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BCA PRACTICE NOTES

ROOT CAUSE ANALYSIS IN BUSINESS CASE DEVELOPMENT

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BCA Practice Notes are a collection of papers designed to explore specific themes or topics of business case development in depth. They are written with Business Case Approach (BCA) practitioners in mind, but may be of relevance and interest to anyone involved in business cases – whether through development, assessment or decision making. They are not intended as strict guidance in the traditional sense and do not represent formal NZ Transport Agency policy

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Every business case follows the same basic line of enquiry, starting with a definition of the problem that is to be solved. In order to be useful for business case development, problem definitions need to include both a **cause** and an **effect** (or **consequence**).

» The **cause** tells us what is driving the problem, and forms a focus for our responses.

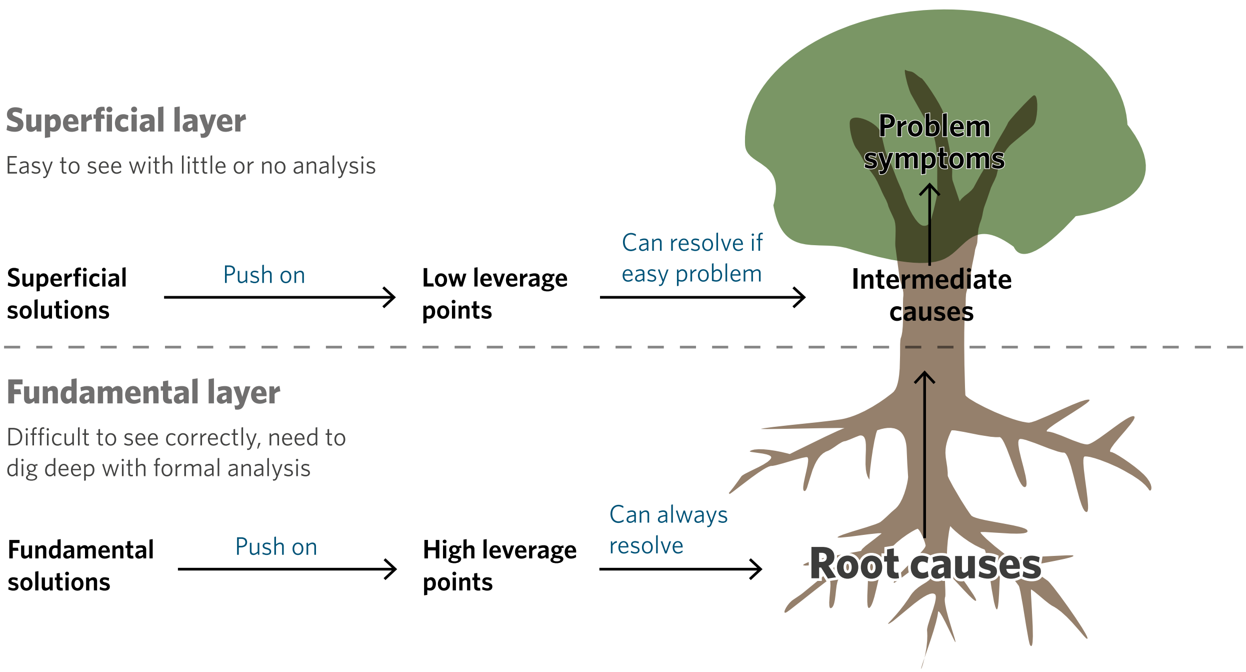
» The **consequence** tells us why we should care about the problem, for example by articulating what will happen if the problem remains unaddressed.

Analysis of problem statements used to support business cases shows that in many cases the cause of the problem is stated at a relatively superficial level. This means the underlying or **root causes** are often not clear, even by the time a solution has been proposed. As a result, there is little confidence that the investment will effectively address the problem, with a high risk that the problem will simply keep recurring.

To avoid this situation and make sure investments are effective, it is important in the early stages of business case development to identify the root causes that underlie the problems to be addressed. This requires more effort in the problem definition stage, and the root cause may not be fully identified and agreed on by the end of a strategic case.

