



Root Cause Analysis & Multi-Criteria Decision Analysis

Course Content

- Session Objectives
- What is Root Cause Analysis (RCA)?
- Benefits of RCA
- The Problem Solving Process through RCS

- Real time examples & hands-on

Recommended book: Bjørn Andersen & Tom Fagerhaug “Root Cause Analysis Simplified Tools and Techniques” 2nd Edition

Session Objectives

Upon completion of this session, participants should be able to:

- Understand the importance of performing root cause analysis
- Identify the root cause of a problem using the problem solving process
- Understand the application of basic quality tools in the problem solving process

What is a root cause?

Effect

CEA

Ishikawa dia
Fishbone

ROOT CAUSE =

- The causal or contributing factors that, **if corrected**, would prevent recurrence of the identified problem
- The “factor” that caused a problem or defect and should be permanently eliminated through process improvement
- The factor that sets in motion the cause and effect chain that creates a problem
- The “true” reason that contributed to the creation of a problem, defect or nonconformance

What is root cause analysis?

- A standard process of:
 - ❖ identifying a problem
 - ❖ containing and analyzing the problem
 - ❖ defining the root cause
 - ❖ defining and implementing the actions required to eliminate the root cause
 - ❖ validating that the corrective action prevented recurrence of problem

Benefits of RCA

By eliminating the root cause...

You save time and money!

- Problems are not repeated
 - Reduce rework, retest, re-inspect, poor quality costs, etc...
- Problems are prevented in other areas
- Communication improves between groups and
- Process cycle times improve (no rework loops)
- Secure long term company performance and profits

Less rework = Increased ops profits (lower OPEX)!



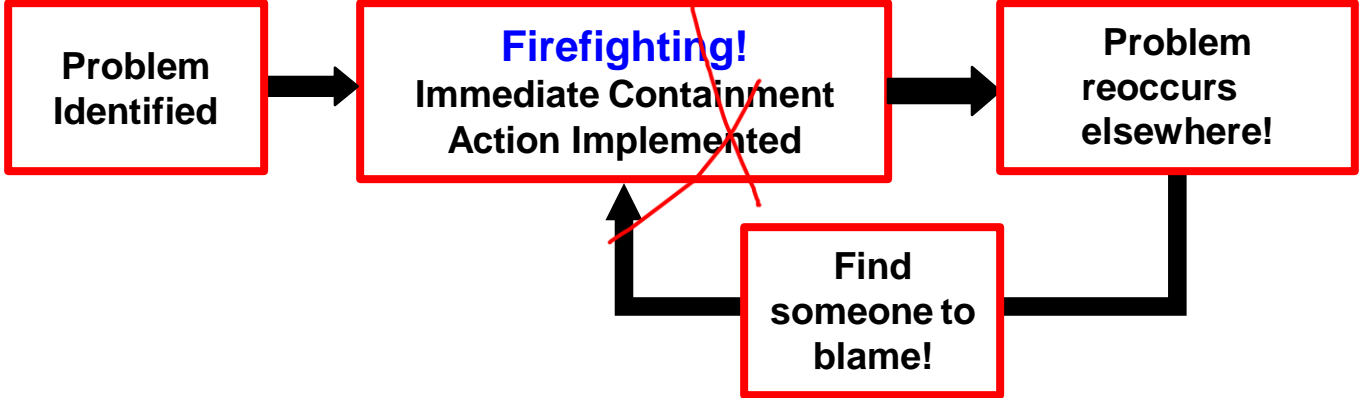
When should root cause analysis be performed?

When PROBLEMS occur !!

- Excess Inventory**
- Supplier raw material Defects**
- Out of Control Process**
- Computer issues**
- Scrap Problems**
- Human Error**
- Audit Finding*
- medical errors*
- Missed Deliveries**
- Machine Defects**
- Safety Issues**
- Workmanship Defects*
- Overspending Budget**

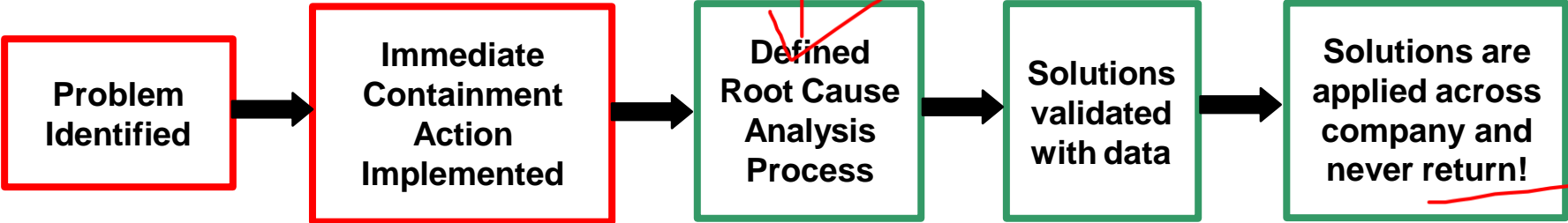
How does it differ current analysis approach?

