to carry out dyestuff boxes up to weighing scale

SUMMARY FISHBONE DRIAGRAMS

Advantages	Disadvantages
• It is a visual tool which is very easy to understand and to analyse. • It helps you identify the root cause of the problem. • It helps you to find bottlenecks in the process. • It helps you identify ways to improve the process. • It involves in-depth discussion of the problem which educates the whole team. • It prioritises further analysis and helps you take corrective action.	• Graphically speaking, all causes look equally important. • Sometimes effort is wasted in identifying causes which have little effect on the problem. • Is based on opinion rather than evidence. • This process involves a democratic way of selecting the cause, i.e. voting down the causes, which may not be an effective way of identifying causes. • If the discussion is not controlled properly it may deviate from its objective.

SELECTING A ROOT CAUSE ANALYSIS METHOD

	Advantages	Disadvantages
5 Whys	Quick to perform	Subjective Subject to errors in determining more complex root causes
Fishbone Diagram	Visual Identifies complex root cause(s) Identifies bottlenecks Identifies improvements needed Consensual definition of a root cause In-depth discussion of the problem Prioritises further analysis and corrective action	Time consuming Needs guidance and consensus

ACTIVITY

GROUP WORK

Work in two groups. Follow the instructions in your workbook, exercise (16-2).

Consider the following situation in the factory. You see a worker handling Azo dyes without using personal protective equipment (PPE). There is a high chance that the worker may suffer from immediate lung problems.

Group A: What actions do you suggest using the 5 Why method?
Group B: What actions do you suggest using the Fishbone diagram?

Assessing Alternatives

EVALUATING ALTERNATIVES - SWOT ANALYSIS

A basic, analytical framework that assesses what a ‘solution‘ can and cannot do, for factors both internal (the strengths and weaknesses), as well as external (the potential opportunities and threats).

Strengths

We have specialized staff to know how to set up, operate and maintain a photovoltaic plant .

Weaknesses

The set-up of a photovoltaic plant will require high investment and we do not have budget for new investments until 2019 .

Invest in own photovoltaic plant

Opportunities

The government subsidies photovoltaic plants.

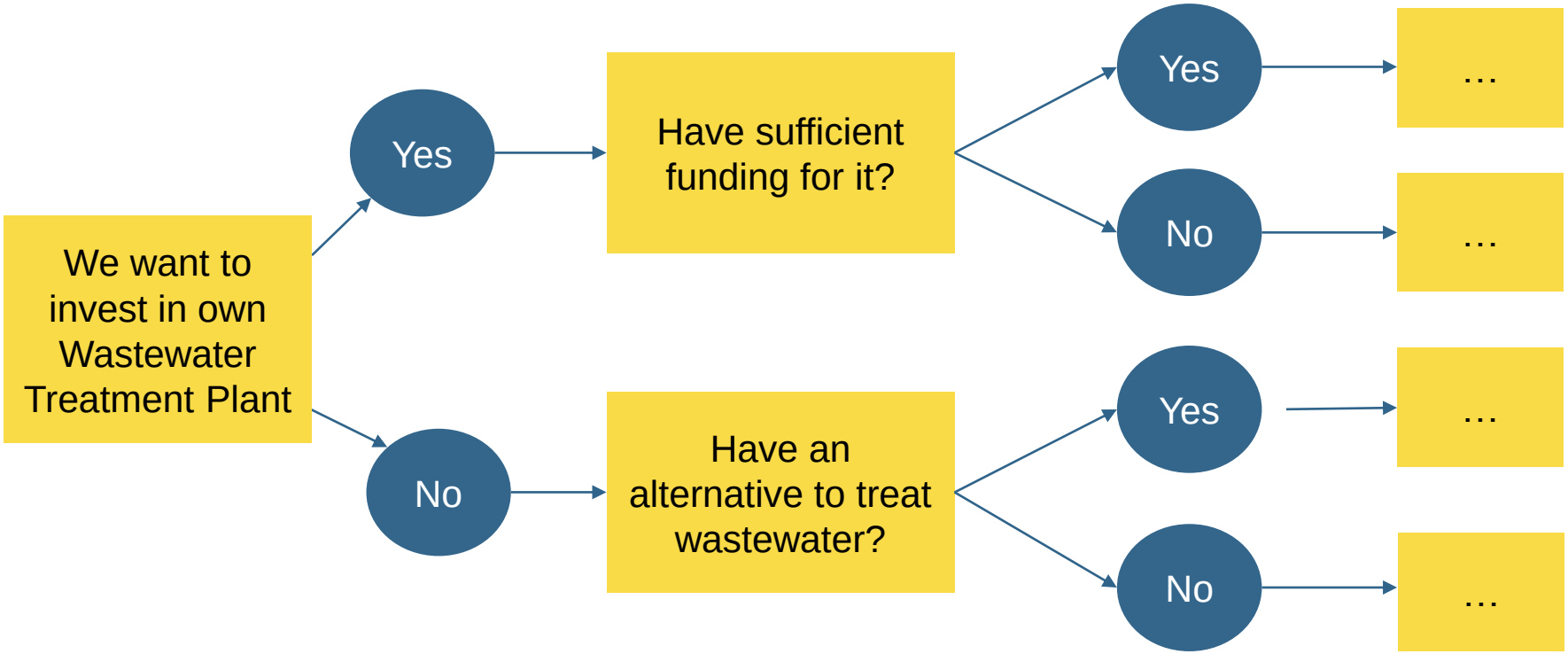
We can enhance our reputation as environmentally friendly company.