Sometimes it will not be possible to fully identify root causes by the end of a strategic case. It is important to openly acknowledge this, and include adequate time and resources for the necessary analysis to be done when scoping the next steps.

What is root cause analysis?



The nature of root causes

A root cause is a fundamental reason for the occurrence of a problem – either now or in the future. Essentially, a root cause represents a fundamental process, system or policy that is failing or that doesn't exist, which needs to be addressed if the problem is to be avoided or prevented from recurring.

As shown in the diagram on the previous page, root causes are often hidden from view and can be far from obvious. For anything other than the very simplest problems, a structured approach is needed to fully understand the root causes; otherwise, there is a high likelihood that you will end up simply dealing with the **symptoms** of the problem, or some intermediate cause.

This is like turning up at your doctor's surgery complaining of severe chest pains, and being prescribed strong painkillers after only minimal examination. Yes, your pain may go away (for now), but the cause may well be something quite serious; most people would expect their doctor to carry out a detailed examination, followed by treatment of whatever is causing the pain.

Root cause analysis refers to the practice of formally exploring the causes of a problem in order to identify its root causes. The aim is to identify the cause of a problem which, if adequately addressed, will prevent a recurrence of the problem (or, in the case of an anticipated future problem, will prevent it from occurring in the first place). You can take this a step further by saying that the aim is to identify a cause which, if adequately addressed, will prevent the problem **or similar problems** from recurring; in other words, the cause is something so fundamental, so basic, that it has wide-reaching consequences.

Identifying root causes can often appear daunting, requiring patience and a willingness to go through multiple iterations. Typically, it requires input from a range of people who are familiar with the subject matter and evidence surrounding the problem. However, the importance of root cause analysis and responding to root causes in developing successful investments cannot be overstated.

The importance of root cause analysis

Often, interventions are aimed at symptoms or intermediate causes. For a simple problem this may be enough to prevent a recurrence, but many problems for which investments are developed are driven by multiple underlying causes that need more effort to understand. Typically, such problems will not be effectively dealt with by simply addressing the intermediate causes or the symptoms.

Investigations into the root causes of the Challenger and Columbia space shuttle incidents provide valuable insights into why understanding **and addressing** root causes is so important (see 'The extreme difficulty of fixing root causes' on the following page). Even today, it is commonly thought that the Challenger disaster was caused by failure of an O-ring leading to a fatal explosion. However, investigation by the Rogers Commission highlighted glaring systemic failures in the management of the space shuttle programme, and showed how decision making had become separated from a clear understanding of the risks associated with the engineering involved. The O-ring failure was simply one symptom of these fundamental failures; it was a trigger for the disaster, but not a root cause.

In fact, as the Rogers Commission revealed, the engineering flaws that led to the disaster had been known about for years before the disaster occurred. Yet, despite this knowledge, the decision was made to launch under circumstances that engineers had already predicted would lead to failure.

Although NASA clearly made substantial efforts to address the decision-making and management flaws, the fact that similar issues were identified 17 years later when the Space Shuttle Columbia disintegrated on re-entry shows the scale of the challenges involved in addressing root causes; it also highlights that failing to address the root causes effectively means that new problems are highly likely to occur.

A key lesson from this example is that a flawed process or system can give rise to multiple, recurring problems. No amount of engineering-level problem solving would have produced the type of safety outcome that NASA management believed it already had, given its programme included fundamental flaws in decision making. With the benefit of hindsight, it seems obvious that another critical failure would occur before long, which is in fact what happened.

So, attempting to find the right kind of response before identifying the root causes of a problem carries a high probability of failure. Although the immediate consequences may be addressed (for example, fixing the problem with the O-rings or prescribing painkillers), it is likely that similar problems will keep being experienced because the faulty process or system that is causing the failures has not been resolved. This applies as much to transport problems as it does to aerospace.

The extreme difficulty of fixing root causes

On 28 January 1986 the NASA Space Shuttle Challenger suddenly exploded 73 seconds into flight, killing the seven astronauts aboard. A Presidential Commission, led by William P Rogers, was created to investigate the causes of the disaster.

