Root Cause Analysis

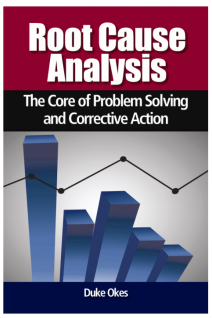
Course by: Duke Okes

Instructor: Douglas C. Wood

ASQ
The Global Voice of Quality™

1

Contents

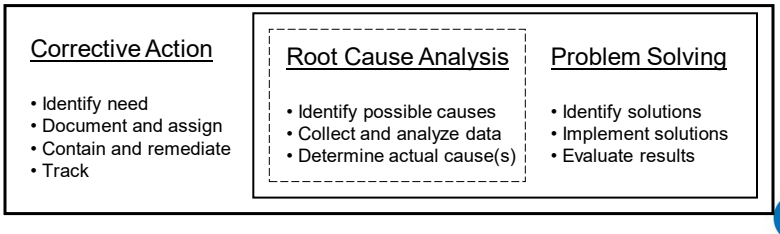


ASQ

2

What is RCA?

- A critical part of the problem solving process
- An analytical process
  - breaking the system down into its components
  - understanding the effect of each component on others and/or the system



3

Some Problem Solving Terminology

Proactive actions

- Preventive action is taken prior to a problem so as to reduce the likelihood of occurrence

Reactive actions

- Correction
  - *Containment puts a barrier around defective items so they won't get used*
  - *Remedial action corrects the problem symptoms by reworking/repairing/replacing defective items*
- Corrective action addresses the causes to prevent recurrence
  - *Physical level cause that created the problem*
  - *System level cause that created the physical cause*

4

The DO IT^2 Problem Solving Model

FIND IT* **Diagnostic Phase**

1. Define the Problem
2. Understand the Process
3. Identify Possible Causes
4. Collect Data
5. Analyze the Data

FIX IT* **Solution Phase**

6. Identify Possible Solutions
7. Select Solution(s) to be Implemented
8. Implement the Solution(s)
9. Evaluate the Effect(s)
10. Institutionalize the Change

** IT means root cause of the problem!*

ASQ

5

The Complexity of Multiple Causes

Relationship of Causes:	Levels	Independent	Combination
Diagram of:	Problem → Physical Cause → System Cause	Problem → Cause 1, Cause 2	Problem → Cause 1, Cause 2
Decision to Make:	Correct only physical or also system cause?	Work only on largest contributor or on all simultaneously?	Work on all or only those most likely to occur?

ASQ

6

Step 1 - Define the Problem

7

The Problem Statement

- Should tell what is happening, as well as
  - where the problem was found (geography, process, physical)
  - when it was found (and how long it has gone on)
  - how much it has occurred (absolute *and % if useful*)
  - *who* (but only if relevant, such as who was impacted)
- Use variable instead of attribute data if possible
- Should use clear operational definitions
- Should not point toward causes
- Can include impact if desired

The problem statement becomes a baseline against which success can be measured

8

Poor Problem Statements

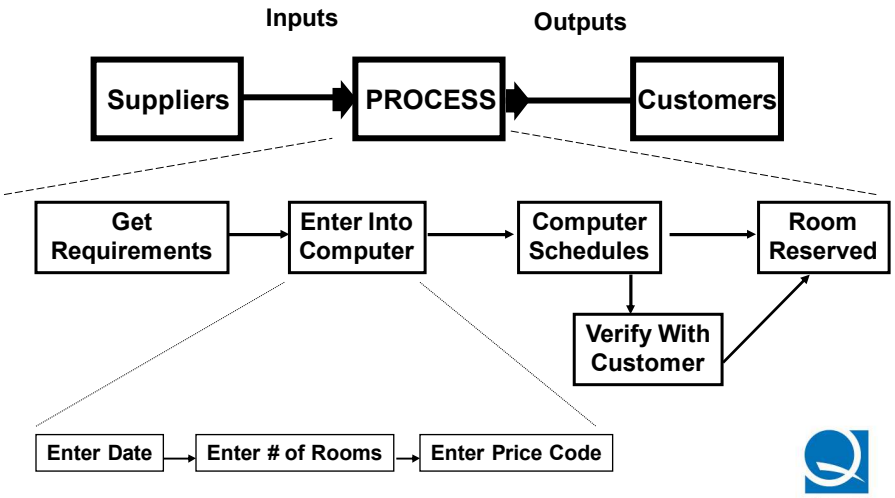
- Computer downtime is too high
- # of errors have increased from 70 to 400
- Amount of time to respond to inquiries has increased in the past 3 months
- 3% of customers with reservations do not have a room available when they arrive at XYZ hotel