Threats

Weather conditions (sunny days) might be unpredictable in our geographical area.

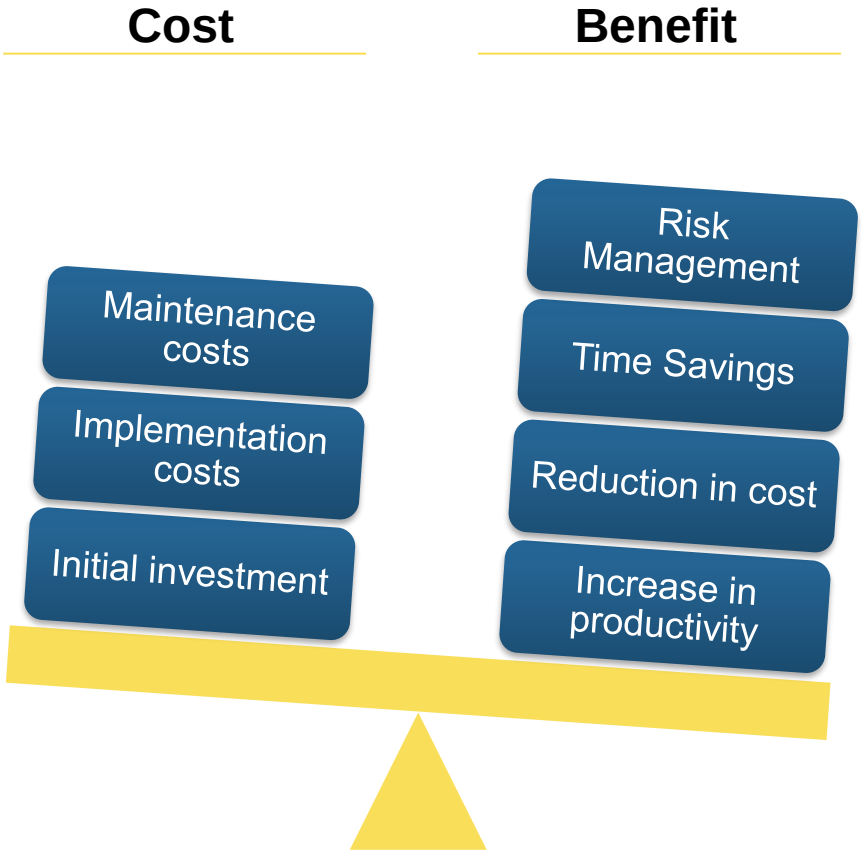
EVALUATING ALTERNATIVES – DECISION TREE

- Graphical representation of possible solutions to a decision based on certain conditions.
- Allows you to approach the problem in a structured and systematic way to arrive at a logical conclusion.
- Represents a documented record of the inputs that were available, the way you performed your evaluation and the reasons for the final decision.



EVALUATING ALTERNATIVES – COST BENEFIT ANALYSIS

- Quick and simple technique that you can use for non-critical financial decisions.
- Straightforward tool for deciding whether to pursue a project.
- You can include financial and intangible items into your analysis.
- Where decisions are mission-critical, or large sums of money are involved, this approach lacks complexity.



ACTIVITY

GROUP WORK

Work in pairs.
Follow the instructions in your workbook, exercise (16-3).

A university asks you to participate in a pilot project on waterless dyeing.
If the project is successful, you will be able to save water and chemicals, plus the time from drying. The dyeing process is twice as fast as your current process.

The project is subsidised heavily, however your investment still is at 1 Million USD. Could this be of interest for you? Use one of the methods to evaluate this case.

Problem Solving

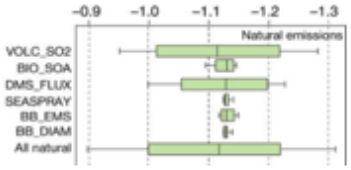
PROBLEM SOLVING: MAIC METHODOLOGY

Measure

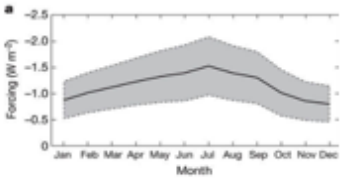
1) Describe the Problem

	IS	IS NOT
What		
Where		
When		
Extent		

2) Measure the Magnitude of a Problem



3) Determine when the problem started



Analyse

4) Identify the Root-Cause

5) Analyse Existing Data

6) Construct List of Verified Facts

Facts
Fact 1
Fact 2
Fact 3
Fact 4

7) Compare Causes to Facts

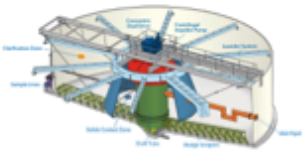
	Fact 1	Fact 2	Fact 3
Cause 1	o	x	o
Cause 2	o	o	o
Cause 3	x	x	o

8) Collect additional data until root cause is identified

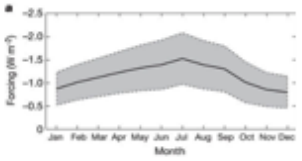
Improve

9) Determine Best Solution

10) Pilot Solution

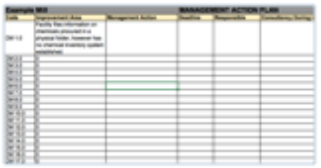


11) Verify Solution Works



Control

12) Control Plan



Open To Questions

SUMMARY

Each participant to feedback with one key learning from this session.

Take notes in your workbook, exercise (16-4).