TMC Recommended Practice

RP 551

VMRS None

ROOT CAUSE ANALYSIS METHODOLOGY

PREFACE

The following Recommended Practice is subject to the Disclaimer at the front of TMC's *Recommended Maintenance Practices Manual*. Users are urged to read the Disclaimer before considering adoption of any portion of this Recommended Practice.

PURPOSE AND SCOPE

This Recommended Practice (RP) provides general training and guidance for applying fundamental Root Cause Analysis (RCA) methods to a variety of industrial operating environments (e.g., in manufacturing, as part of repair shop floor operations, in service provider delivery, and within the end-to-end supply chain). This introductory-level RP describes the fundamental RCA framework and commonly used tools (e.g., "5 Whys" and "Fishbone Diagram"). Additional tools and resources, especially for more complex problem situations, may be developed for future RPs.

INTRODUCTION

RCA is part of a class of analytical problem-solving methods known primarily for its identification and removal of known causes of problems at the source or "root" level. The method is used extensively within manufacturing as part of Quality Assurance (QA) and Quality Control (QC), mostly for its pivotal role in understanding the drivers and causes of defects, deviations and other undesirable conditions adversely affecting product and service quality.

RCA's step-by-step methodology is based on the belief that problems are best solved and prevented by addressing their source, or root-level cause(s) versus merely temporarily fixing the symptoms. When combined with effective diagnostic procedures, Corrective Action (CA) and Continuous Improvement (CI) capability, superior quality and satisfaction is possible, regardless of company or industry type.

With the ever-increasing complexity and nature of problems within trucking maintenance and repair, the need for RCA is stronger now than it has ever been. The typical audiences for RCA include fleet operations and organizations in which individuals and teams desire sustained product and service quality.

The RCA methodology provides:

- value to those who wish to advance their formal problem-solving skills;
- first-hand involvement of front-line team members, crucial to understanding the nature of problems and ways to prevent their recurrence;
- accelerated adoption and sustained use of operational best practices, and;
- an effective method for defining reliable standard operating procedures or SOP's that are proven to meet or exceed the mission at hand.

This RP provides a fundamental understanding of RCA and its powerful capability to find lasting solutions to problems, both simple and complex. It also provides a baseline framework of the steps to follow and tools to use.

RCA can and should be used for a variety of problem event scenarios and organizations where the identification and removal of confirmed causes of problems are desired. The application of RCA should be simple enough for individual commercial vehicle technicians to use as part of their diagnostic and repair work, effective within interdepartmental operations teams, and a tool of choice for management-level improvement of company systems and processes.

ORIGINS OF THE ROOT-CAUSE ANALYSIS APPROACH — THE SCIENTIFIC METHOD

Fundamental RCA is based on the time-proven scientific method — which is methodically progressing through critical milestones and findings toward the following objectives:

a. Defining the problem effect (or opportunity) and reason to care about it.
b. Collecting information and data to fully understand the problem scenario.
c. Establishing a plausible hypothesis of likely or probable causes.
d. Confirming likely causes are indeed "root" sources of the problem with empirical test-

© 2024—TMC/ATA

ing and data verifying when eliminated, the problem effect no longer occurs.

e. Determining what to do to permanently eliminate root-causes through effective change management, process re-design and implementation of standard and reliable best practices. Preventing or eliminating the root-causes(s) permanently, through proactive CA and CI. within the problem environment or process.

