# Root Cause Analysis

**Root Cause Analysis** (**RCA**) is a class of problem solving methods aimed at identifying the root causes of problems or events. The practice of RCA is predicated on the belief that problems are best solved by attempting to correct or eliminate root causes, as opposed to merely addressing the immediately obvious symptoms. By directing corrective measures at root causes, it is hoped that the likelihood of problem recurrence will be minimized. RCA is often considered to be an iterative process, and is frequently viewed as a tool of continuous improvement.

RCA, initially is a reactive method of problem detection and solving. This means that the analysis is done **after** an event has occurred. By gaining expertise in RCA it becomes a pro-active method. This means that RCA is able to **forecast** the possibility of an event even **before** it could occur.

- Root cause analysis is not a single, sharply defined methodology; there are many different tools, processes, and philosophies of RCA in existence.
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## General principles of root cause analysis

1. Aiming performance improvement measures at root causes is more effective than merely treating the symptoms of a problem.
2. To be effective, RCA must be performed systematically, with conclusions and causes backed up by documented evidence.
3. There is usually more than one potential root cause for any given problem.
4. To be effective the analysis must establish all known causal relationships between the root cause(s) and the defined problem.
5. Root cause analysis transforms an old culture that reacts to problems to a new culture that solves problems before they escalate, creating a variability reduction and risk avoidance mindset.

## General process for performing and documenting an RCA-based Corrective Action

Root Cause Analysis (in steps 3, 4 and 5) forms the most critical part of successful corrective action, because it directs the corrective action at the root of the problem. That is to say, it is effective solutions we seek, not root causes. Root causes are secondary to the goal of prevention, and are only revealed after we decide which solutions to implement.

1. Define the problem
2. Gather data/evidence.
3. Ask why and identify the causal relationships associated with the defined problem.
4. Identify which causes if removed or changed will prevent recurrence.
5. Identify effective solutions that prevent recurrence, are within your control, meet your goals and objectives and do not cause other problems.
6. Implement the recommendations.
7. Observe the recommended solutions to ensure effectiveness.
8. Variability Reduction methodology for problem solving and problem avoidance.

# Root cause analysis techniques

- 5 Whys

  The **5 Whys** is a question-asking method used to explore the cause/effect relationships underlying a particular problem. Ultimately, the goal of applying the 5 Whys method is to determine a root cause of a defect or problem.

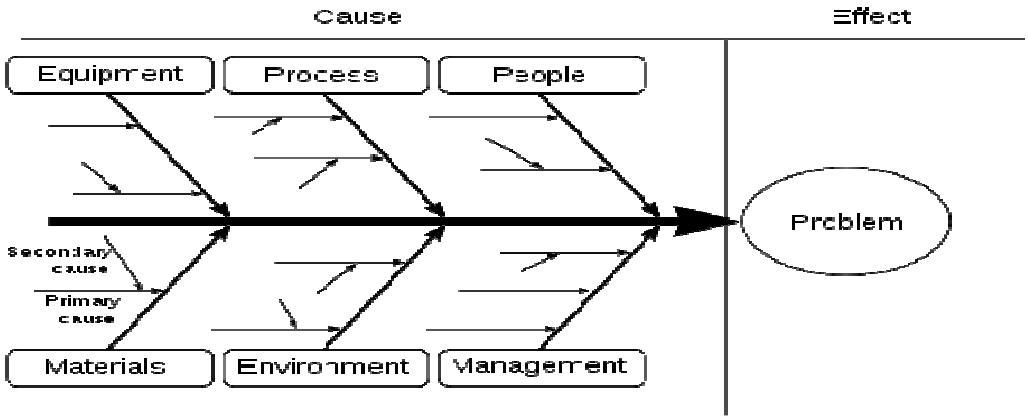
  The following example demonstrates the basic process:

  - My car will not start. (the problem)

  1. *Why?* - The battery is dead. (first why)
  2. *Why?* - The alternator is not functioning. (second why)
  3. *Why?* - The alternator belt has broken. (third why)
  4. *Why?* - The alternator belt was well beyond its useful service life and has never been replaced. (fourth why)
  5. *Why?* - I have not been maintaining my car according to the recommended service schedule. (fifth why, root cause)

- Ishikawa diagram, also known as the fishbone diagram or cause and effect diagram

  **Ishikawa diagrams** (also called **fishbone diagrams** or **cause-and-effect diagrams**) are diagrams that show the causes of a certain event. Common uses of the Ishikawa diagram are product design and quality defect prevention, to identify potential factors causing an overall effect




- Pareto analysis

  **Pareto analysis** is a statistical technique in decision making that is used for selection of a limited number of tasks that produce significant overall effect. It uses the Pareto principle – the idea that by doing 20% of work you can generate 80% of the advantage of doing the entire job. Or in terms of quality improvement, a large majority of problems (80%) are produced by a few key causes (20%).