USUAL APPROACH

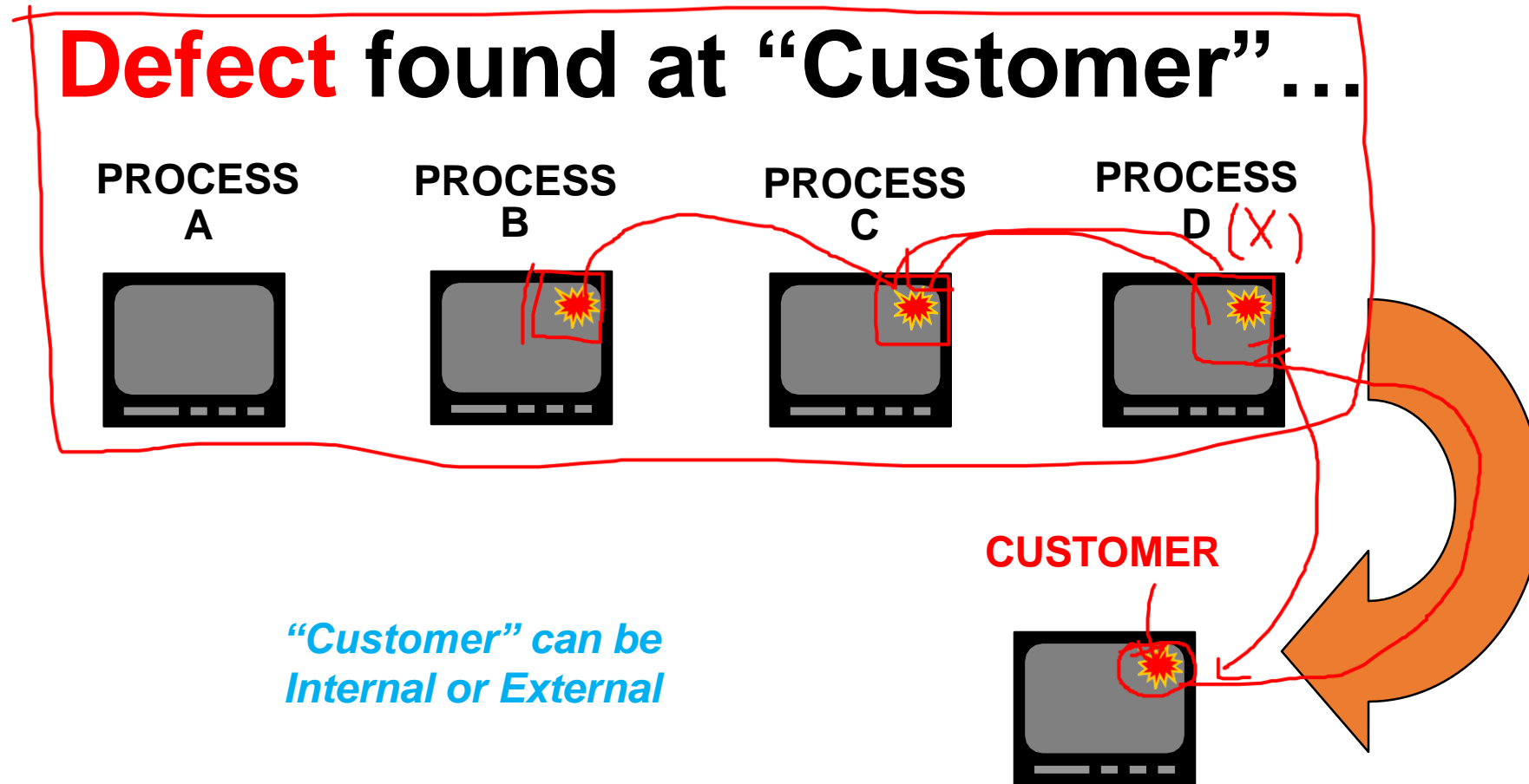


Similar to Value system diagram 1

RCA APPROACH

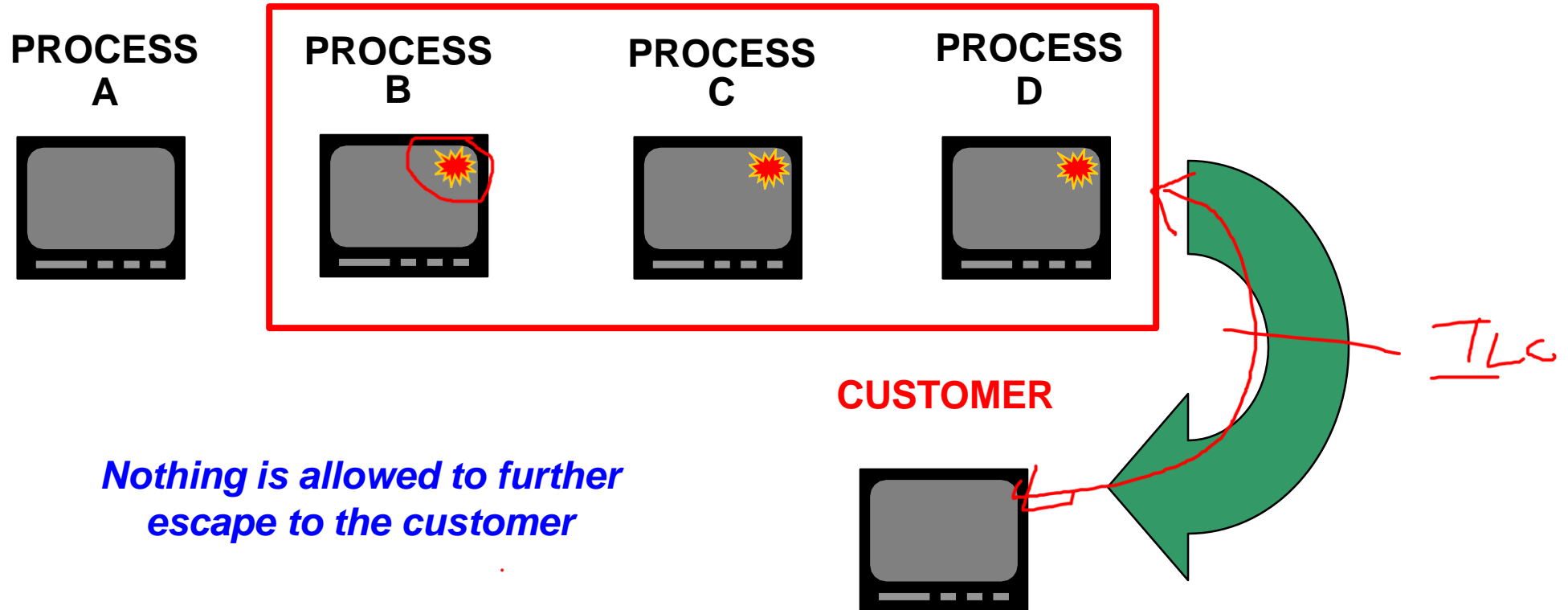


RCA working approach



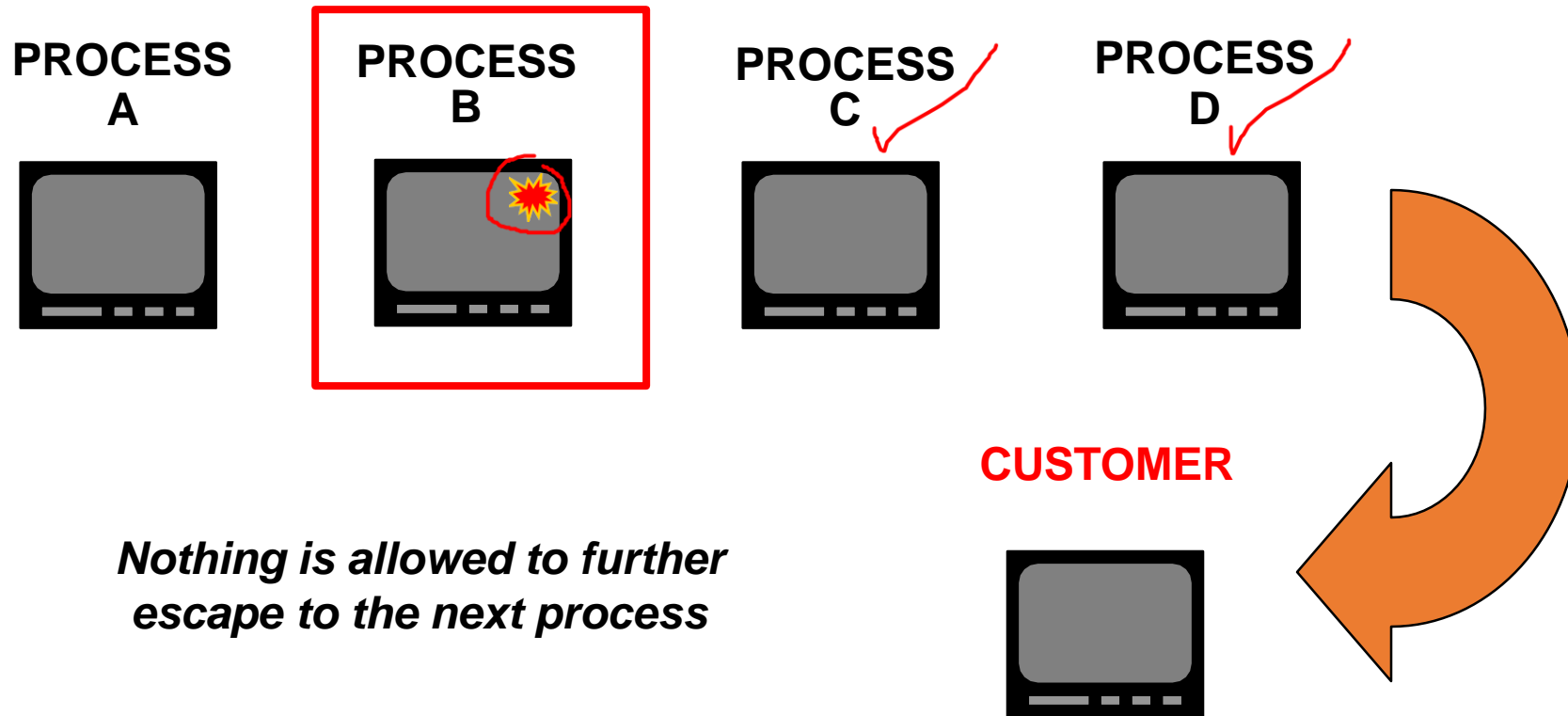
RCA working approach

Contain the problem...