RCA WORKFLOW

The step-by-step formal RCA methodology to first understand the problem, and then to fix the problem involves eight milestone steps as shown in **Table 1.**

TABLE 1: RCA METHODOLOGY WORKFLOW

RCA STEP	DEFINITION	KEY TO-DO'S
Steps 1 - 4: Understanding the Problem		
1. Define Problem	Define the problem or opportunity that requires solving.	Clearly define the **problem effect**, **condition** or **opportunity,** with preliminary available data and information.
2. Gather Data	Collect detailed data and information behind the problem.	Gather relevant data and evidence related to the problem scenario.
3. Analyze Data	Verify what is true and not true regarding the problem. Analyze and confirm whether data confirms or refutes the problem condition	Review the data for causal conditions and relationships associated with the problem. Seek additional specific data for deeper understanding of the problem data.
4. Identify Root Causes	Brainstorm, analyze and confirm root-causes.	Identify root-causes most contributing to the problem effect and **confirm** that when removed or changed, eliminates or reduces recurrence of the problem effect.
Steps 5 - 8: Fixing the Problem		
5. Identify Counter-Measure Solutions	Determine what to do to address root-causes. Eliminate, reduce or prevent adverse conditions and problem drivers.	Identify & Evaluate solutions that: 1. Effectively eliminate the root causes. 2. Are within the organization's control. 3. Do not cause harm, other problems or unintended consequences.
6. Deploy Solutions	Plan, prepare & deploy improvement actions & counteractions.	Use disciplined project management to detail the deployment of proposed solutions. Define/update and operationalize Standard Operating Procedures (SOPs).
7. Monitor Solutions	Update measurement dashboard per new corrective actions.	Continue to gather data or evidence to ensure the problem effect has been effectively eliminated
8. Maintain CA/CI	Proactively manage the problem scenario and root-cause sources.	Maintain an ongoing and optimal **LEAN** environment for problem prevention, detection and Corrective Action (CA)/ Continuous Improvement (CI)

© 2024—TMC/ATA

RCA TOOLS SELECTION

Using RCA within an organization to find lasting solutions to problems, both simple and complex, depends greatly on management's commitment to making it a central part of delivering product and service quality. Providing training and allotting time and priority for RCA within individual jobs, teams and the organization should be leadership driven. This section assists in determining which tools to use when and how to use them effectively. Tool selection depends on the problem type.

Simple, Single-Event Problem Types

This type of problem scenario or occurrence is common in the repair and maintenance environment, and often only requires use of common sense "questioning as a tool "and simple tools such as "Fishbone Diagrams" and "5 Why's" to identify root causes (see **Table 2**).

The problem type criteria for using the Single-Event Tools are the following:

- There are not high impact stakes or consequences.
- Problem is not safety-related.
- There is not a trend or adverse occurrence pattern.
- There is not a high likelihood of recurrence.

"Questioning as a tool" provides starting point for problem insight and understanding.

1. What is the evidence of **what "actually" occurred** (skid marks, black-box or system generated data, video)?
2. Who are the witnesses, victims or persons with f**irst hand accounts** of the experience? Get front-line workers involved in RCA, as they likely are the ones who witness or experience the failure.
3. What did witnesses **say** "happened"?
4. What is the **measurable impact(s)** or damages?
5. Is this a Recurring Issue? **Has this happened before?**
6. **What was done the last time** this happened (to prevent or fix it)?
7. Were there any **"out of the ordinary conditions"** or circumstances?
8. Did the people involved **do what they were supposed to do?**

NOTE: If an RP currently exists, and is expected to be followed, there is strong possibility that employees are not following or adhering to SOPs. This must be considered as a strong contributing cause of the problem.

9. If no, **were there any consequences?**
10. Any thoughts on what **might have prevented** its occurrence?

Complex Conditions and Causes or Complex Problem Types

This type of problem is an increasingly occurring adverse scenario in the repair maintenance environment, especially with advancements in electrical and engine componentry throughout the entire truck. Diagnosing and solving complex problems requires both data and subject matter insight, often on an manufacturer-by-manufacturer basis (see **Table 3**).

