The Shortcomings of Existing Root Cause Analysis Tools

Hari Agung Yuniarto

***Abstract*-The effective use of the Six Sigma problem-solving methodology is strongly influenced by the efficacy of the Root Cause Analysis tools, the tools used for performing the Analyze-phase of Six Sigma's DMAIC. This paper elucidates how the shortcomings of the existing tools have characterized Six Sigma as being reductionist. It first gives an overview of the vital importance of Root Cause Analysis to the Analyze-phase, and then examines several of the existing Root Cause Analysis tools. It will then go on to the results of an in-depth study into the efficacy of these tools. The fundamental problems are recognized as the basis for improving the tools of Root Cause Analysis, escaping from reductionism.**

***Index Terms*- holistic approach, reductionism, root cause analysis, systems thinking**

I. STATE OF THE ART OF ROOT CAUSE ANALYSIS CONCEPTS OF THE ROOT CAUSE

To solve a problem, factors causing the problem must be first recognized and understood. According to Handley [1], the root cause poses the most basic reason for an undesirable condition or problem. The root cause is the reason for a non-conformance. It is the underlying cause, or causes of the problem that persist inherently in the system, not just the apparent causes. It is the contributing factor that, if removed, will eliminate the non-conformance or the undesirable event and prevent the recurrence of the problem. Identifying the root cause is the key to preventing similar recurrences. If the real potential root causes can not be identified, then analysis of the root cause will only be able to address the symptoms leaving the problem to exist. The ability to identify and eliminate the inherent root cause of the problem, i.e. the 'common-cause', will be of the utmost importance in problem-solving [2].

Root Cause Analysis (RCA) is a process of analysis to define the problem, understand the causal mechanism underlying transition from desirable to undesirable condition, and to identify the root cause of problem in order to keep the problem from recurring by using a structured procedure [3]. The aim is to determine how to keep the problem from ever occurring again by designing prevention that recognizes and eliminates the root cause.

ROOT CAUSE ANALYSIS AND SIX SIGMA

Six Sigma problem-solving methodology uses a structured procedure of 'Define-Measure-Analyze-Improve-Control' (DMAIC) to administer Process Quality Improvement (PQI), with emphasis on the analysis of causal mechanisms underlying a problem. It puts more emphasis on understanding what lies behind the problem than generating the best solutions to the problem [4]. Therefore, every effort to challenge the optimum recommended actions on tackling the problem with Six Sigma should be built upon the root cause of problem. To examine whether the root cause revealed is the real potential one or not, a comprehensive understanding of the problem-causation needs to be fully attained. The Analyze-phase of DMAIC has a vital role in doing so.

To function, the Analyze-phase needs an appropriate technique to analyze the root cause of the problem. The application of Root Cause Analysis meets this need. With the aim of keeping the problem from recurring, the Root Cause Analysis plays an important role in the effective use of the Analyze-phase of DMAIC to delve into the causal mechanisms of the problem. These will engender a firm understanding of the problem-cause so that the root cause of problem, that is to say the vital few 'Xs' in Six Sigma can be finally determined to put an end to the long-standing problem.

II. ANALYSIS OF THE EXISTING TOOLS FOR ROOT CAUSE ANALYSIS

THE EXISTING TOOLS

A thorough analysis of some of the existing tools for Root Cause Analysis has been done by the author through an exhaustive study of literature review. The result is shown in Table 1 in a matrix form. It relates the existing Root Cause Analysis tools under study to the distinctive features of Root Cause Analysis. The features' list is compiled from investigating various literatures in Root Cause Analysis [5, 6, 3, 1, 2, 7-9, 10, 11, 12, 13-53]. This study investigates the presence of the distinctive features in the selected current tools of Root Cause Analysis listed below:

- Cause-Effect Diagram / CED [8, 16]
- Kepner-Tregoe Process / K-T [12]
- Fault Tree Analysis / FTA [10]
- Current Reality Tree / CRT [8, 19]
- 5-Whys [20]
- Apollo Root Cause Analysis (ARCA) [7, 11]
- Interrelationship Diagram (ID) [8]
- CATWOE [5]
- Barrier Analysis [3]
- TRIZ [6]
- System Process Improvement Model / SPIM [1]

Manuscript received March 20, 2012; revised April 20, 2012. Dr Hari Agung Yuniarto is with Universitas Gadjah Mada in the Department of Mechanical and Industrial Engineering, Yogyakarta, INDONESIA (corresponding author to provide e-mail: h.a.yuniarto@gadjahmada.edu or h.a.yuniarto@ugm.ac.id).