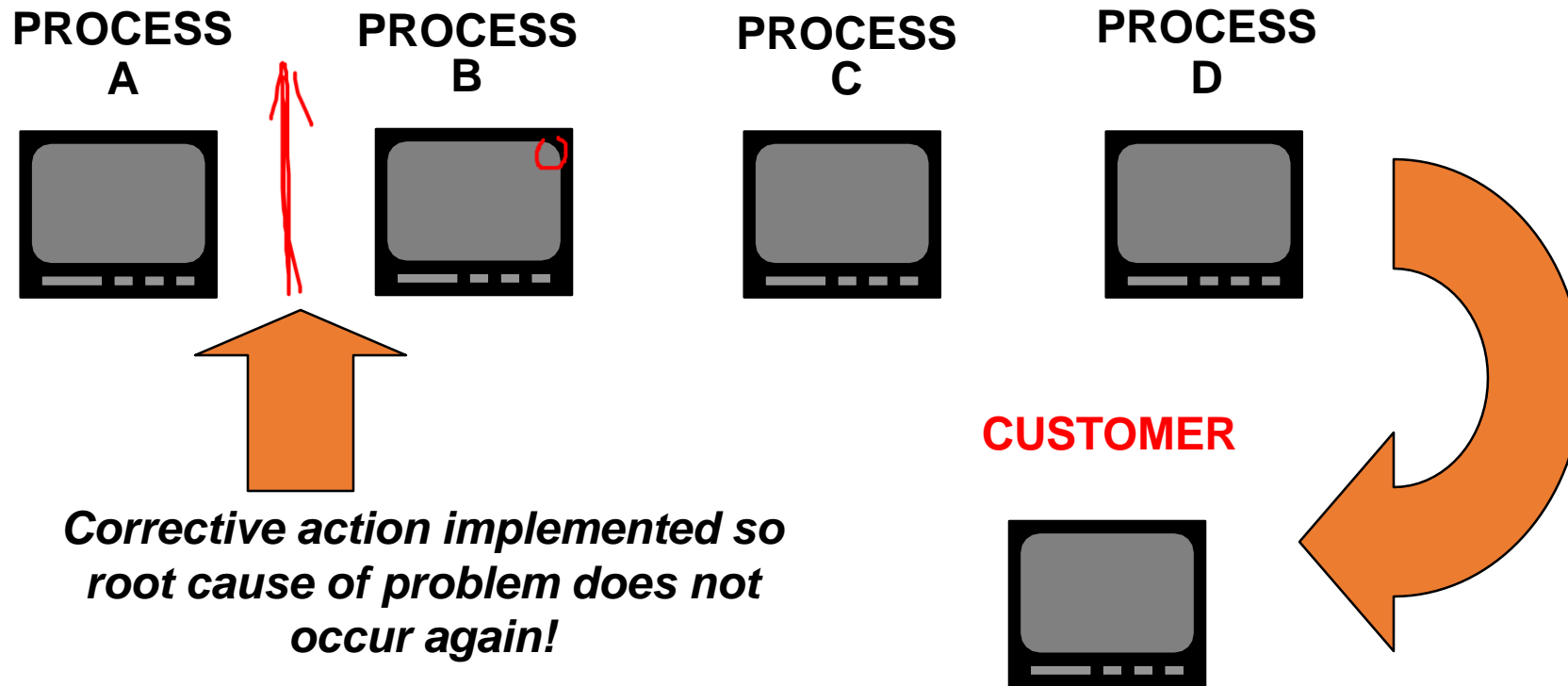
How does it work?

Contain the root process...

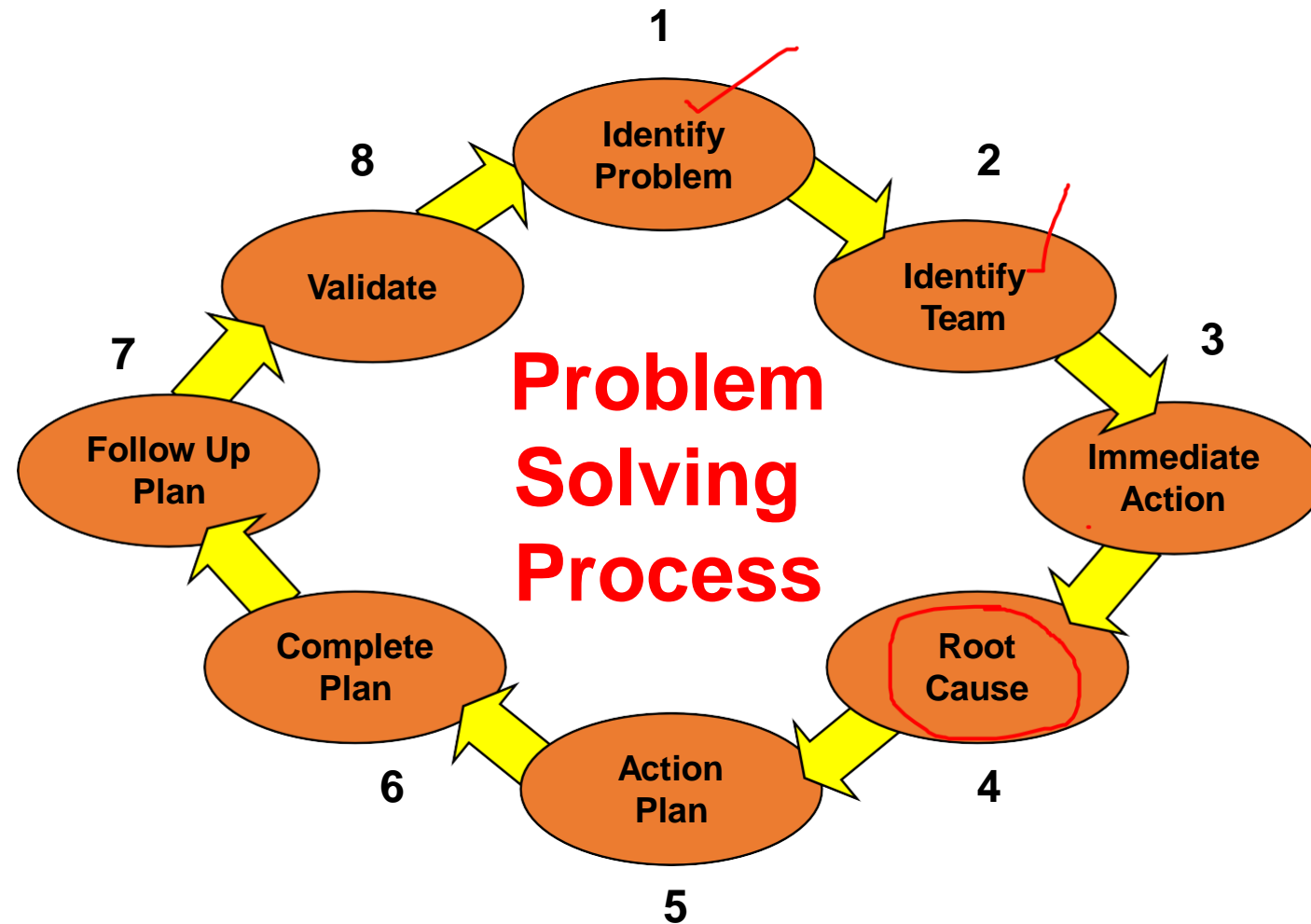


RCA working approach

Prevent the problem...



8 Stage Problem Solving Process



Stage #1

Problem Identification

Very important!

- Clearly state the problem the team is to solve
 - Teams should refer back to problem statement to avoid getting off track

- Use 5W2H approach

- Who? What? Why? When? Where?
- How? How Many?

G2C ✓

5W2H

- **Who?** Individuals/customers associated with problem
- **What?** The problem statement or definition
- **When?** Date and time problem was identified
- **Where?** Location of complaints (area, facilities, customers)
- **Why?** Any previously known explanations
- **How?** How did the problem happen (root cause) and how will the problem be corrected (corrective action)?
- **How Many?** Size and frequency of problem

Stage #2

Identification of Team or Group

When a problem cannot be solved quickly by an individual, use a team!

- Should consist of domain knowledge experts
- Small group of people (4-10) with process and product knowledge, available time and authority to correct the problem
- Define R&R of team members
- Consider input from every group member

Stage #3

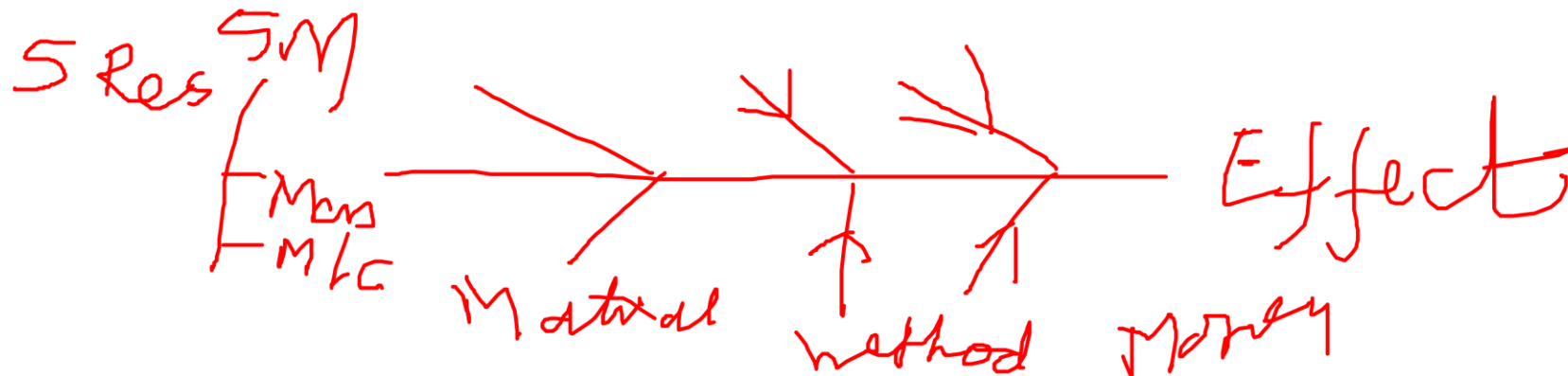
Immediate Action

- Must isolate effects of problem from customer
- Re-inspection before shipping
- Rework
- ~~Recall parts/documents from customer or from storage~~
- Only temporary until corrective action is implemented (very costly, but necessary)
- Must also verify that immediate action is effective