The Rogers Commission concluded that the Challenger accident was triggered by a failure on the O-rings, which sealed a joint in one of the two solid rocket boosters. The failure allowed leakage of hot gases and flame, which reached the adjacent external fuel tank causing structural failure.

The O-ring failure was deemed to have been a design flaw, one which, it later emerged, had been known about by both NASA and its contractor, Morton Thiokol, as early as 1977. This included knowledge that the design flaw had the potential to cause a disaster.

However, in addition to confirming the trigger for the explosion, the Rogers Commission also strongly criticised NASA's decision-making process leading up to the launch of Challenger, citing concerns voiced by Morton Thiokol engineers regarding the performance of the O-rings in low-temperature conditions failed to be acted on. So why was a shuttle allowed to launch, with a known engineering problem, under conditions that were believed by engineers to be likely to result in catastrophic failure?

The report produced by the commission listed a number of recommendations designed to improve the safety of the space shuttle programme; the recommendations focused on management, decision-making and safety processes, as these were recognised as underlying systemic failures. Essentially, these were the root causes the inquiry had identified as being instrumental in the disaster.

In 2003, a second disaster occurred when the Space Shuttle Columbia disintegrated shortly before landing, again killing all seven crew members. On this occasion, the trigger for the disaster was very different; during take-off, a piece of foam insulation from the heat shield had broken off and damaged the wing of the orbiter. However, the problem was similar to the O-ring failure in that 'foam shedding' was a common occurrence on space shuttle flights to which management had become accustomed.

Although the problem had been identified in previous flights, the launch still proceeded. On this occasion, however, the foam debris struck the wing, critically damaging the thermal protection; the wing disintegrated on re-entry.

After further investigation by the Columbia Accident Investigation Board, it was concluded that:

> Despite a sincere effort to fix these problems after the Challenger loss, seventeen years later almost identical management and organizational factors were cited in the Columbia Accident Investigation Board report.
>
> These are not two isolated cases. In most of the major accidents in the past 25 years (in all industries, not just aerospace), technical information on how to prevent the accident was known and often even implemented. But in each case, the potential engineering and technical solutions were negated by organizational or managerial flaws.

