Root Cause Analysis – Dealing with problems not just symptoms[1]

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Abstract

As test managers, we seek ways to improve in areas such as processes, tools, resources, ROI and so on. In this article I will discuss how we can find the underlying problems within the engineering group (some related to testing, some affecting the testing group in a big way), rather than focusing on the symptoms.

Root-cause analysis and cause-effect graphing (or cause mapping) are known techniques that are used in various ways. I have enhanced them to identify priorities that assist in selecting the best roots for improvement with regard to the implementation and its impact.

Introduction

As a test manager, I have used and exercised RCA (root cause analysis) and CEG (cause effect graphing) a few times in my projects. It always bothered me that I invested so much time in interviews, analysis, questioning, and that I do not get the priorities of the paths and roots which were most probably going to succeed.

One of the fundamental techniques is the “5Ys” or “5Whys”. In this technique, we ask ourselves "why" a phenomenon happens, get an answer and then ask "why" again – 5 times – to get to the bottom of things.

The following example demonstrates the basic process:

- My car will not start. (the problem)

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

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The questioning for this example could be taken further to a sixth, seventh, or even greater level.

The technique was originally developed by **Sakichi Toyoda** and was later used within Toyota Motor Corporation during the evolution of their manufacturing methodologies. The tool has seen widespread use beyond Toyota, and is now also used within Six Sigma.

There are a few disconnections that can be found in this technique:

- What if one of the 'Whys' is answered wrongly? Maybe our answer is possible, but what if the actual cause is something else?
- Who says the result is the only one derived from the answer of the "why" - There is the assumption that a single cause, at each level of "why", is sufficient to explain the effect in question.
- When we have found the problem, and draw the route, how 'strong' is this solution (how strong is the connection between the source and target phenomenon?) Maybe we should prefer one over the other?

On top of that, at the end of the process I get a nice diagram with connections, (cause-effect diagram/graph), but with no clear observation or a suggestion related to the best root possible, the probability of that root succeeding or the added value of that root by removing the root cause.

What I have witnessed happening today…

In my long years of experience with customers, I have seen that we are doing many things wrong in trying to get it right.

Companies tend to jump too quickly to solutions, not spending enough time on problem analysis.

Usually the quick solutions come up first (sometimes not so easily), but they may not be the best ones (long-term problem eliminators), and often they represent a solution to a symptom(s), but not to the real problem – which we have not identified yet!

I have collected some behaviors which I have observed from the market during the years:

- We pay attention to details, but tend to miss the whole picture…
- We sometimes are too focused on the now and the near future, and do not see enough in the long term,
- We just hate to keep looking for the problem, if we believe we have just found it (or so we believe…),

- We often think we have enough evidence to support the problem identification we have at hand, but we don't…
- We tend to complicate things – otherwise it would not be a challenge to find the problem…

Root Cause Analysis Method – My interpretation

From Wikipedia, I have found a pragmatic definition:

— **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.

— However, it is recognized that complete prevention of recurrence by a single intervention is not always possible. Thus, RCA is often considered to be an iterative process, and is frequently viewed as a tool of continuous improvement.

My interpretation and simple definition is:

— RCA is a problem-solving method designed to search for the root of a problem, using drawing symbols and a predefined structural process of thinking.

From Bill Wilson's website:

— *Root cause analysis* (RCA) is a methodology for **finding and correcting the most important reasons** for performance problems.

— It differs from troubleshooting and problem-solving in that these disciplines typically seek solutions to specific difficulties, whereas **RCA is directed at underlying issues.**

Now, to demonstrate how this process of identifying problems is not easy, look at the following picture:

It is a "Cows and rocks are falling from the mountain" sign.

- Is it a symptom or a problem?
- Should we eliminate all cows in that area?
- Should we dig-out the mountain?
- Should we divert the road elsewhere?
- [or maybe] the sign is not posted right…

Sometimes (in my eyes, in most times) eliminating the causes is not an easy task and finding problems merely from symptoms is a hard cognitive process to go through.

Root Cause Analysis Techniques

There are a few techniques being used today. I will mention a few, and will focus only on two I have examined.