9

Step 2 - Understand the Process

10

Breaking the Process Down



11

The Importance of Flowcharts

- All problems are a result of a process … part of a system
  - *Lack of a defined process*
  - *"Defective" process*
  - *Process not followed*
- The process is part of a larger system, interacting with other processes
- Keep the focus on activities, not people!

Note: All errors in human systems are actually human errors (e.g., someone designed the system). But this level of analysis is usually only warranted after a high number of similar problems/causes.

12

Step 3 - Identify Possible Causes

13

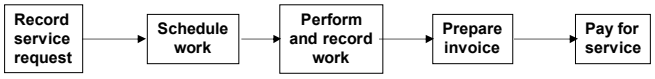
Methods for Identifying Causes

- **Steps in the flowchart**
- **Branches of the logic tree (5-whys)**
- **Lists (e.g., brainstorming, C&E diagram)**
- Barrier (controls) analysis
- Change analysis

14

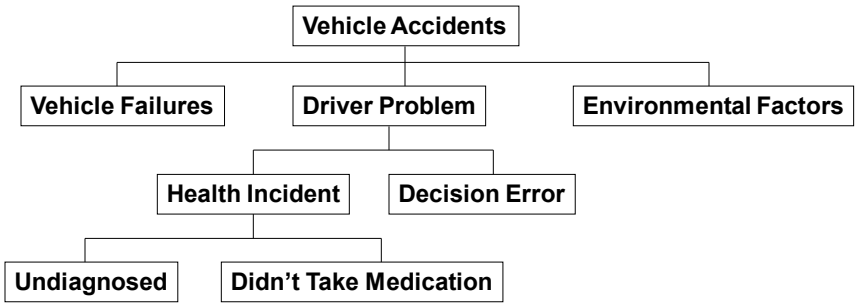
Which Steps Could Be Causes?

Problem statement: *Errors in auto repair invoices have increased from nearly zero to 3% in the past 2 months*



15

A Beginning Logic Tree



16

Why This Process is Critical

- Cause & effect relationships are multiple and incremental
- This logical thinking process supports all five steps
- The system can be analyzed methodically using both logic and data

17

5-Whys

2 flat tires in past week

↑

Roofing nails in tires

↑

Ran over nails in yard

↑

Roofers didn't adequately clean up

↑

Magnet doesn't deal well with tall, thick grass

18

Options for the Logic Tree

- Functions – What system is supposed to accomplish
- Failure modes – How it could fail to work
- Features/attributes – Product/process parameters
- System modules – "Bill of materials"
- Process – Sequence of operation of the system
- 7M's – Sources of system variation

19

Random Cause Generation - *Brainstorming*

- Unstructured
- Structured
- Round robin
- Crawford slip (brainwriting)

20

Sources of Possible Cause Information

- Personnel involved with the process
  - *Those who designed the process*
  - *Those who operate the process*
  - *Those who maintain the process*
- Suppliers and customers (internal and external)
- Technical staff (engineers, scientific personnel)
- Expert systems or other diagnostic guides (e.g., FMEA, HAZOP, HACCP, equipment manuals)

21

Steps 4 & 5 – Collect Data, then Analyze

22

Fundamentals for Data Collection

1. What theories (cause & effect relationships) are to be tested and what variables are involved?
2. Where could the data be collected and what form would it take?
3. What would the data look like if the cause was or was not at play?
4. When and how to collect the data?