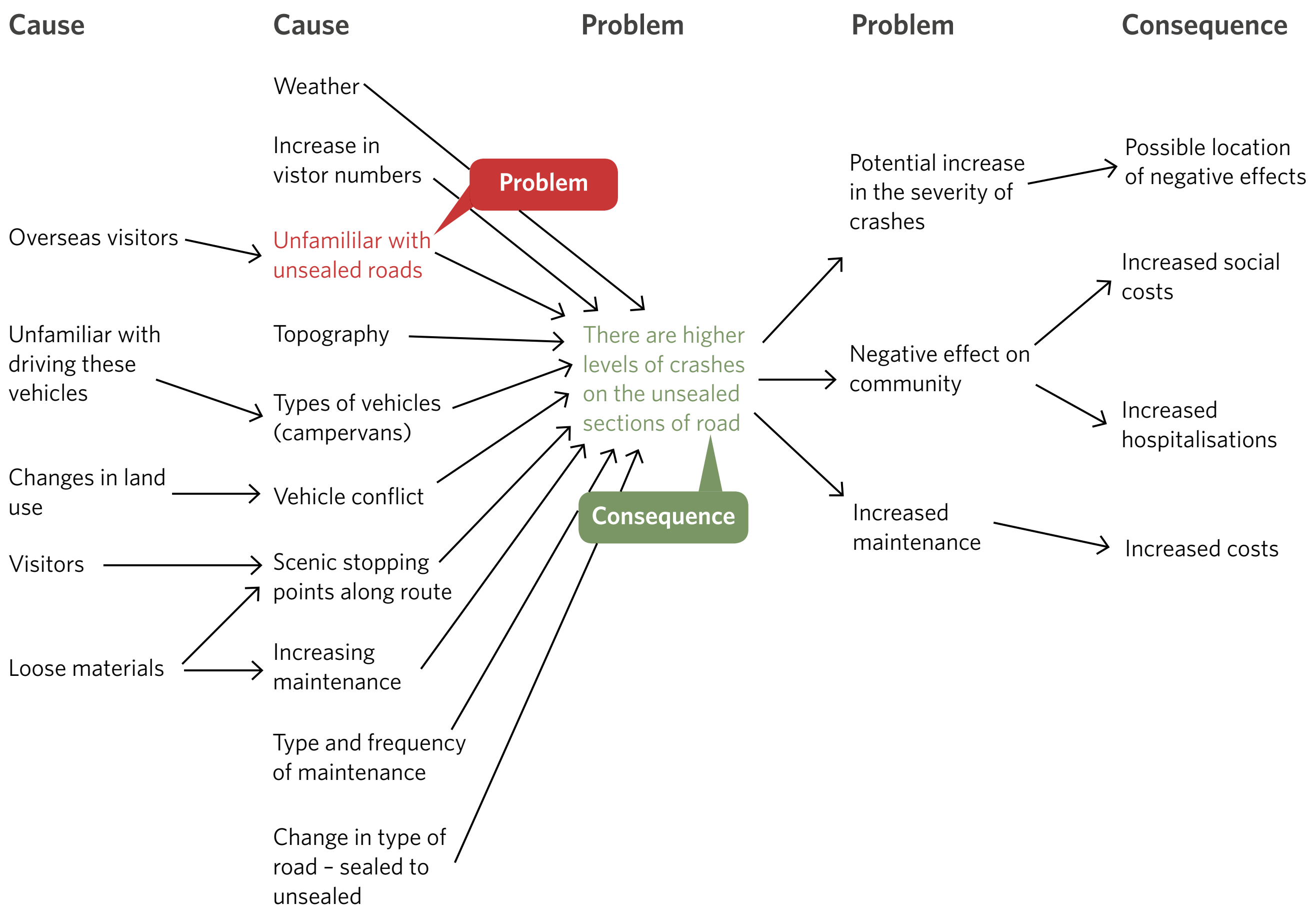
That shows how hard it is to fix root causes for complex problems – and why it is important to understand the need to address them.

What tools or techniques can be used to identify root causes?

The problem trajectory

The aim of exploring problems and benefits through investment logic mapping workshops (ILMs) is to help identify the root causes, as well as the consequences, of a problem. Often, a facilitator will lead workshop attendees through a process known as 'unpacking the problem' to define a **problem trajectory**.

Example problem trajectory



In the example above, the initial view of the problem (green text) was agreed to by the end of the workshop as representing the main consequence of the problem, stated at a level that was compelling and clear. In contrast, the underlying causes had been shown to be many and varied. However, discussion among the participants led to agreement that the main underlying cause, stated at a level over which the participants might have some influence, was that many road users were unfamiliar with driving on unsealed roads.

This is a highly effective approach for many problems, although there is a strong reliance on having the right people in the room – people who know the most about the problem, and have direct evidence of what is going on.

Working out who to invite to workshops can often be challenging, especially when business case developers are relatively new to the ILM practice or to a particular area of work and might not know many of the key players. At such times, it is really important for the business case developer to remember that they are not expected to develop a business case in isolation, and that they can seek advice from colleagues.