  The **Pareto principle** (also known as the **80-20 rule**, the **law of the vital few,** and the **principle of factor sparsity**) states that, for many events, roughly 80% of the effects come from 20% of the causes

Pareto analysis is a formal technique useful where many possible courses of action are competing for your attention. In essence, the problem-solver estimates the benefit delivered by each action, then selects a number of the most effective actions that deliver a total benefit reasonably close to the maximal possible one.

Pareto analysis is a creative way of looking at causes of problems because it helps stimulate thinking and organize thoughts. However, it can be limited by its exclusion of possibly important problems which may be small initially, but which grow with time

# Basic elements of root cause

- Materials
  - Defective raw material
  - Wrong type for job
  - Lack of raw material
- Machine / Equipment
  - Incorrect tool selection
  - Poor maintenance or design
  - Poor equipment or tool placement
  - Defective equipment or tool
- Environment
  - Orderly workplace
  - Job design or layout of work
  - Surfaces poorly maintained
  - Physical demands of the task
  - Forces of nature
- Management
  - No or poor management involvement
  - Inattention to task
  - Task hazards not guarded properly
  - Other (horseplay, inattention....)
  - Stress demands
  - Lack of Process
- Methods
  - No or poor procedures
  - Practices are not the same as written procedures
  - Poor communication
- Management system
  - Training or education lacking
  - Poor employee involvement
  - Poor recognition of hazard
  - Previously identified hazards were not eliminated
  - 4ME (Man, Machine, Materials, Method and Environment).

# Root cause

A **root cause** is an initiating cause of a causal chain which leads to an outcome or effect of interest. Commonly, **root cause** is used to describe the depth in the causal chain where an intervention could reasonably be implemented to change performance and prevent an undesirable outcome.

The term **root cause** has been used in professional journals as early as 1905, but the lack of a widely accepted definition after all this time indicates that there are significantly different interpretations of exactly what constitutes a root cause.

The two biggest differences in viewpoint regard the possibility of an outcome having more than one root cause.

## Single cause

The single cause philosophy is based on the belief that there is a single cause for any outcome that, if prevented, would prevent the outcome itself. In this context, the root cause is the cause which dominates over all other contributing factors.

This viewpoint results in the identification of a single root cause that provides a clear direction for preventing an undesired outcome. The subjective criteria used for selection of the root cause from among the contributing factors has been criticized as being arbitrary and inconsistent.

One basis for the argument supporting this as the 'proper' interpretation is the decomposition of the words in the phrase – the root cause is the **cause** at the **root** of the outcome. While there may be nuances in the meanings of the words, the common usage of the words lead to a straightforward and simple interpretation.

It should be noted however that the notion of a single root cause is the exception, not the rule.

## Multiple causes

The multiple cause philosophy stems from the belief that a root cause can exist for each of the contributing factors that were necessary for a resulting outcome. By preventing any of those necessary causes, the undesired outcome can be prevented.

The result of this philosophy is a branching model that attempts to incorporate all the identified ways that the outcome could be prevented. The inclusive model provides a variety of corrective actions that can potentially break the causal chain.

One basis for the argument supporting this as the 'proper' interpretation is the common illustration of the model with the undesired outcome at the top and the causes spreading below like roots spreading from the trunk of a tree.

## Application

Effects have causes. The causes may be natural or man-made, active or passive, initiating or permitting, obvious or hidden. Those causes that lead immediately to the effect are often called direct or proximate causes. The direct causes often result from another set of causes, which could be called intermediate causes, and these may be the result of still other causes. When a chain of cause and effect is followed from a known end-state, back to an origin or starting point, root causes are found. The process used to find root causes is called root cause analysis.