Stage #4

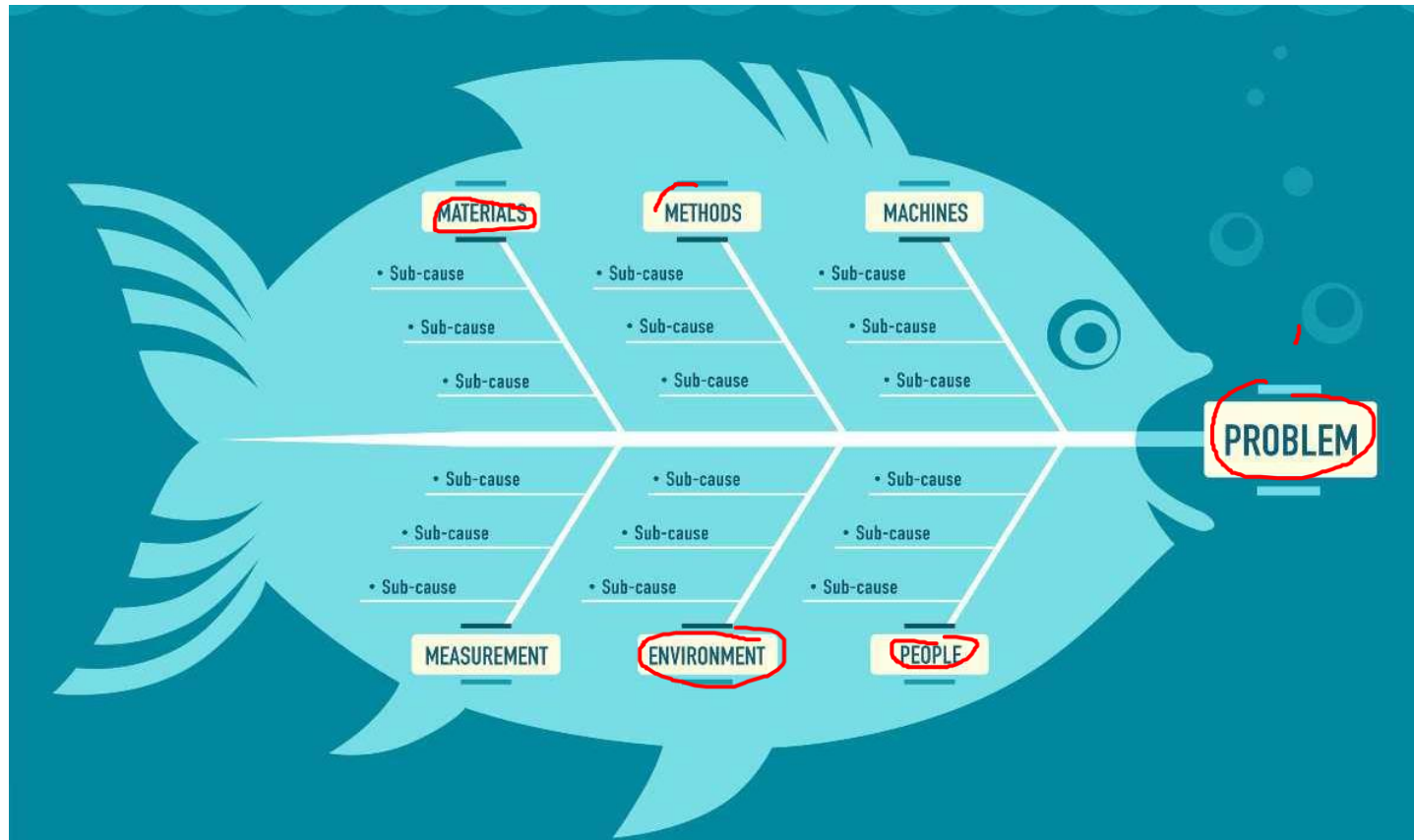
Root Cause Finding/Analysis

- Brainstorm possible causes of problem with team
- Organize causes with Cause and Effect Diagram
- Perform Pareto Analysis to causal factors causes to identify those most likely
- Use 5 Why? method to further define the root cause of symptoms
- May involve additional research/analysis/investigation to get to each “Why?”



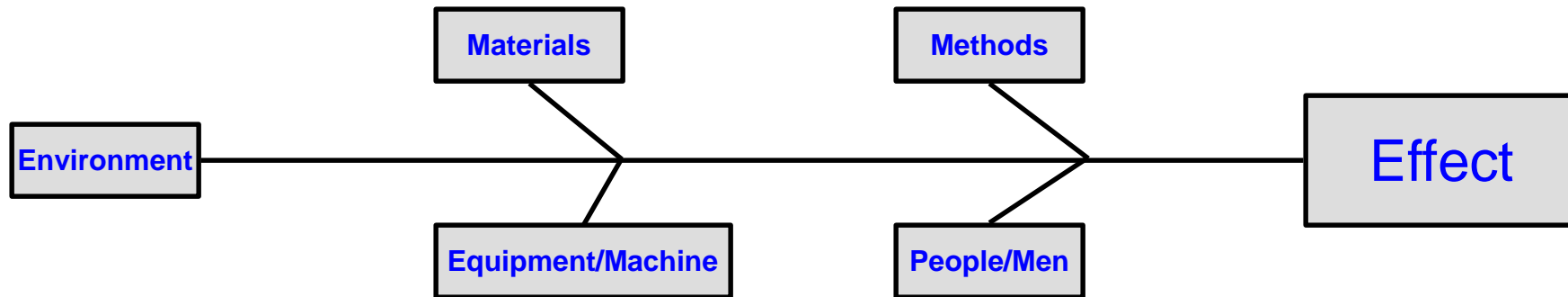
Development of Cause-Effect Diagram?

- A Cause-Effect (also called “Ishikawa” or “Fishbone”) Diagram is a Data Analysis/Process Management Tool.
- A Cause-Effect Diagram is typically generated in a group meeting
- It is a graphical method for presenting and sorting ideas about the causes of issues or problems



Cause-Effect Diagram

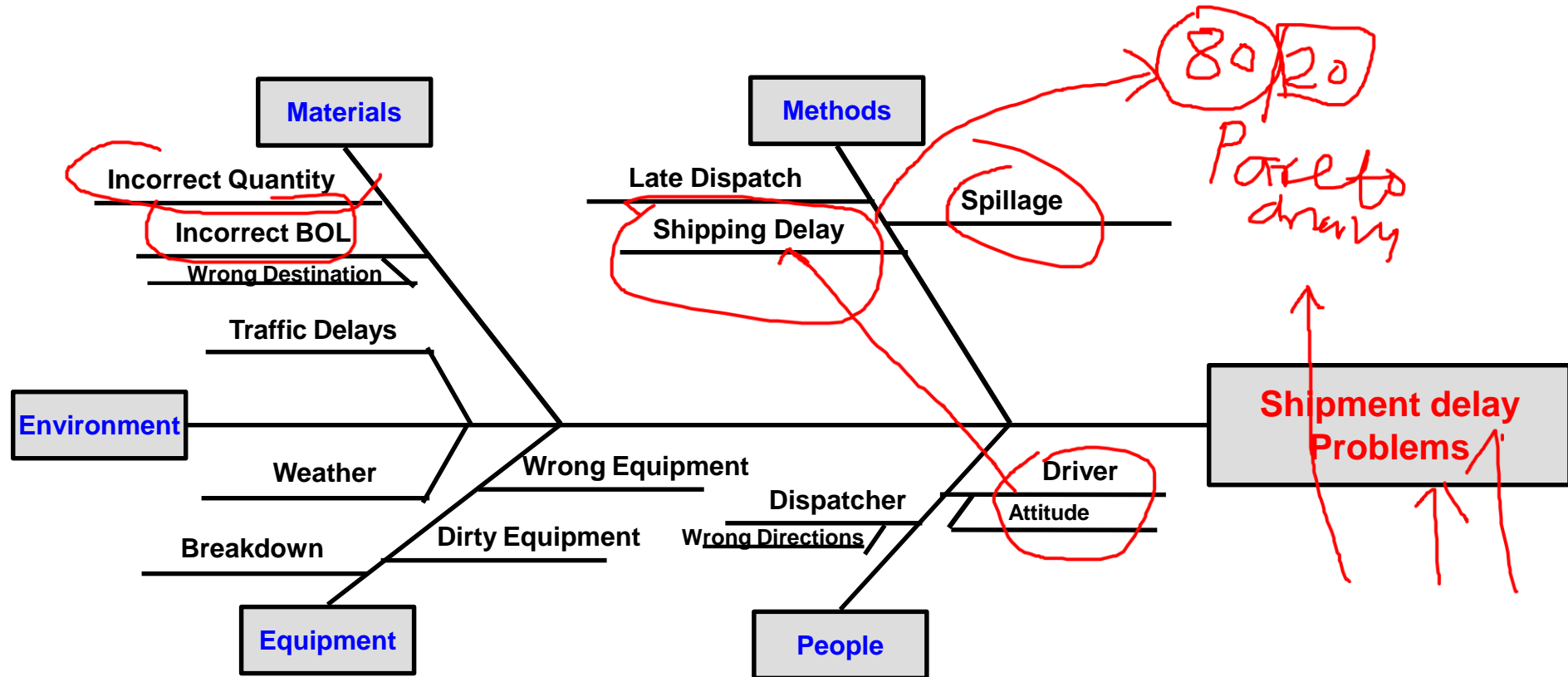
- Steps used to create a Cause-Effect Diagram:
 - Define the issue or problem clearly
 - Decide on the root causes of the observed issue or problem
 - Brainstorm each of the cause categories
 - Write ideas on the cause-effect diagram. A generic example is shown below:



NOTE: Major system causes are not limited above 5 categories, but serve as a starting point

Cause-Effect Diagram

- Allow team members to specify where ideas fit into the diagram
- Clarify the meaning of each idea using the group to refine the ideas. For example:



Stage#5

Corrective Action Plan

- Must verify the solution will eliminate the problem
 - Verification before implementation whenever possible
- Define exactly...
 - What actions will be taken to eliminate the problem?
 - Who is responsible?
 - When will it be completed?

Stage #6

Complete Action Plan

- Make certain all actions that are defined are completed as planned
- If one task is still open, verification and validation is pushed back
- If the plan is compromised, most likely the solution will not be as effective

Stage #7

Follow Up Plan

- What actions will be completed in the future to ensure that the root cause has been eliminated by this corrective action?
- **Who** will look at what data?
- **How long** after the action plan will this be done?
- **What criteria** in the data results will determine that the problem has not recurred?

Stage#8

Validate and Celebrate

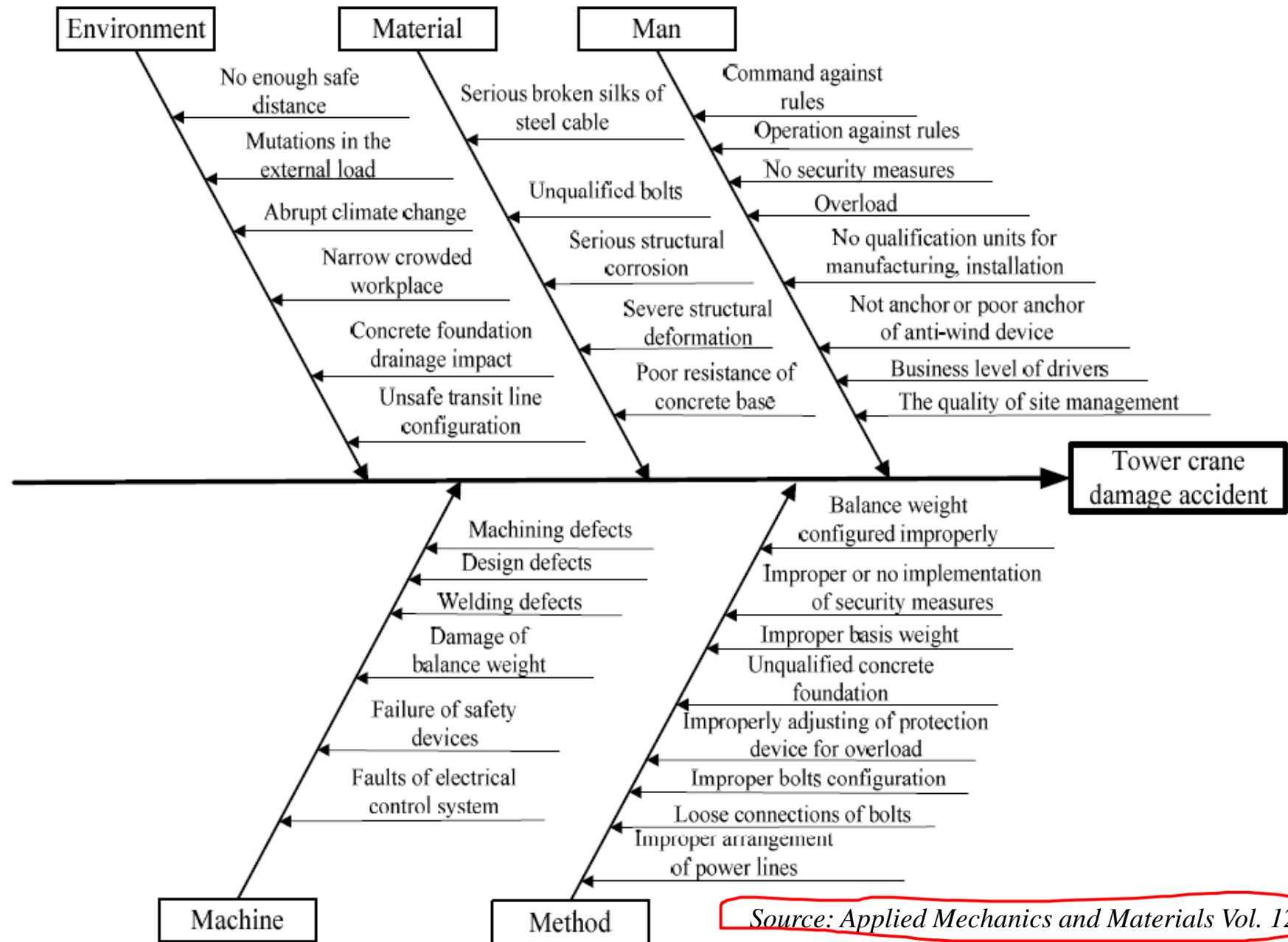
- What were the results of the follow up?
- If problem did reoccur, go back to Step #4 and re-evaluate root cause, then re-evaluate corrective action in Step #5
- If problem did not reoccur, celebrate team success!

Some important points about root causes

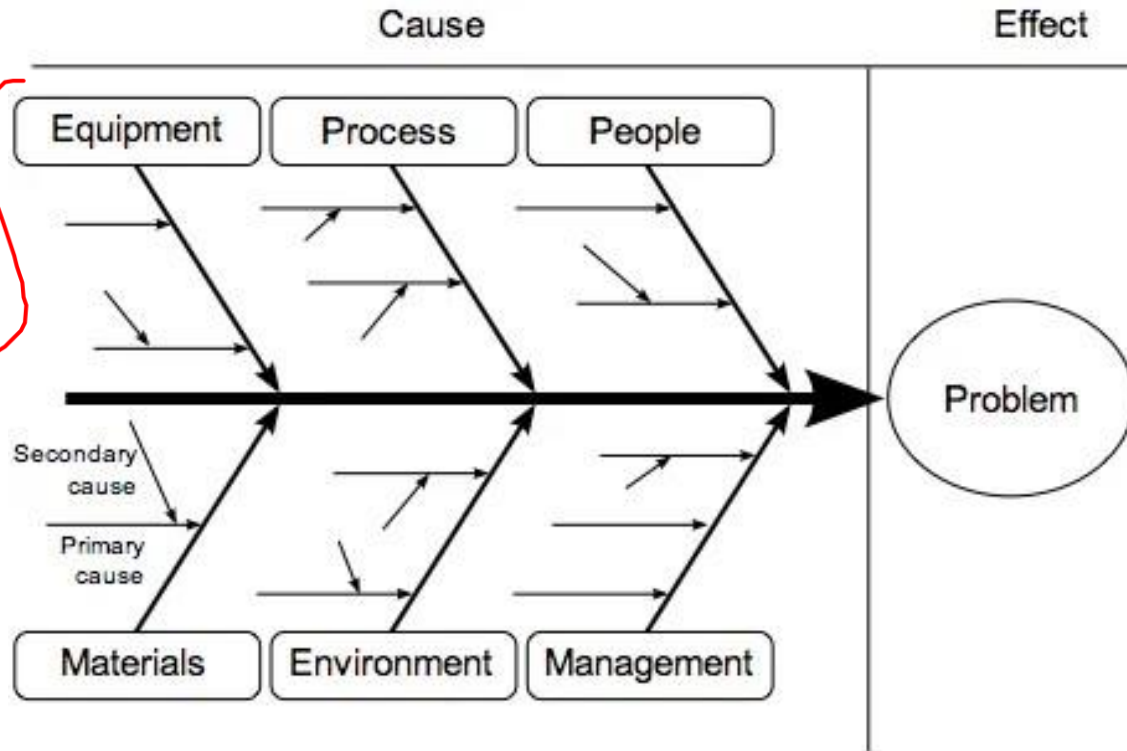
- One problem **may have more than one root cause**
- One root cause may be contributing to many problems
- When the root cause is not addressed, expect the problem to reoccur
- **Prevention is the key!**

https://www.youtube.com/watch?v=ivd_oOI-U-0

Tower crane accident RCA



Class Exercise Guideline



- Even Group (2,4,6) will develop RCA for COVID-19 Booster Dose (under dimensions of Society, Government, Individual, Process)
- Odd group (1,3,5) will develop RCA for fire issues/safety in car/2w (under production, sourcing, quality assembly, and government/regulatory)

Respective problem statements are given in next slides.