1. **Cause and effect analysis** Simplest technique out of all the RCA techniques. For every **effect** there is a **cause**. There is a fairly long chain of relationships between the **cause** and its **effect**. As we move along the chain the cause and effect become finer and finer. Just like when we dig out a tree its roots become finer and finer. The finest **cause** if removed, the problem will not re-appear. This is the essence or Root Cause Analysis.
2. **5 Whys**
3. **Kepner-Tregoe Problem Analysis** - original root cause analysis process developed in 1958, which provides a fact-based approach to systematically rule out possible causes and identify the true cause
4. **Failure mode and effects analysis** Also known as FMEA.

5. **Pareto analysis**
6. **Ishikawa diagram**, also known as the *'fishbone'* diagram or cause and effect diagram
7. **Cause Mapping** - A problem solving method that draws out, visually, the multiple chains of interconnecting causes that lead to an incident. The method, which breaks problems down into specific cause-and-effect relationships, can be applied to a variety of problems and situations
8. **Change analysis** - an investigation technique often used for problems or accidents. It is based on comparing a situation that does not exhibit the problem to one that does in order to identify the changes or differences that might explain why the problem occurred.

Although common methods are: Cause-effect analysis, 5Whys, FMEA, Cause Mapping and fish-bone – I have focused on 2:

- 5Whys
- Cause Mapping

These are commonly used and exercised in the market, and highly understood from my experience.

Enhancing the Method

I have enhanced the method, and present this below using a project implementation.

This is the process I have constructed and used:

1. Conduct structured interviews with customer's personnel
2. Draw the cause-effect diagram and apply the 5Whys method
3. Investigate the arrows/lines in the diagram, asking the following questions:
    - What proof do you have that the cause exists?
    - What proof do you have that the cause leads to the effect?
    - Is anything else needed together with the cause for the effect to occur?
    - Is there proof that the cause is contributing to the problem I'm looking at? How much does it contribute?
4. After this questioning phase, I construct the following matrix for each and every arrow in the diagram:

Type	Question	Cause-Effect arrow score
Relevancy	Do you have a proof that the cause exists?	**Yes /** No
Strength (S or W)	How strong the proof you have that the cause is leads to the effect?	H/**M**/L
Strength (S or W)	Is anything else needed together with the cause for the effect to occur?	Yes (W)/**No** (S)
Impact (D or I)	Is there a proof that the cause is contributing directly to the problem I'm looking at?	**Yes /** No
Impact (D or I)	In what way it contributes?	**Direct /** Indirect
	Mark	
I have used: High = 3 points, Medium = 2 points and Low = 1 point, Direct = *2, while indirect = *1. Also, S = strong, W = Weak, D = Direct, I = Indirect.		

5. Identify the routes leading to the problem/s
6. Identify the strength and direction (impact) they have (calculating the mark for each arrow)
7. Choose the best route/path to focus on, after discussing it and analyzing it
8. Act: Improve it (focus your efforts on the chosen route/path), re-create the cause-effect diagram, and go to the highest root in priority again.

In the next diagram you can see the first drawing we made in one of the projects, illustrating the initial causes identified (pointing hands).

We have identified "Only partial test planning and not full coverage" and "partial execution and low coverage".