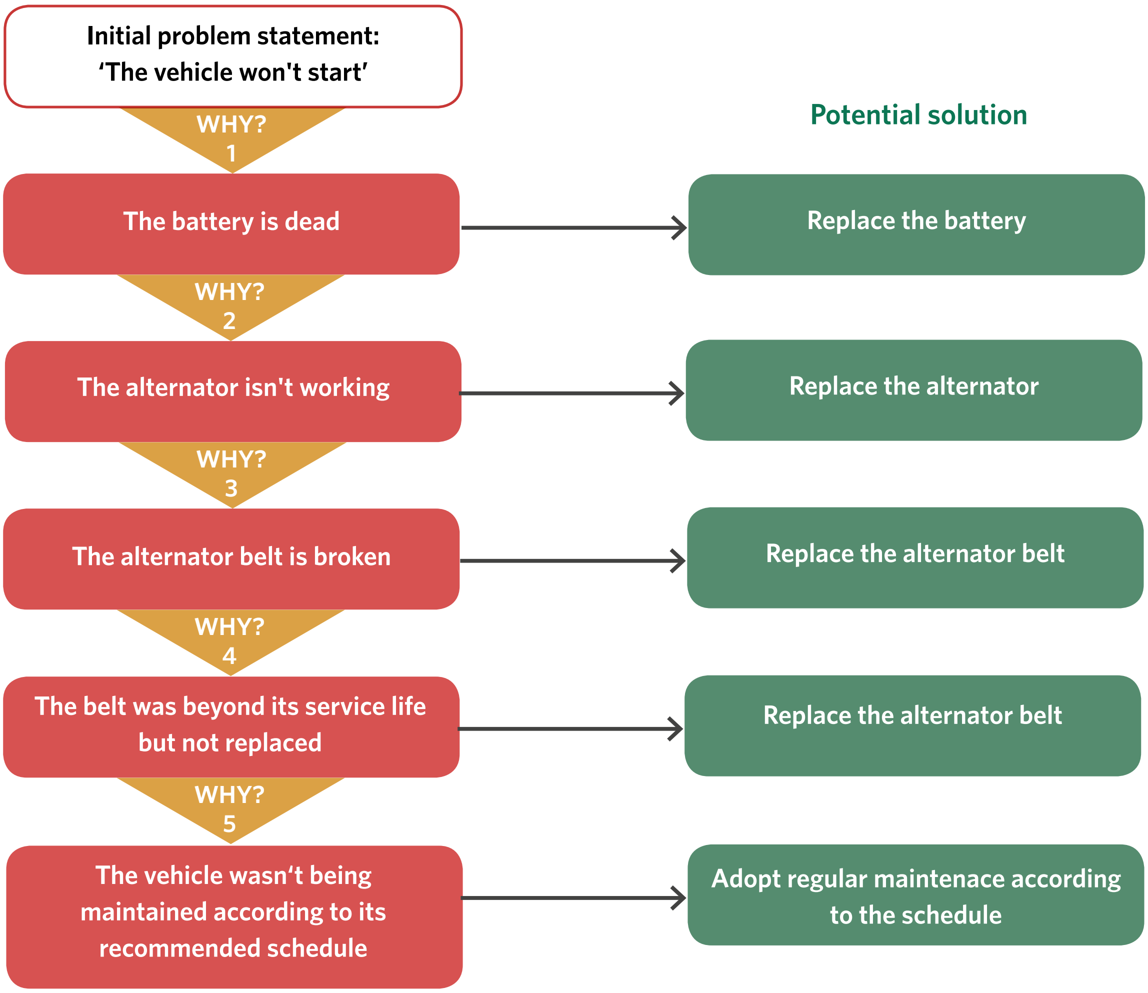
In addition to the problem trajectory, there are a number of other techniques described below that can be used to support or enhance the effectiveness of the ILM; either during the workshop, or before or after it. These are recognised approaches to peeling back the layers of a problem to understand it fully, including getting to a root cause. They all place a strong emphasis on asking 'Why?'

The '5 whys'

This is a deceptively simple, but powerful, technique which basically consists of asking the question 'Why?' multiple times, until something resembling a root cause can be identified. Experience shows that often five iterations are needed before a process level cause is identified, hence the title. It is a guide, not an absolute, and in some cases there may be as few as three or as many as seven iterations required. Take the following example of a simple problem statement: 'The vehicle will not start.'