Problem statement-1 (Booster Dose)

Another vax push by Centre

Centre said it will make booster doses free for adults at govt-run centres from July 15 for 75 days - a part of efforts to accelerate the pace and expand the country's booster drive

92.1% adults eligible for a third dose are late for the shot

BY AGE GROUP		
98.8%	98%	73%
for the 18-45 yrs group	for the 45-60 yrs age grp	for the 60+ yrs group

WHAT'S SLOWING IT DOWN?
At present, booster doses are free only for people above 60, although several states sponsor third doses for younger adults. Experts say that having to pay for the third dose appears to be a significant deterrent.

Leading to a large stockpile 100mn doses
the stock of vaccines lying with states. At the current pace of daily vaccination, it will take 2,520 days to consume this stock.

"Vaccination is an effective means to fight Covid-19. Today's Cabinet decision will further India's vaccination coverage and create a healthier nation."
- NARENDRA MODI, PM

Tuesday, August 23, 2022

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Home / Cities / Pune / Amrut Mahotsav campaign: Push for free booster dose sees positive response across state

Amrut Mahotsav campaign: Push for free booster dose sees positive response across state

The campaign to administer the free precautionary (booster) dose was launched across the country on July 15 to encourage citizens to get vaccinated and ensure protection against Covid-19.

Wednesday, August 24, 2022

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Home / Lifestyle / Health / Have you received your Covid-19 booster dose yet? Doc explains its efficacy

Have you received your Covid-19 booster dose yet? Doc explains its efficacy

"After three deadly waves, people should realise how fatal Covid can be and, therefore, after two primary doses of the vaccine, getting jabbed with booster doses is crucial," says a doctor

Centre reduces gap between 2nd & booster doses of Covid vaccine to 6 months from 9

Sushmi Dey / TNN / Updated: Jul 7, 2022, 03:07 IST

22 PTS

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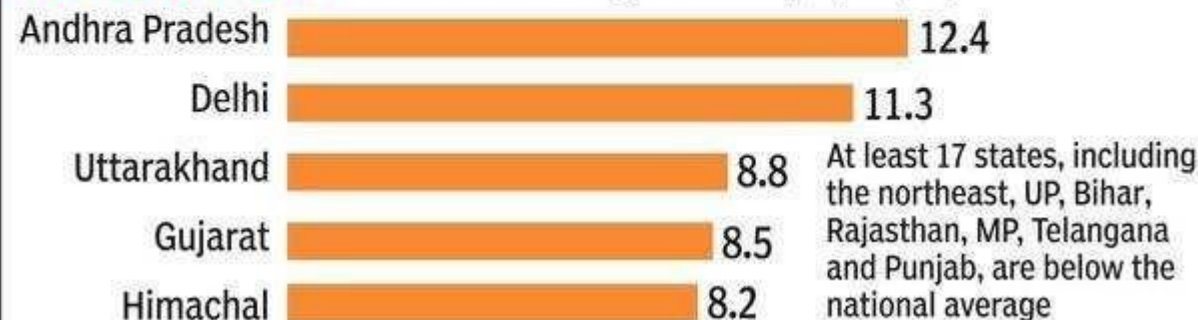
AA

NATL COVERAGE 5.1%, BEST STATE AT 12.4%

Age Group	Population (cr)	Booster Shots (cr)	% Covered
18-59	80.1	0.6	0.8
60+	13.8	4.1	30.1
Total	93.9	4.7	5.1

Source: Health ministry. Data as of 7am on July 6. Figures rounded off

TOP 5 STATES Booster coverage of 18+ popn (%)



87 per cent people in Odisha yet to receive booster shots

Not only the precaution dose, but the second dose coverage in around eight districts is also low as 25 lakh people are yet to take their second jab.

Published: 05th August 2022 02:10 AM | Last Updated: 05th August 2022 02:10 AM A+ A

Problem Statement-2 (Vehicle Recall issues)

US: Hyundai, Kia recall vehicles due to fire risk

AP / Feb 8, 2022, 17:16 IST



ARTICLES



US: Hyundai, Kia recall vehicles due to fire risk



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US approves \$100 million arms sales to Taiwan amid tension with...



US defends



HYUNDAI

Hyundai, Kia recalls over 2 lakh vehicles; advises owners to park cars outside due to fire risk

Hyundai and Kia Motors has issued an recall of over 2 lakh vehicles; advising the owners to park their large SUVs outdoors and away from buildings after reporting 25 fire incidents in the US and Canada.

Written By [Zee Media Bureau](#) | Last Updated: Aug 24, 2022, 11:35 AM IST | Source: Bureau

- Hyundai, Kia recalls over 2 lakh vehicles
- Advises owners to park their large SUVs outdoors and away from buildings
- Multiple cases have been reported where four-wheelers have



BMW Recalls iX and i4 electric vehicles Over Battery Fire Risk

The US National Highway Traffic Safety Administration has released a report which states that the North American division of the company has to recall the 2022-2023 iX SUV and 2022 i4 sedan models due to a potential battery fire risk. Owners of the vehicles have been asked to not charge or drive their cars, with special instructions like "park away from building."



IANS Updated Aug 2, 2022 | 03:18 PM IST

Ola S1 Pro caught fire in Maharashtra – will investigate to understand root cause, affirms Ola Electric

A Twitter User on Friday, posted a video of an Ola S1 Pro up in flames in Pune, Maharashtra.

Written by [Express Mobility Desk](#)

Updated: March 26, 2022 10:43:09 pm

Maruti Suzuki to issue a recall for Dzire Tour S over defective airbag control unit

Maruti Suzuki has said that they will issue a recall of its commercial vehicle Dzire Tour S due to faulty airbag control unit. This recall will affect 166 units of the Maruti Suzuki Dzire Tour S manufactured between August 6th 2022 - August 16th 2022. This replacement will be done free of charge.



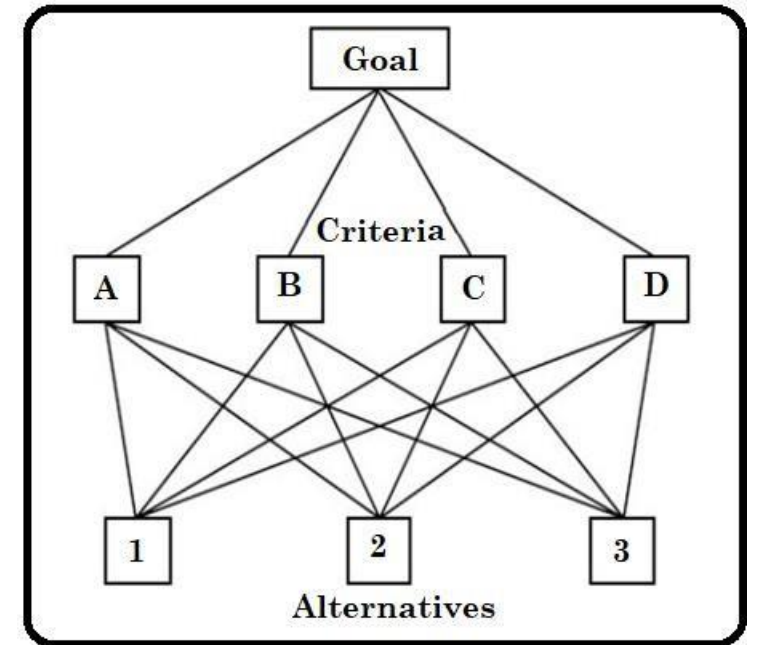
Atul Bandhu | Updated Aug 24, 2022 | 02:02 PM IST

Decision making trial and evaluation laboratory (DEMATEL)