This process is often called a "thought experiment"

23

Data Collection vs. Problem Frequency

Tools for any event (especially low frequency)

- Interviews
- Observation
- Process records
- Failure analysis
- Component swap

Additional tools for repetitive situations

- Check sheet
- Concentration diagram
- Multifactor data collection form

24

Types of Data

- Variable – Measured, natural scale
- Attribute – Counted, integers
- Text – Words
- Five (human) senses

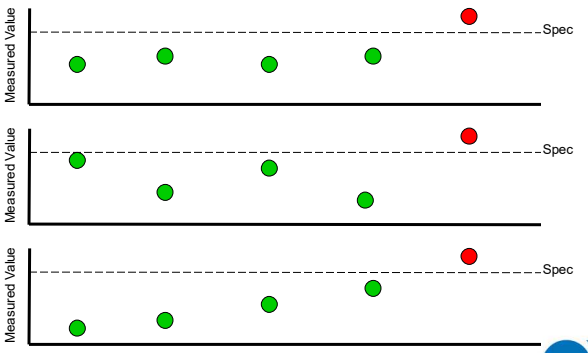
Each type has specific tools for gathering & analyzing

25

Dangers of Attribute Data

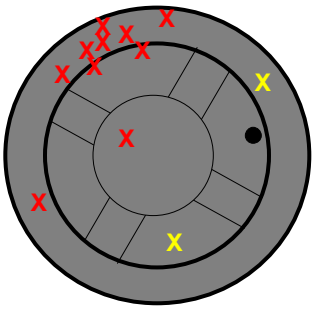
Batch #:	1	2	3	4	5
Attribute:	OK	OK	OK	OK	NG

Possibilities:



26

Collecting Spatial Data - *Pictogram*



Can be applied to products, facilities, forms, etc.

27

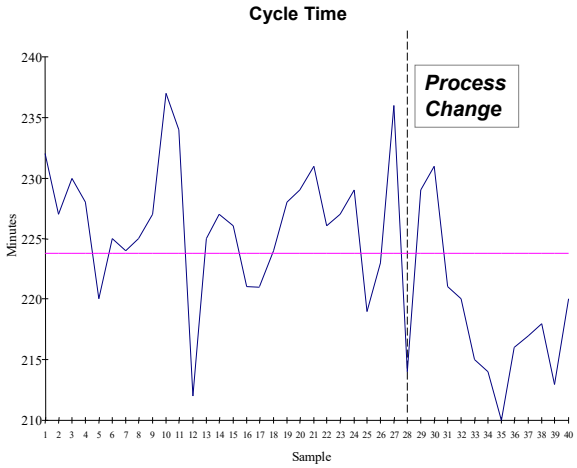
Data Analysis vs. Problem Frequency

Tools for single/low frequency events
- Compliance/logic analysis
- Flowchart
- Scientific analysis
- G-chart

Additional tools for repetitive situations
- Pareto diagram
- Concentration diagram/cluster analysis
- Contingency table
- Run chart
- Histogram
- Dot plot
- Multivari
- Pivot tables
- Is/Is-not table