The usual purpose of attempting to find root causes is to solve a problem that has actually occurred, or to prevent a less serious problem from escalating to an unacceptable level, for example). The basic concept is that solving a problem by addressing root causes is ultimately more effective than merely addressing symptoms or direct causes. Consider the following example, where root cause *a* leads to effect *e*, with a few intervening steps.

$$a \rightarrow b \rightarrow c \rightarrow d \rightarrow e$$

Assume each of these factors is as described below:

- *e*: car will not start
- *d*: battery is dead
- *c*: alternator does not function
- *b*: alternator is well beyond its designed service life
- *a*: car is not being maintained

The effect, *e*, could be prevented by addressing any of the other factors. For example, attaching jumper cables from another car (addressing factor *d*) will probably allow the problem-car to be started. However, this solution is not likely to provide long-lasting relief from the undesired effect, as factor *c* will ensure that the car shuts down again in a very short period of time. Addressing factor *c* by repairing the alternator may solve the problem for a longer period, but factor *b* will eventually result in another age-related breakdown in the alternator. The alternator could be replaced with a new unit, addressing factor *b*, thus allowing the car to be driven for an extended period of time. However, factor *a* will eventually ensure that the car breaks down again for some other reason. Clearly, a better solution to the problem (and many other potential problems) is to maintain the car properly, which addresses factor *a*, the root cause.

Note that the preceding example highlights one difficulty with root cause analysis: knowing when to stop. That example could have been carried further to ask why the car wasn't being maintained, and then why the vehicle was designed such that this maintenance was even required. It is often the analysis' frame of reference that determines where the stopping point ought to be. For instance, if the example is viewed from an individual vehicle owner's frame of reference, then factor *a* may represent a valid stopping point. However, if the frame of reference is moved to the vehicle manufacturer, dealing perhaps with hundreds of thousands of such problems, the proper stopping point may indeed lie in the realm of design.

So, the root cause is a function of who owns the problem and what corrective action they choose to prevent recurrence. This perspective holds that any root cause is relative and can not be determined until the owner attaches a solution to it. The solution must prevent recurrence, meet the owner’s goals and objectives, and be within the owner's control to implement.
An issue closely related to solving an existing problem is to foster learning that will embed knowledge (within a person, group, or organization) that may help prevent similar problems from occurring in the future. Such knowledge is often referred to as *lessons-learned*.

Practitioners of root cause analysis often define what the phrase "root cause" means for a particular setting and application. The benefits of finding deeper layers of root cause tend to diminish after a certain point. The practical application of root cause analysis therefore often searches only as long as the benefit of answers outweighs the effort of the search.

# Continuous Improvement Process

**Continuous Improvement Process** (CIP, or CI) is a management process whereby delivery (customer valued) processes are constantly evaluated and improved in the light of their efficiency, effectiveness and flexibility.

Some successful implementations use the approach known as **Kaizen** (the translation of **kai** ("change") **zen** ("good") is "improvement"). This method became famous by the book of Masaaki Imai "Kaizen: The Key to Japan's Competitive Success."

- The core principle of CIP is the (self) reflection of processes. (Feedback)
- The purpose of CIP is the identification, reduction, and elimination of suboptimal processes. (Efficiency)
- The emphasis of CIP is on incremental, continuous steps, avoiding quantum leaps. (Evolution)

The elements above are more tactical elements of CIP, the more strategic elements include deciding how to increase the value of the delivery process output to the customer (Effectiveness) and how much flexibility is valuable in the process to meet changing needs.

## 5 Whys

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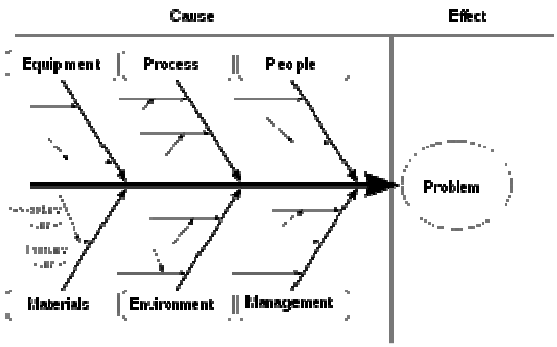
## **Ishikawa diagram** (also called **fishbone diagrams** or **cause-and-effect diagrams**)




Ishikawa diagram, in fishbone shape, showing factors of Equipment, Process, People, Materials, Environment and Management, all affecting the overall problem. Smaller arrows connect the sub-causes to major causes.

Ishikawa diagrams are diagrams that show the causes of a certain event. Common uses of the Ishikawa diagram are product design and quality defect prevention, to identify potential factors causing an overall effect.