The criteria for using the "Complex Problem Type" tools are the following:

- There ***are*** high-impact stakes or consequences.
- The problem ***is*** safety-related.
- There ***is*** a problematic trend or adverse occurrence pattern.
- There ***is*** a high likelihood of recurrence.
- If the problem is part and parcel with a manufacturing or service delivery scenario, it is likely root-causes are embedded in a core process or procedure and must be addressed systematically as there will be multiple and complex sources of the root causes. In these cases, RCA tools such as Cause-effect Mapping, Process Mapping, Fault-Tree Analysis, Failure Mode and Effects Analysis (FMEA) and Statistical Analysis (SPC) will be needed.

RCA TOOLS TRAINING

This section discusses training for several RCA tools — what they are, why and when to use them, d tips on construction of a use case.

Although RCA and the simpler tools, such as the "5 Whys" and "Fishbone Diagram" appear intuitive and simple to create, the effectiveness in the outcome of the analysis depends greatly on user/creator setting up the problem with an effective problem statement. This is not an easy task, especially with many problems "appearing" to be straight forward upon their initial discovery. There is a natural tendency to "just get going" with little patience to slow down enough to understand what the problem is about. More often, the initial problem is really just an outer layer of the onion, and a symptom that will require further decomposition and insight. This takes more time and discipline than most organizations have, with

© 2024—TMC/ATA

TABLE 2: RCA TOOLS SELECTION
SIMPLE, SINGLE-EVENT PROBLEM TYPES

	Problem Type	If	If	Or	And
		"Single Event" occurrences where "common sense" informal problem solving fixes the problem		**"Systemic"** process-centric problem affecting safety and/or operations	**Complex Conditions or Causes** & prevention is a high priority
	High impact stakes or consequences	No			
Or	Safety-related	No			
Or	Trend or adverse occurrence pattern	No			
Or	High likelihood of recurrence	No			
	Recommended Tool	• Rapid ProblemDiagnosis and Resolution (RPD&R) • Fishbone Diagrams • 5 Why's • Pareto		• Cause-Effect Mapping • Process Mapping	• Fault-Tree Diagram • FMEA • Statistical Analysis

TABLE 3: RCA TOOLS SELECTION
COMPLEX CONDITIONS AND CAUSES OR COMPLEX PROBLEM TYPES

	Problem Type	If	If	Or	And
		"Single Event" occurrences where "common sense" informal problem solving fixes the problem		**"Systemic"** process-centric problem affecting safety and/or operations	**Complex Conditions or Causes** & prevention is a high priority
	High impact stakes or consequences		Yes	Yes	True
Or	Safety-related		Yes	Yes	True
Or	Trend or adverse occurrence pattern		Yes	Yes	True
Or	High likelihood of recurrence		Yes	Yes	True
	Recommended Tool	• Rapid Problem Diagnosis and Resolution (RPD&R) • Fishbone Diagrams • 5 Why's • Pareto		• Cause-Effect Mapping • Process Mapping	• Fault-Tree Diagram • Failure Mode and Effects Analysis • Statistical Analysis

NOTE: This RP only addresses in detail the most basic RCA tools for single event problem types (“Fishbone Diagrams” and “5 Why's”). A discussion of more complex RCA tools (e.g., Pareto, cause-effect mapping, faut-tree diagrams, statistical analysis, etc., may be developed in the future).

© 2024—TMC/ATA

the culture of "take action, then ask questions later" mentality. The recommended practice is to leverage the RCA method, using the various tools and analytical techniques most appropriate to the stage of problem solving at hand. Additonally, critical thinking and subject matter expertise are imperative. The tools should be used at the right time, by the right people.

The RCA methodology should be trained on as combination of step-by step procedure, with tools used as required and as critical thinking judgment dictates throughout the course of problem solving. Ultimately, solutions and counter-measures chosen to remove or mitigate root-causes must be data quantifiable and confirmed, so analytical thinking skills are key to the success of RCA.

NOTE: This RP addresses several of the most basic RCA tools for single event problem types ("5 Why's"and "Fishbone Diagrams"). A discussion of more complex RCA tools (e.g., Pareto, cause-effect mapping, fault-tree diagrams, failure mode and effects analysis, and statistical analysis) may be provided in a future update of this document.