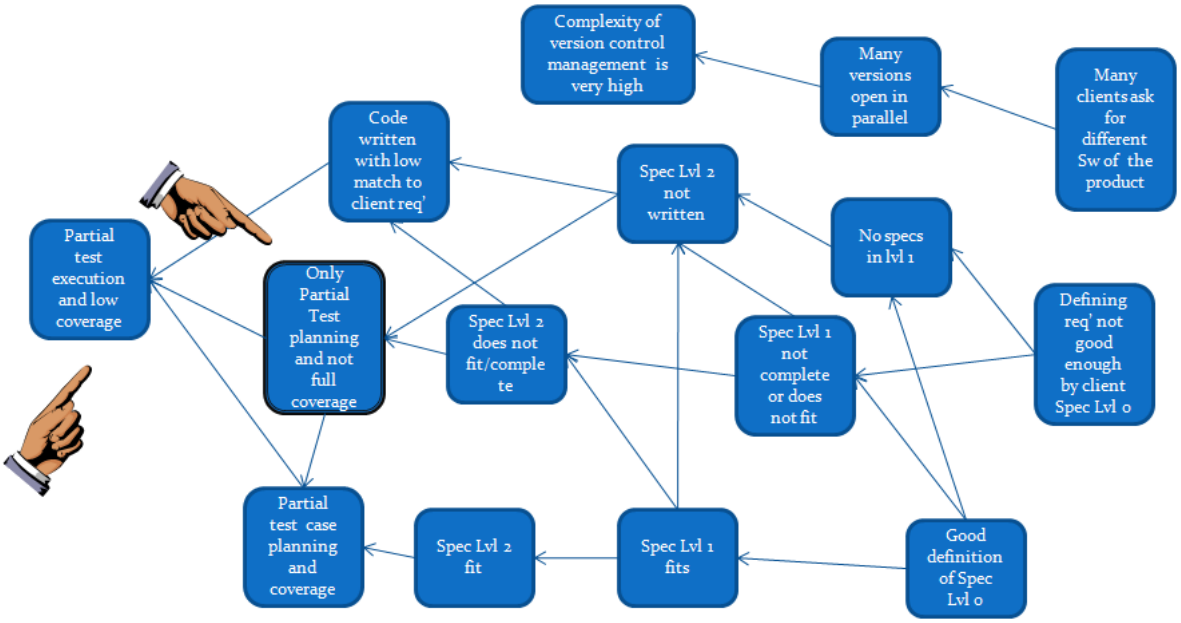

Figure-1: First draft drawing, iteration #1

Even in this diagram, we have identified a few possible improvement roots already:

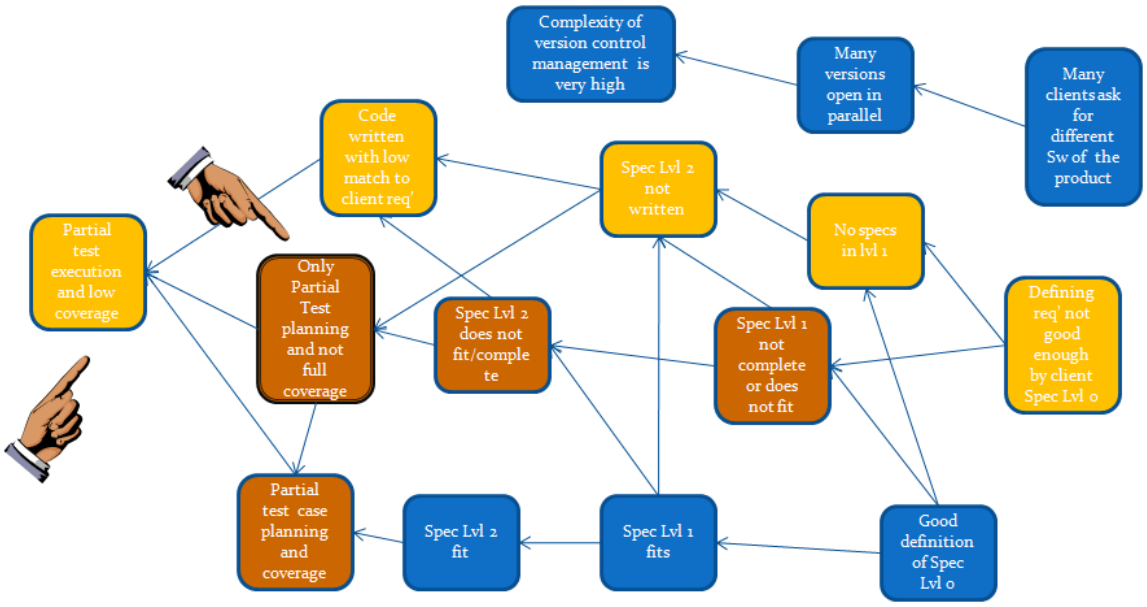

Figure-2: First draft, improvement roots identification (yellow, brown), Iteration #1

We have identified a disconnection with the upper cause-effects (blue), which is usually a sign that we do not see the whole picture yet.

We then continued discussing things, trying to identify more causes and phenomena. It is at that point that we shifted from the starting point of "partial testing being executed (not enough run)" to "poor-quality product".

It is with that focus that we continued investigating and building up the diagram. This is the next stage we reached:

Figure-3: Middle draft, identifying more causes, closing the disconnection, Iteration #3

We were now ready to investigate the arrows of the diagram and find out the scores for all of them.

We did that by, marking two signs on each arrow: strong/weak, and direct/indirect. The markings used were bold line vs. regular line for the strong/weak and straight line vs. dotted line for direct/indirect.