28

Patterns Over Time - *Run Chart*

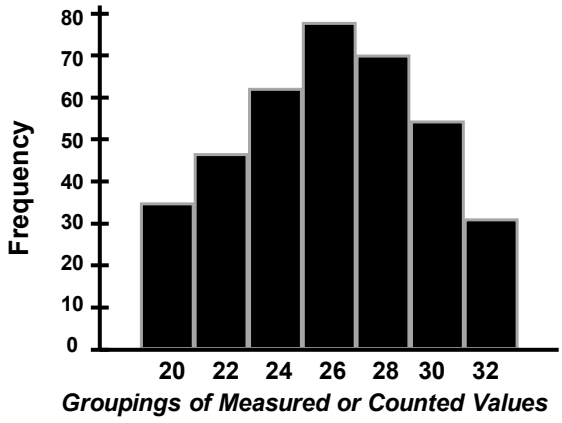


Looking for:
- **Spikes**
- **Trends**
- **Shifts**
- **Runs**

***Important Note*:**
Also look at a histogram of the data

29

Patterns in Variable Data - *Histogram*



Looking for:
- **Normality**
- **Skewness**
- **Outliers**
- **Multimodality**

***Important Note*:**
Also analyze using a run chart, if data is time oriented

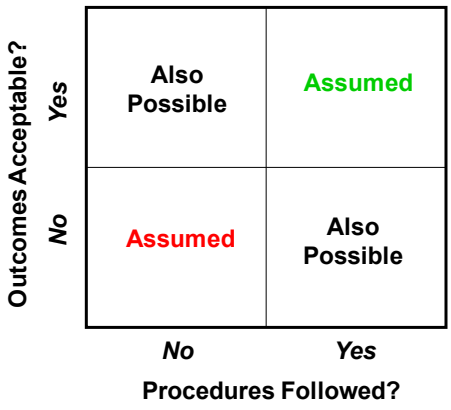
30

Patterns of Characteristics – *Is-Is Not Table*

It Is	It is Not	Implications
Between 3&3:30 PM	Mornings, nights	Time specific
Line 3	Lines 1, 2 & 4	Location specific
Sensor #4	Other sensors	Location specific
Sunny day	Cloudy day	Brightness/light

31

Watch Out for Assumptions



32

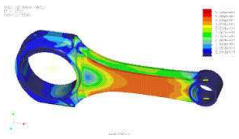
Step 6 - Identify Possible Solution(s)

- **Engineering analysis**
- **Creative Thinking**
- **Mistake-proofing**
- Benchmarking
- Biomimicry
- TRIZ

33

Engineering Analysis

- Analyzing properties regarding relevant scientific principles and laws of physics
- Looking at component-system relationships
- Mathematical/statistical modeling
- Computer or physical simulations
- Material sciences
- Task analysis
- e.g., finite element analysis, stack-up analysis



34

Creative Thinking

- Looking at things from another angle
- Going outside conventional boundaries
- Often uses techniques such as:
  - *Scale up or scale down*
  - *Forced relationships or associations*
  - *Reverse or morph*
  - *WWXD*
  - *No limits*
- Creativity as a process: *Saturate, Incubate, Illuminate, Validate*
- Consider the best time/location/situation for creativity

ASQ

35

Mistake Proofing

- Also called Poka-yoke
- Designed to prevent defects, especially in low occurrence situations
- Accomplished through control (e.g., jigs or software) or detection (e.g., light curtains or timing) and alarms
- Designed to be a low-cost solution to problems
- Difficult to apply in human-oriented situations, so barriers (checklists, second checks, etc.) are often used

ASQ

36

Partial List of TRIZ Techniques

- Ideal final result (IFR)
- Resources
- Smart little people (SLP)
- Nine boxes/windows
- Evolutionary trends
- Functional analysis
- Contradictions

37

Ensuring Linkage of Causes and Solutions

	Description	Evidence		
Symptoms	Contamination levels above spec	Weekly biological sample results	**Solution**	**Rationale**
Physical Cause	Cleaning personnel improperly trained	Unable to properly describe procedure	Retrain them, implement new cleaning procedure	???
System Cause	???			

38

Likely Solution Effectiveness

Low:
- Retraining
- Warnings (verbal or written, labels)
- Another check

Medium:
- Job aids
- Reduce similar items/language
- Reduce distractions

High:
- Physical changes to environment/process
- Standardize
- Simplify

Adapted from VA NCPS

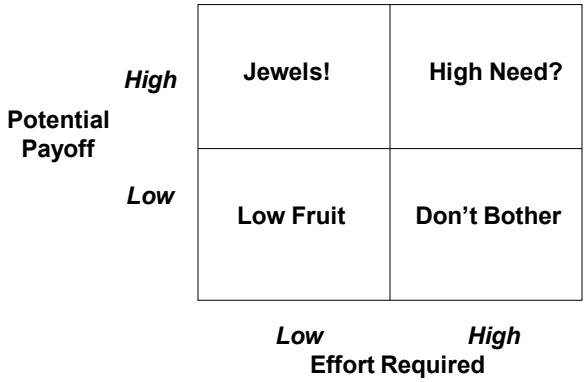
39

Step 7 - Select Solution(s) to Implement

- Which solutions are fastest or easiest?
- What is the benefit/cost ratio, and/or payback period?
- Can possible solutions be tested?
- What is the probability of success?
- What other problems might be created?
- How would people be impacted?