A series of 'why' questions aimed at understanding this apparently simple problem could look like this:

5 whys example 1

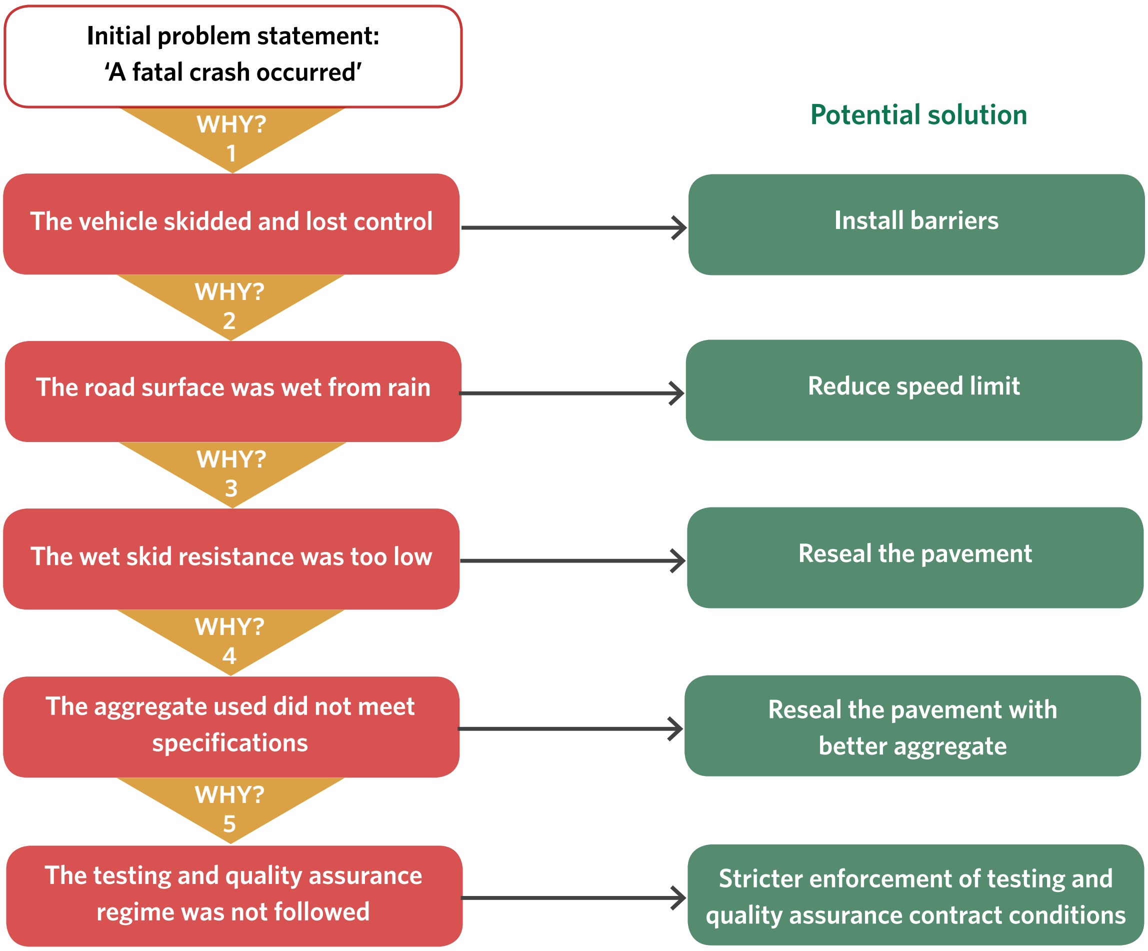


Notice how, if the most obvious solution is followed in the first four responses, only the **superficial** problem (the car not starting) will have been dealt with. Because the car is not being maintained properly, there is a high chance that something else will go wrong very soon, including a potentially dangerous fault. The root cause is the owner's failure to maintain their car correctly.

Notice also that even if the underlying cause is addressed (you start maintaining your car regularly), you will still have to fix the broken alternator belt, and probably recharge your battery, before you can get going again. In other words, you still need to deal with consequences that have already happened.

Now let's take a look at an example from the transport world:

5 whys example 2



This is very similar to the first example, in that the problem will only truly be solved if the final 'why' is addressed; unless contract quality control measures are enforced, new problems will continue to occur. Also, even if the process-level cause is addressed (a more rigorous testing regime and enforcement of contract conditions), there will still be a need to go back and reseal the stretch of road where the problem arose.