This was the result of the next iteration:

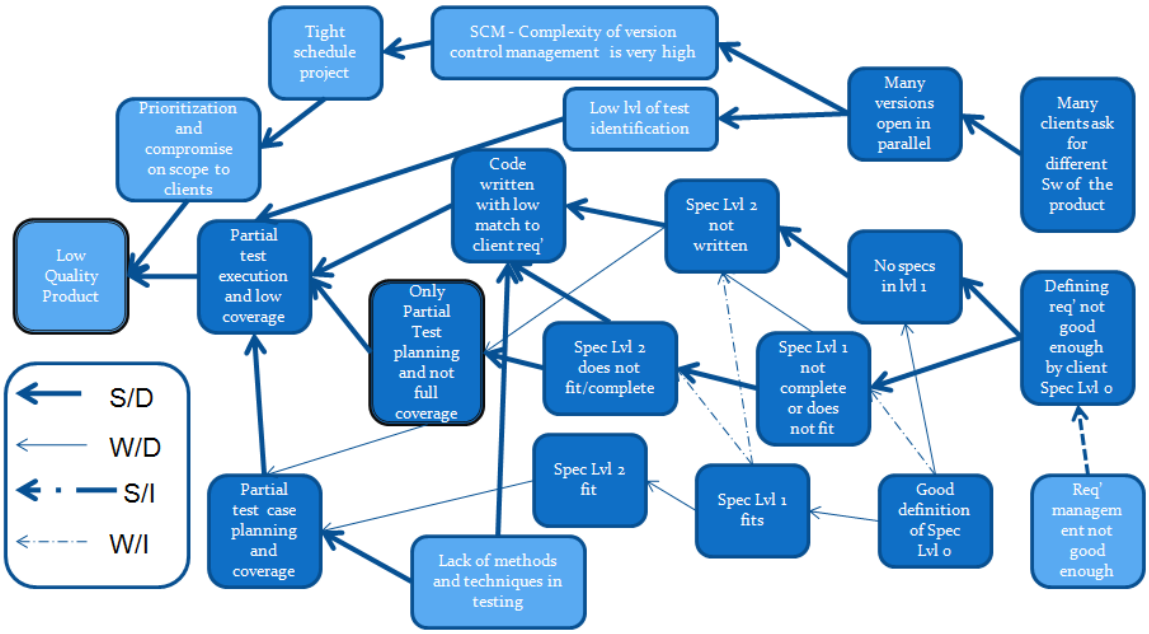

Figure-4: Final draft, identifying the strength/relevancy/direction of the arrows, iteration #4

We then went back to double-check the RCA of the routes/paths leading to the primary problem, marking the arrows with their scores.

We completed the process by circling (marked in green) the main causes that have initiated the strongest routes and are directly impacting our problem (see next figure):