THE 5 WHY'S RCA TOOL

What Is It?

"5 Why's" is a simple and practical "successive questioning" technique for discovering potential root-cause of a problem (see **Figure 1**).This method relies on its directness and simplicity to "wring" out the reasons for a problem when used by SME's knowledgeable of a problem situation. It is most effective for simpler, relatively isolated problem events clearly defined by "before" and "after" evidence.

Why Use it?

Certain problem events require swift and direct analysis for effectiveness and using a more structured and time intensive approach would not justify the effort.

When to Use It?

The "5 Why's" technique can be used as soon as the problem event has been defined.

Construction Steps and Tips

It is often helpful to augment the "5 Why's" questioning with qualifying questions to get to the heart of what happened, especially if little or no cause insight is being generated. Example qualifying questions are:

- What control mechanism or barrier should have been present to prevent the event ***but wasn't***?
- ***What changed*** between what normally happens and what happened?
- Did someone do something they ***do not ordinarily do***?

Using the "5 Why's" Tool

The goal of "5 Why's" is to facilitate discussion to arrive at plausible chain of events resulting in the problem effect that led to identifying root-cause(s), utilizing the following model:

1. Assemble the team of subject matter knowledgeable problem solvers around a table or wall surface. Use a flip chart or white board to capture results so all team members can hear and see the answers.
2. Finalize the problem statement (the "problem effect or what") and place its summarized version in an event rectangle at the top of the page.
3. Ask "Why did this problem happen?" Chart the answer in as complete as sentence as possible. Pause, then repeat, asking "Why did that happen?"
4. Continue asking "Why" four more times, until the root-cause becomes evident.
5. Each answer to "why" likely will have multiple pathways to explore. Take each path and again, asking "why" and recording the answer, moving in a "top-to-bottom" fashion.

FISHBONE DIAGRAM

What is it?

The "Fishbone Diagram" is a widely used and popular fish-shaped diagramming structure for identifying, organizing and understanding possible causes of a problem in order to discover its root causes utilizing

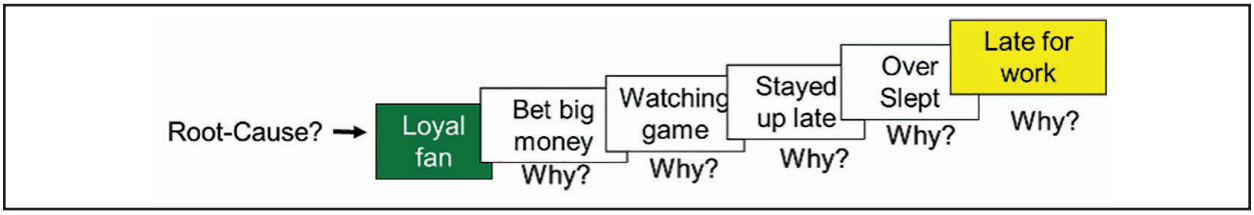

Figure 1

© 2024—TMC/ATA

a "Fishbone Diagram." See **Figure 2 f**or an example. It provides focus on the causes of a problem, not the symptoms. It also provides a simple, yet well-organized structure to systematically identify and build consensus regarding causes of a problem.

Why Use it?
The "Fishbone Diagram" is a relatively easy and fast developing technique for identifying causes of a problem or event. Its strength is its simplicity when used to analyze relatively noncomplex, single-event problems. It facilitates the "harvesting" of team knowledge and subject matter expertise required to gain the needed insights regarding root causes.

When to Use It?
It should be used after first defining the problem effect.

Construction Steps and Tips
The building of a "Fishbone Diagram," although relatively easy, is actually more difficult to do effectively in root-cause efforts mostly due to the urge to get going. The pausing to clearly define the problem effect, with quantitatively supported facts and information, is the vital ingredient necessary to constructing this diagram. The following steps detail the importance of setting up the problem scenario with the appropriate categories before building the diagram and brainstorming potential causes of a problem.