In this example, understanding what is causing the issue may also highlight that there are other sections of road likely to have similar problems, which could then be treated or have steps taken to prevent further crashes.

Ishikawa (fishbone) diagram

Another technique used to determine root causes is the **Ishikawa diagram**, sometimes referred to as a fishbone diagram or cause-and-effect diagram. It was initially introduced in the Kawasaki Shipyards as a quality management tool, and was later used more famously by the Mazda Motor Corporation in designing the highly successful Miata (MX5) sports car. It is particularly useful when there are likely to be multiple underlying causes of a problem.

Developing a fishbone diagram is best done as a facilitated group exercise, and usually comprises some variation of the following steps:

» Create a 'head', which states the problem to be analysed.

» Create the spine of the fish – a straight line leading to the head.

» Identify the major types of cause (or 'cause categories') that contribute to the problem. Aim for at least four cause categories; some brainstorming may be needed to identify the best ones. Connect these causes with arrows to the spine – these are the first bones of the fish.

» A good starting point for cause categories could be the '4 Ps' (policies, process, people and place). If these don't cover everything, don't worry; you can always add other cause types later. Alternatively, if a more relevant set of categories can be found, use them!

» Now brainstorm each cause type to document the things that contribute to each cause, adding these to the bones as you go.

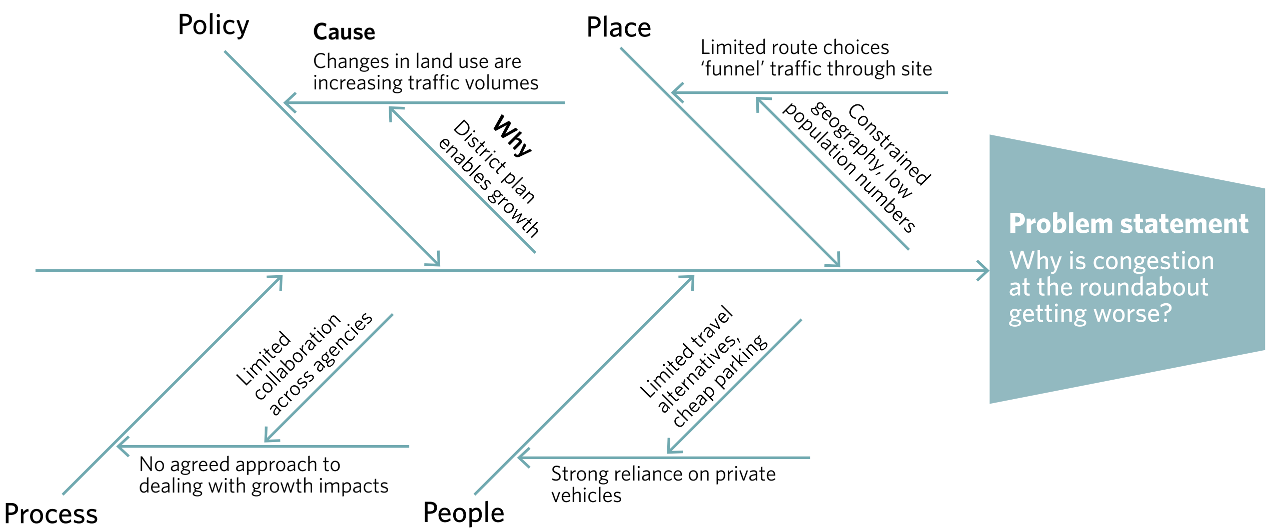
» Continue breaking down each cause until the root causes have been identified. Use the 5 whys or another questioning process such as the problem trajectory to keep people focused and make sure a genuine root cause is identified in each case.

The facilitator will then ask the team to prioritise the causes, highlighting those that are most likely to be effective in addressing the problem, for example causes that keep recurring throughout the diagram.

This example illustrates how a group might begin a fishbone diagram to identify all the possible reasons for a problem in order to discover the root cause.