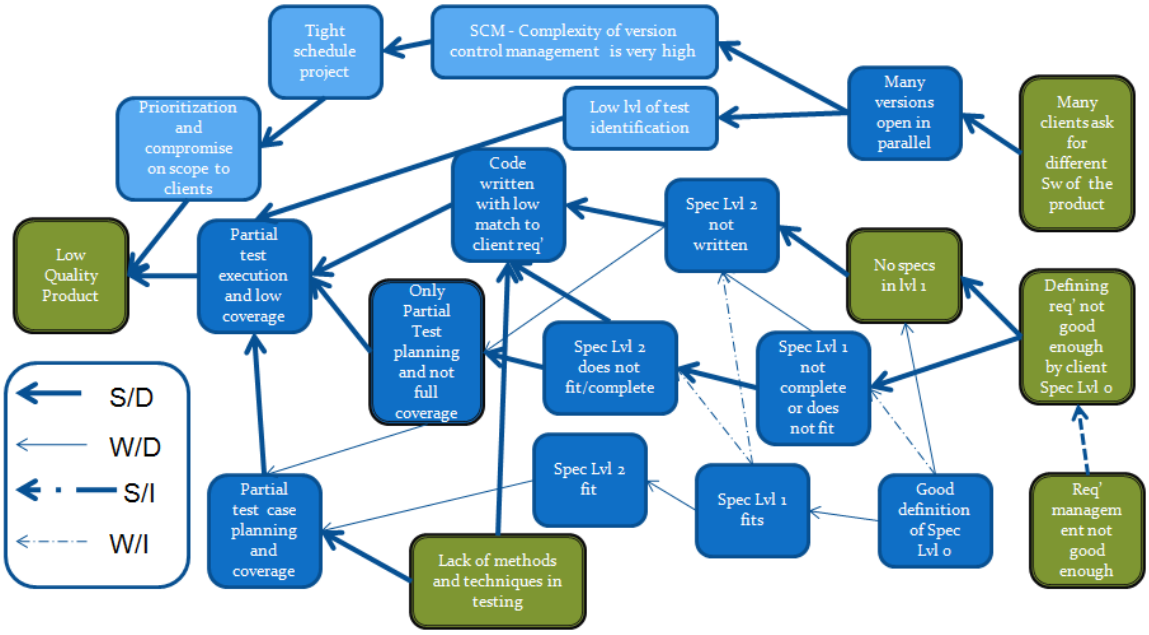

Figure-5: Final draft, identifying the root causes, and major effect, iteration #5

The next phase was to identify the possible routes/paths that lead from the root-causes to the effect. We have identified 5 such roots in that project:

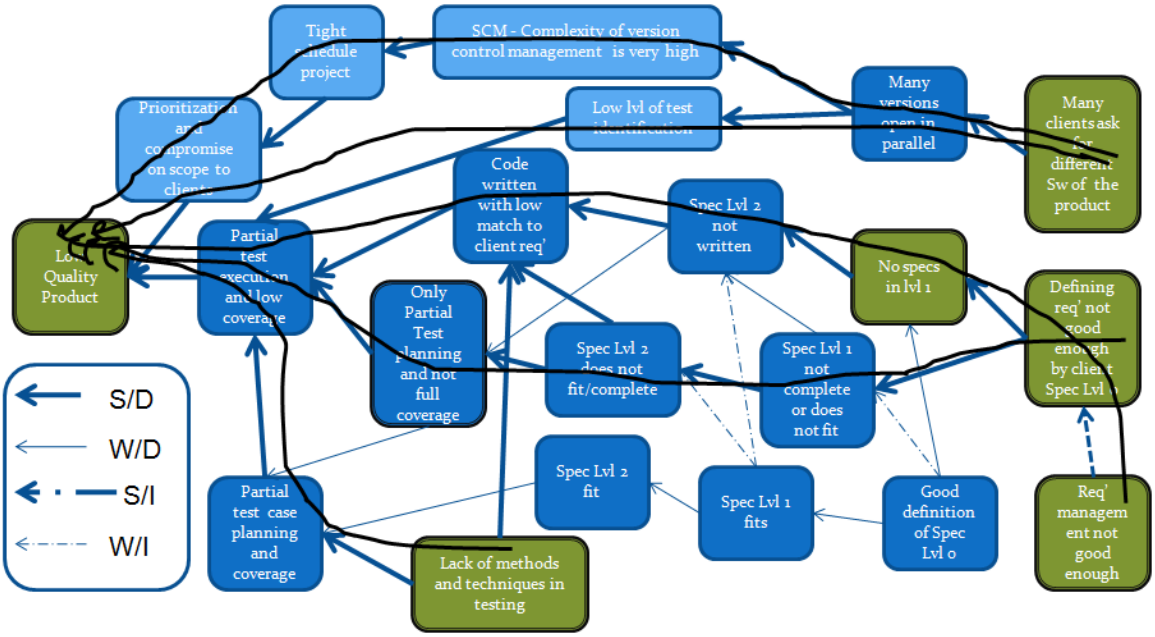

Figure-6: Final draft, Identifying possible improvement roots, iteration #6

From that point, the scores helped us realize which of the routes/paths have a higher probability to succeed and gave us more 'clear' impact on our [new] baseline statement – “poor-quality product”.

After double-checking the arrow details and scores we initiated a task to build a corrective action plan for improvement.

Conclusions & Recommendations

For that project we identified 5 major Root Topics using the enhanced method and a clear process. These are explained and prioritized below:

1. Produce requirements from client definitions
2. Requirements management
3. Either ‘No Spec Level 1’, or ‘Spec level 1 not matching requirements’
4. Lack of methods and techniques in testing for development and testing teams

5. Many clients define slightly different requirements for the SW – there are many "specials"

We defined a pragmatic plan of corrective actions with priority items, which was then realized and monitored.