- An effective method for the identification of cause-effect chain components of a complex system .
- Evaluates interdependent relationships among factors.
- A structured matrix based method.
- Finds the critical ones through a visual structural model

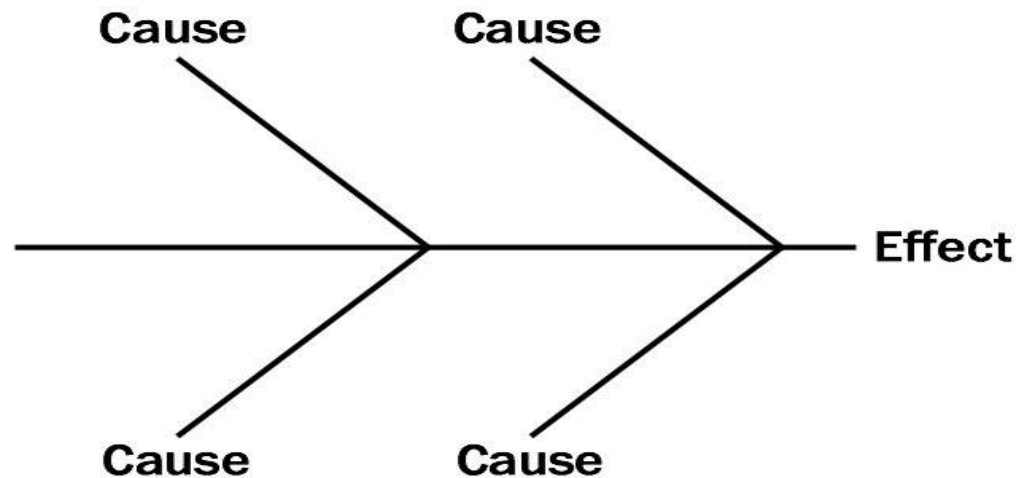
DEMATEL

- A decision making problem can be structured as –
 - Goal
 - Criteria
 - Alternatives
- DEMATEL focuses
upon the criteria and the interrelations among them.

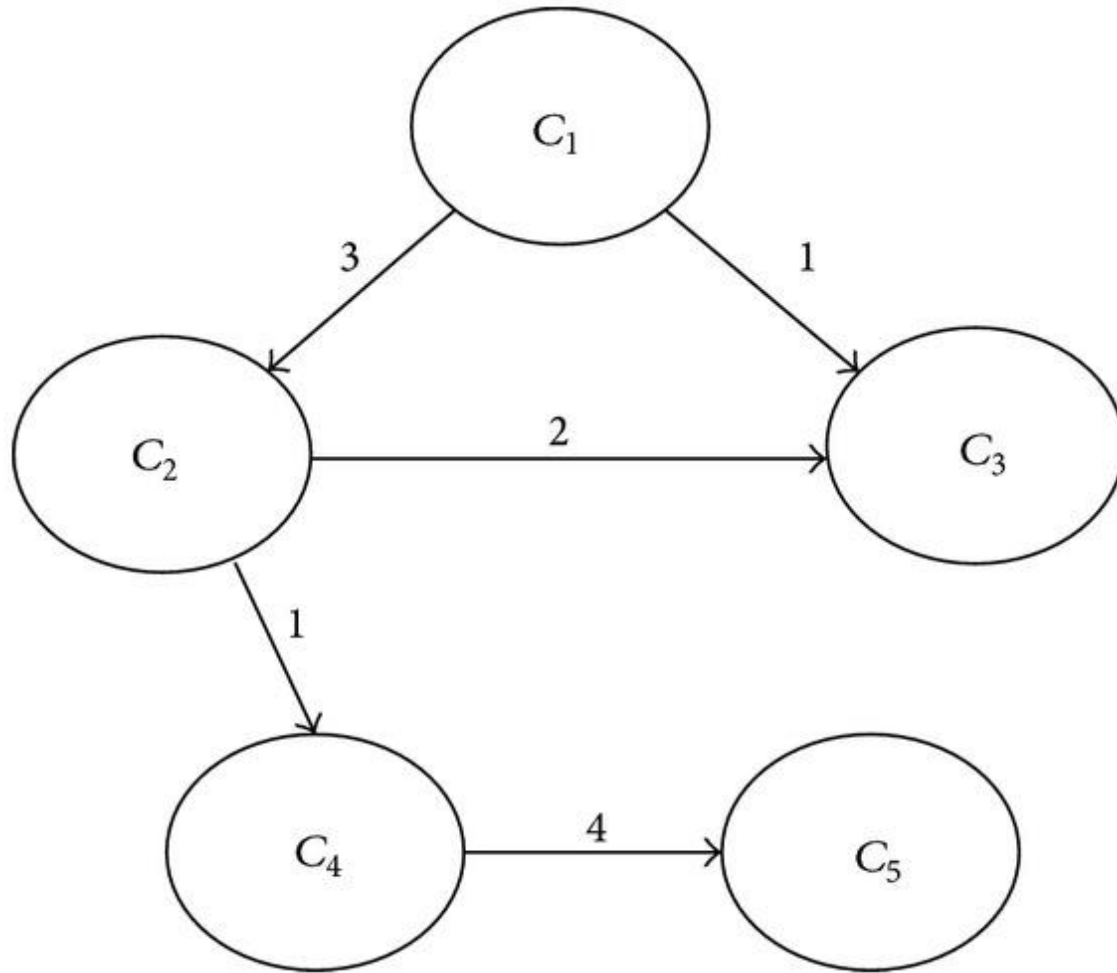


DEMATEL

- Cause = The reason for something happening.
- Effect = What happened
- Cause + Effects = Creation of complex phenomenon

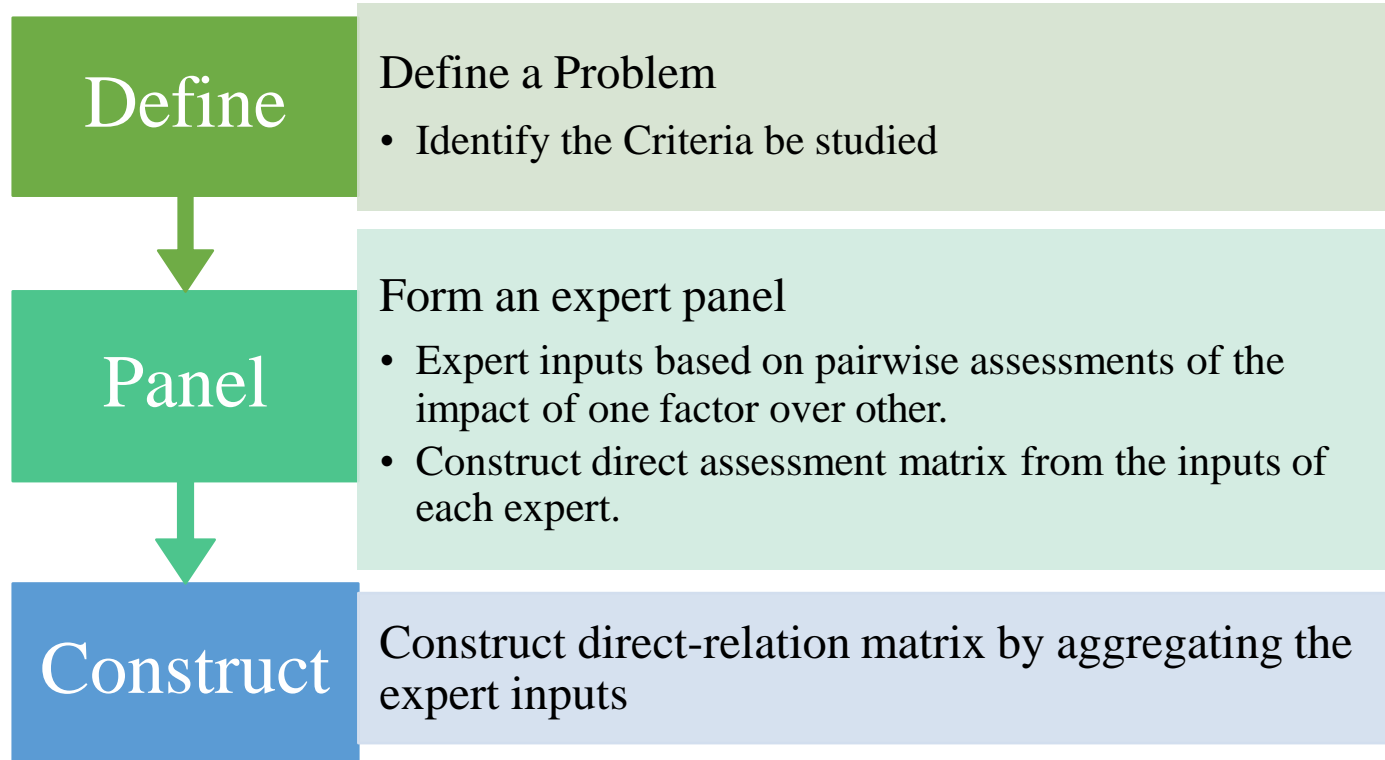


- But in reality, situations are not linearly defined.
- There are interrelations among factors as well.