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- Causal Factor Analysis [24]
- Event-Causal Chart [40]
- Bayesian Interference [42]
- Failure Modes and Effects Analysis / FMEA [29]
- Change Analysis [6]
- Rapid Problem Resolution / RPR [44]
- Common Cause Analysis / CCA [11, 18]
- Cause-Effect Matrix [25]
- Markov Models [2]
- Drill-Down Tree [37]
- Swim Lane [41]
- Value Stream Map / VSM [45]
- Process Map [48]

THEIR SHORTCOMINGS

The effective use of the existing Root Cause Analysis tools for the Analyze-phase of Six Sigma's DMAIC is limited in practice. Some noticeable reasons are:

a. The existing Root Cause Analysis tools were not designed for a problem-structuring method. Before offering solutions to the problem, a Root Cause Analysis tool is supposed to be able to first assist in structuring the problem, so as to help understand the problem-causation. Having a comprehensive understanding of the rationale as to why causes underlying a problem occur, is more important than just pinpointing a specific root cause. 'Common-causes' of the problem can then be identified and marked down afterwards for an effective solution generation.

b. They lack a systems perspective. Their negligence in observing the non-linear causal mechanism among the cause-effect relationships confines them to finding a single absolute root cause, subscribing to the myth of Root Cause Analysis. For this reason, the interrelatedness among the causes of problem can not be considered. The existing Root Cause Analysis tools have also neglected 'soft' issues as significant causes of the problem occurrence, just aiming at the 'hard' factors. This, as a consequence, impairs their ability to capture the whole of the problem. It is understandable therefore, with a shortage of those holistic features, that all the existing tools of Root Cause Analysis may not be competent to resolve problems in the complex system [54,55,5,56-58].

III. CONCLUSIONS

The Analyze-phase has a vital role in DMAIC, as Six Sigma puts more emphasis on understanding how the problem occurred than generating the best solutions. This gives rise to a significant role of Root Cause Analysis (RCA) in the Analyze-phase of DMAIC. In order to identify the 'common-cause' as the inherent root cause of the problem, the Root Cause Analysis tool should help afford explanations of what caused the problem, why the problem should arise, and how it developed.

Unfortunately, existing Root Cause Analysis tools fail to address this issue. Their effective use is limited due to their reductionism. The lack of systems perspective has prevented the existing tools of Root Cause Analysis from representing the interrelatedness among the causes of problem and the importance of the 'soft' factors.

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Table 1 – Comparison of existing RCA tools based on their functionality

No	Features	Tools																							
		CED	K-T	FTA	CRT	5-Why	ARCA	ID	CAT-WOE	Barrier Analy-sis	TRIZ	SPIM	Causal Factor Analy-sis	Event-Causal Chart	Baye-sian Interfe-rence	FMEA	Change Analy-sis	RPR	CCA	Cause-Effect Matrix	Mar-kov Models	Drill-Down Tree	Swim Lane	VSM	Pro-cess Map	Stat-Test
1	quantitative approach	×	×	✓	×	×	×	✓	×	×	×	✸	×	×	✓	✓	×	✓	✓	✓	✓	×	×	×	×	✓
2	modeling the problem	×	×	✓	✸	×	×	×	×	×	×	×	×	×	✸	×	×	✓	✸	×	✓	×	×	×	×	×
3	simulation analysis	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✸	×	×	×	×	×
4	understanding why the causes occurred	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
5	exploring reasonably causes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	pinpointing specific root causes	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✸	✓	✓	✓	✓	×	✓	✓	✓	✓	×
7	focussing on solutions generation	✓	×	✓	✓	✓	✓	✓	×	✓	×	✓	×	×	✓	✓	✓	✓	✓	×	✓	×	✓	×	✓	×
8	addressing hard issues	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	addressing soft issues	✸	×	×	×	×	×	×	✸	×	×	×	×	×	×	×	✸	×	×	×	×	×	×	✸	×	×
10	observing a synthesis of hard & soft issues	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
11	aiming for single absolute root cause	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	showing chain of cause-efect	✓	✓	✓	✓	✓	✓	✓	✸	✓	✸	✓	✓	✓	✓	✓	✓	×	✓	✓	×	✓	×	×	×	×
13	identifying non-linear causal mechanism	×	×	×	×	×	×	×	✸	×	✸	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
14	tackling systemwide complex problems	×	×	×	×	×	×	×	✸	×	✸	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
15	resolving ill-structured problem	×	×	×	×	×	×	×	✸	×	✸	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
16	holistic approach	×	×	×	×	×	×	×	✸	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
17	adopting atomistic view point	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	identifying 'common cause' variation	×	×	×	×	×	×	×	✸	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
19	identifying 'special cause' variation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	aiming for wholeness & interrelatedness	×	×	×	×	×	×	×	✸	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
21	a theoretical tool	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
22	obtaining systematic procedure	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
23	promoting learning process	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

× - feature does not exist ✓ - feature exists ✸ - recommended (by the author)

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