The problem is often stated as a 'why?' question, for example, why are so many crashes

Ishikawa diagram example



happening at this point in the network? Causes are then identified by analysis, often comprising brainstorming sessions, and grouped into categories. In the example above, four categories are used, sometimes referred to as the '4 Ps'. Note that categories relevant to the problem need to be used.

Because Ishikawa diagrams are often used when the causes of a problem are complex and span multiple disciplines, it is important to have a diverse group involved in the exercise. Include people who can bring views of the problem from different perspectives, not just focus on a single aspect. They are often useful in analysing what has happened although, as originally used by the Mazda Motor Corporation, they can also help to anticipate problems and provide design guidance.

Using root cause analysis to support problem definition and the business case approach

Capturing the richness of information that fully describes a problem in a single sentence is challenging. Yet this is what the Business Case Approach (BCA) requires, since it relies on clear communication of problem drivers as well as consequences to ensure that responses are aimed at the right type of intervention.

One way to help understand this is to think of the problem statement as a news headline – a short, clear statement that engages the reader's attention and makes them want to read further.

That means it is important to back the problem statement up with further details – the 'article', to take the news item metaphor a stage further. Usually it is possible to do this in a few short paragraphs that take the details discussed during the ILM and present them in a readable, logical manner.

From this, it is clear that the 'cause' as captured in the problem statement will often not be the root cause; there will potentially be a number of intermediate or root causes that precede it. Consider the following problem statement:

PROBLEM

High levels of nitrates in groundwater are leading to loss of biodiversity in waterways.

'High levels of nitrates in groundwater' is clearly not a root cause; it tells us nothing about why there are high levels of nitrates in groundwater. It is important to support this statement with a brief description of the factors that lead to nitrates entering the groundwater system, for example the land-use practices that involve nitrate use. In this example, 'high levels of nitrates in groundwater' is an intermediate cause that is used to get the point across in a succinct and compelling statement.

A response that simply says 'prevent nitrates entering groundwater' does not carry enough information to be useful in identifying solutions. Responses to address the situation need to be aimed at the root causes, namely how and why nitrates are entering the groundwater, in order to succeed.

How do I know when I have got to a root cause (not just an intermediate one)?

A common mistake in understanding the cause of a problem is to stop asking 'Why?' too early, allowing an intermediate cause to become the focus of attention. If you are lucky, this might enable the specific occurrence of the problem to be addressed, although it will leave a high risk of similar problems happening again and again.

This is like simply replacing the alternator belt in the '5 whys' example above – it doesn't address the underlying problem of poor maintenance, so another failure is likely. Only addressing a root cause will completely address a problem.

So how do you know when you have got to a root cause, as opposed to an intermediate one? Well, intermediate causes usually point to things that need changing; for example, physical assets. Root causes tend to be more process or system related; for example a maintenance regime that is at best ad hoc, or a poorly drafted contract that doesn't deliver the outcomes that are needed. So when you get to a process, policy or system that either isn't working well or doesn't exist, you have probably found a root cause.

It's important not to make the mistake of thinking that a 'root cause' has to be a single factor; many problems have complex causes with multiple roots, which need to be mapped carefully to understand the best leverage points to drive change. Ishikawa diagrams can be very effective tools to explore multiple causes, and help reach consensus on where most effort will be applied.

There is one more aspect to consider here; once a root cause has been identified, a decision must be made about the ability to influence it. Taken to a logical conclusion, a root cause of falls in the workplace could be identified as the earth's gravity; since we are unlikely to be able to change that, something higher up the chain of logic must be addressed, such as procedures for identifying and addressing trip hazards. An essential part of root cause analysis is to decide, once the causes have been identified, which ones should be the focus of any efforts to find a solution.

Further reading

» Read more about the 5 whys

» Find out more about the Rogers Commission Report

» Learn more about Ishikawa analysis

Where to find more guidance

» BCA guidance on the Transport Agency website: nzta.govt.nz/bca

» BCA online learning modules

» *Strategic case: defining problems and benefits well* information sheet