40

A 2x2 Analysis



41

Step 8 - Implement the Solution(s)

- When will it be done?
- Who needs to be involved in planning and executing the change?
- What needs to be done before implementing the change?
  - *Acquiring or preparing material/equipment*
  - *Communication and/or training for others*
- How will success be validated and verified?

42

Implementation Means

- Technology management
- Project management
- Organizational change management
  - Organization = multiple individuals
  - Understand human behavior
  - Using system concepts to facilitate change
  - Deal with resistance

43

Why People Resist Change

- Like current condition
- Indicates now is inadequate
- Poor history of change
- Don't like change
- Poorly communicated
- Wrong people, method, timing
- Future status unknown
- Fear of failure
- Additional work load

44

The Other "Change Management"

- Configuration control (e.g., applicable to engineering changes and process changes)
- Review of proposed changes to evaluate risk, potential affects on other processes
- Documentation of changes, planning and documenting of effectivity dates, addressing obsolete materials issues, etc.

45

Step 9 - Evaluate the Effects

- Did it work (e.g., is definition of problem no longer valid)?
- How to verify that it is not a temporary change caused by something else (e.g., can you turn it on & off)?
- Long-term follow-up is often needed due to lags and/or other sources of variation
- Work back up the model one step at a time if it was not effective
- *But remember the same problem could occur due to another cause!*

46

46

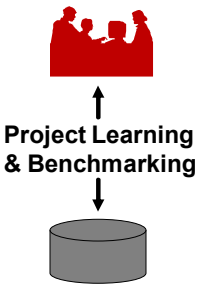
Step 10 - Institutionalize the Change

Standardize

- Revise procedures, instructions, FMEAs, control plans, acceptance samples, training plans

Spread (leverage)

- After action review
- Adapt solution to similar processes
- Add to lessons learned sources



Sustain

- Motivation
- Monitoring
- Internalization

ASQ

47

47

Some RCA References

BOOKS

Ammerman (1998) *The Root Cause Analysis Handbook*, Productivity Press.

Andersen & Fagerhaug (2006) *Root Cause Analysis, 2nd ed.*, ASQ Quality Press.

Brassard & Ritter (1994) *The Memory Jogger II,* GOAL/QPC.

Gano (2007) *Apollo Root Cause Analysis (3rd ed.)*, Apollonian Publications.

Kepner & Tregoe (1981) *The New Rational Manager,* John Martin Publishing.

Latino & Latino (2002) *Root Cause Analysis*, CRC Press.

MacDuffie (April 1997). The Road to Root Cause: Shop-Floor Problem Solving at Three Auto Assembly Plants. *Management Science,* pp. 479-502.

Okes (2009). *Root Cause Analysis: The Core of Problem Solving and Corrective Action*, Quality Press.

Preuss (2003). *School Leader's Guide to Root Cause Analysis*, Eye on Education.

Joint Commission Resources (2005). *Root Cause Analysis in Healthcare, 3rd ed.*

Reason (1990). *Human Error*, Cambridge University Press.

Rooney & Heuvel (July 2004) Root Cause Analysis for Beginners. *Quality Progress,* pp. 45-53.

U.S. Department of Energy (2003). *Occurrence reporting causal analysis guide (DOE G 231.1-2).*

ON-LINE COURSE

Root Cause Analysis: Solving Problems by Eliminating Causes (ASQ Learning Institute).

ASQ

48

Developer/Instructor Contact Info

Developer: Duke Okes
423-323-7576
dukeokes@gmail.com
www.aplomet.com
Instructor: Douglas C Wood
913-669-4173
Doug@DCWoodConsulting.com
WWW.DCWoodConsulting.com

49