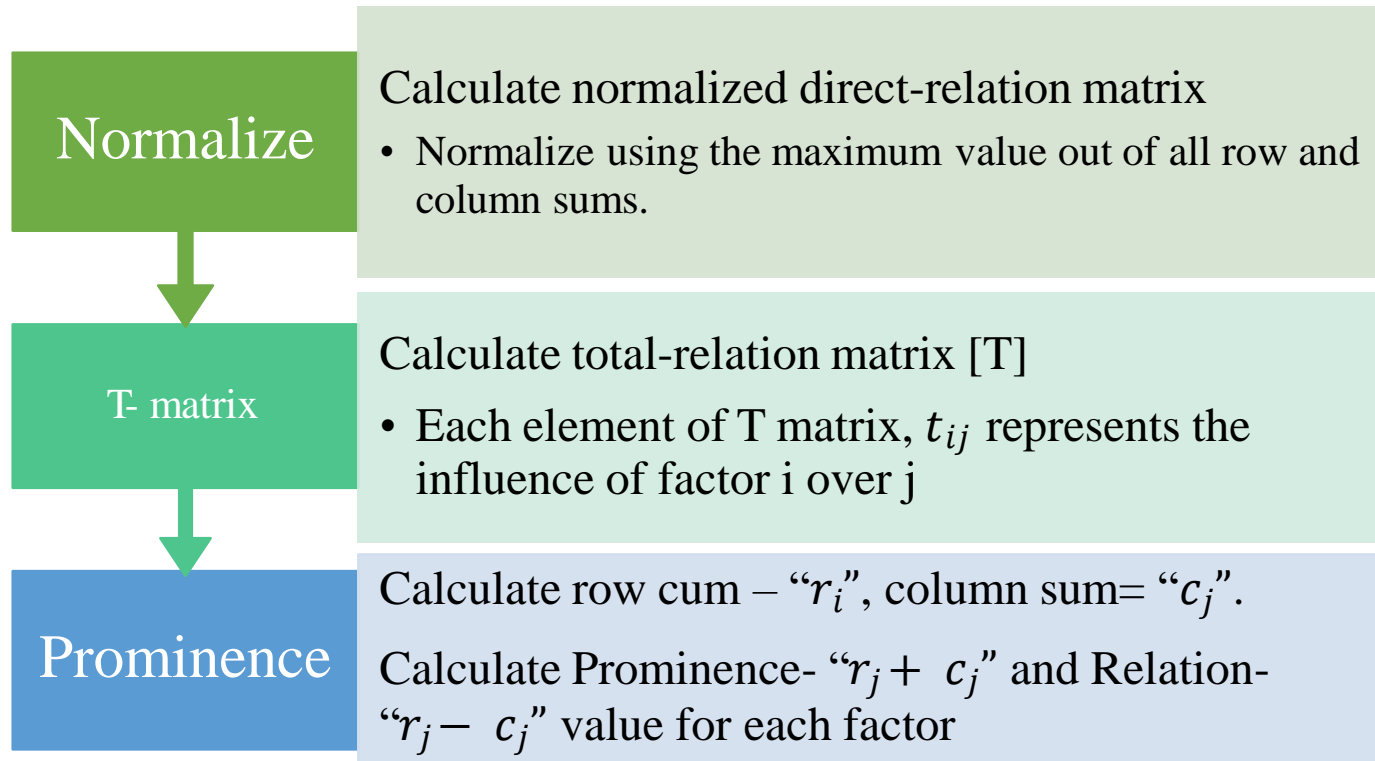


An example of an
Impact-Relation
Map

Steps For DEMATEL



Steps For DEMATEL



Steps For DEMATEL

Threshold

Calculate the threshold value- " Θ " to identify t_{ij} with significant influence.


Priority

Map " $r_j + c_j$ " against " $r_j - c_j$ " to create the impact relation map.

Show only relations with value greater than Θ

An Illustrative Example

- Relevant to the goal the set of factors/criteria are identified.
- Initial direct-relation matrix is constructed for the inputs of each expert .

$$\mathbf{A} = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix}$$


The "Influence" of Factor 1, to Factor 2.

Direct Relation Matrix

- Construct the aggregated direct relation matrix by taking average of the expert inputs

$$A^1 =$$

	F1	F2	F3
F1	0	2	4
F2	1	0	3
F3	4	1	0

$$A^2 =$$

	F1	F2	F3
F1	0	2	2
F2	3	0	1
F3	4	1	0

$$\text{Avg} =$$

0	2	3
2	0	2
4	1	0

0 = no influence
1 = low influence
2 = medium influence
3 = high influence
4 = very high influence

The expert judgements are recorded through verbal scale

Normalize the initial direct-relation matrix

- Matrix = A
- $S = \max\{\max_{j=1}^n a_{ij}, \max_{i=1}^n a_{ij}\}$
- Normalized Direct Relation Matrix = A/S

$A =$	0	2	3	$\sum_{j=1}^n a_{ij}$
	2	0	2	5
	4	1	0	4
$\sum_{i=1}^n a_{ij}$	6	3	5	

Normalize the initial direct-relation matrix

- $S = \max\{\max_{j=1}^n \sigma_j^n = a_{ij}, \max_{i=1}^n a_{ij}\}$

- $\max_{j=1}^n \sigma_j^n = a_{ij} = 5$

- $\max_{i=1}^n \sigma_i^n = a_{ij} = 6$

$$\sum_{j=1}^n a_{ij}$$

A =	0	2	3	5
	2	0	2	4
	4	1	0	5

$$\sum_{i=1}^n a_{ij}$$

6 3 5

Normalize the initial direct-relation matrix

- $S = \max\{\max_{j=1}^n a_{ij}, \max_{i=1}^n a_{ij}\} = \max\{5,6\} = 6$
- $D = A/6$

D =

0	2/6	3/6
2/6	0	2/6
4/6	1/6	0

D =

0	0.33	0.5
0.333	0	0.333
0.667	0.167	0

Calculate the total-relation matrix

- The total relation matrix = T

$$\begin{aligned} T &= \sum_{m=1}^{\infty} D^m = D + D^2 + D^3 \dots D^m \\ &= D (I + D + D^2 + \dots + D^{m-1}) \\ &= D(I - D)^{-1} (I - D) (I + D + D^2 + \dots + D^{m-1}) \\ &= D(I - D)^{-1} (I - D^m) = D(I - D)^{-1}. \end{aligned}$$

- Therefore, T = D (I-D)⁻¹.

Normalize the initial direct-relation matrix

- $T = D (I - D)^{-1}$.

$$D = \begin{bmatrix} 0 & 2/6 & 3/6 \\ 2/6 & 0 & 2/6 \\ 4/6 & 1/6 & 0 \end{bmatrix} \quad I = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$
$$I - D = \begin{bmatrix} 1 & -1/3 & -1/2 \\ -1/3 & 1 & -1/3 \\ -2/3 & -1/6 & 1 \end{bmatrix} \quad (I - D)^{-1} = \begin{bmatrix} 2.372 & 1.047 & 1.535 \\ 1.395 & 1.674 & 1.256 \\ 1.814 & 0.977 & 2.233 \end{bmatrix}$$

$$T = D (I - D)^{-1} = \begin{bmatrix} 1.372 & 1.047 & 1.535 \\ 1.395 & 0.674 & 1.256 \\ 1.814 & 0.977 & 1.233 \end{bmatrix}$$

Calculate D+R and D-R

- $T = [t_{ij}]$
- $D_i = \sigma_{j=1}^n t_{ij}$
- $R_i = \sigma_{i=1}^n t_{ij}$

	F1	F2	F3	D=
F1	1.372	1.047	1.535	3.953
F2	1.395	0.674	1.256	3.326
F3	1.814	0.977	1.233	4.023
R =	4.581	2.698	4.023	

Calculate D+R and D-R

	F1	F2	F3	D=
F1	1.372	1.047	1.535	3.953
F2	1.395	0.674	1.256	3.326
F3	1.814	0.977	1.233	4.023
R =	4.581	2.698	4.023	

	D + R	D-R	Rank	Cause/Effect
F1	8.535	-0.628	I	Effect
F2	6.023	0.628	III	Cause
F3	8.047	0.000	II	Cause/effect