Summary

A few considerations should be taken into account in order to reach a successful implementation of the enhanced method.

- Cause-effect Mapping & RCA combined can reveal real problems, leaving behind the symptoms, but we need to eliminate the problems of the model by answering the questions and scoring them on the diagram for the best route(s),
- We must deal with symptoms in the short term, otherwise…
- The questions (answers) of the enhanced method make sure that our analysis has minimal deviations, and that the route we take is a 'strong' one,
- It is a constructive process that leads to understanding, clarity, focus and the right priority setting for picking the best route for improvement implementation

I now use the method in my projects and I try to enhance it even further. Even so, there are a few open questions to be resolved in order to have this method clear and useful to everyone. I have now added some post-implementation points we will all have to consider while implementing the method.

Post-Process Observations – Next Steps

When further enhancing the model, we must think and get answers to the following questions:

- What about the junction points (*inbound and outbound – see figure-7*): direct impact of routes with those? Indirect? Impact on speed of performance (bottle-necks)?
- What is the ROI for this method?
- Can we validate a route before implementing it? Can we identify it to be a successful problem eliminator?

- How much of the method is context-dependant?
- Can we hook it to test process improvement methods or other key performance/area indicators?
- Other?

I am investigating these questions, looking for the answers and will welcome any cooperation in doing so.

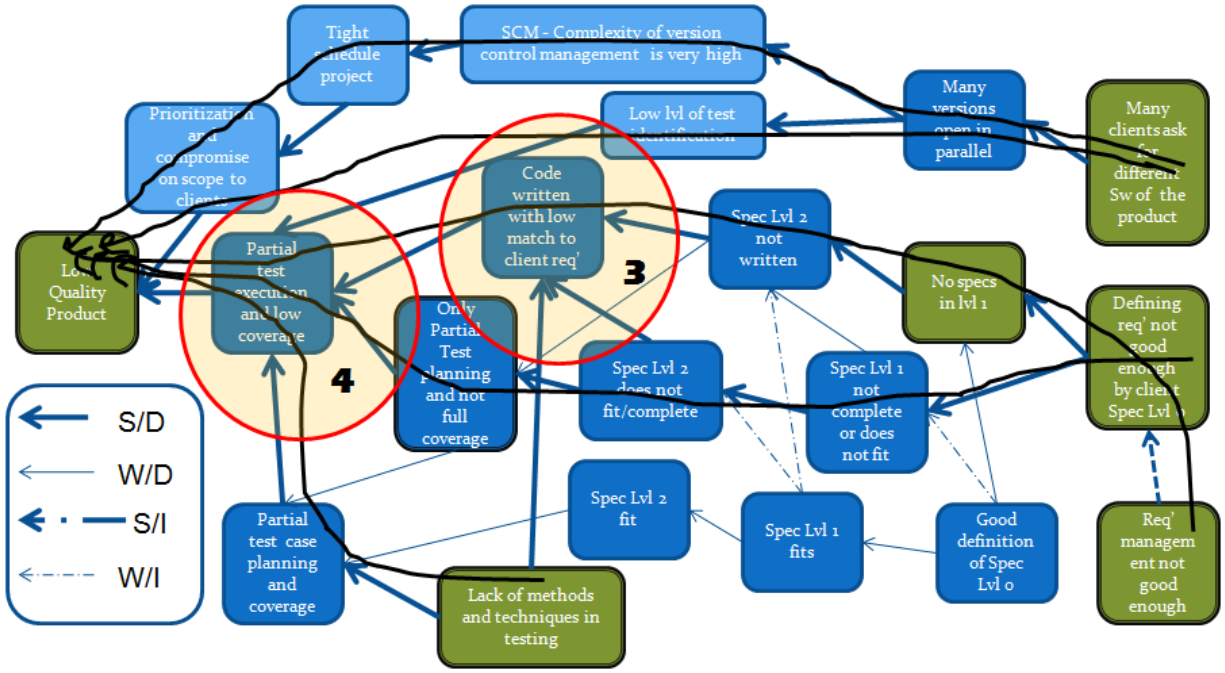

Figure-7: Final draft, inbound/outbound – circles 3 and 4

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