It is equally important to ensure the right subject matter knowledgeable participants create or provide input into the construction of the diagram.

Using the Fishbone Diagram Tool
The following is a six-step model for implementing "Fishbone Diagrams":

1. Finalize the problem definition and place its summarized version in the event rectangle at the tip of the backbone arrow (see **Figure 3**).
2. Decide "cause categories" most appropriate for the nature of the problem.
   a. Define the cause categories or codes with the broadest perspective to ensure all possible causes are considered. Typical categories include, but should not be limited to people, process-procedures, policies and systems-equipment.
   b. Reference relevant resources where available, appropriate for the problem type being solved, such as TMC's *Radial Tire Conditions Analysis Guide*, or other specialized guides for material handling and construction applications.

3. Draw in the branch and sub-branch arrows within each cause category.
   a. There is no right answer as to the selection of cause categories or number of branches.

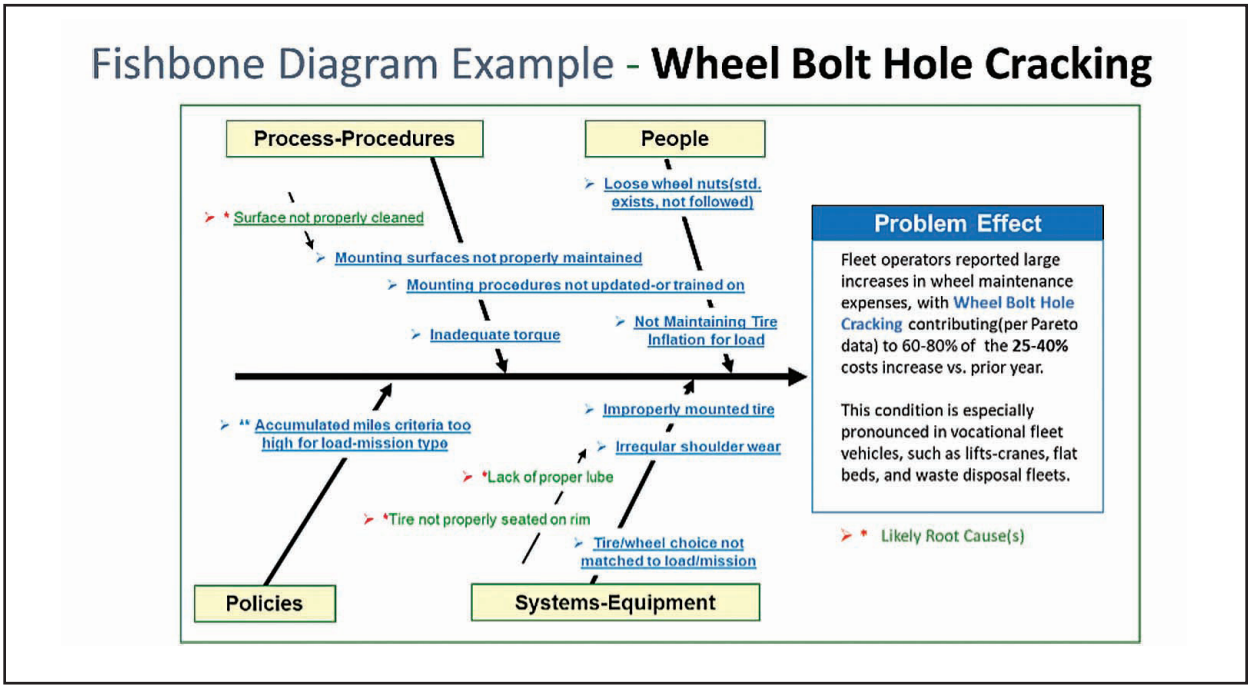

Figure 2

© 2024—TMC/ATA

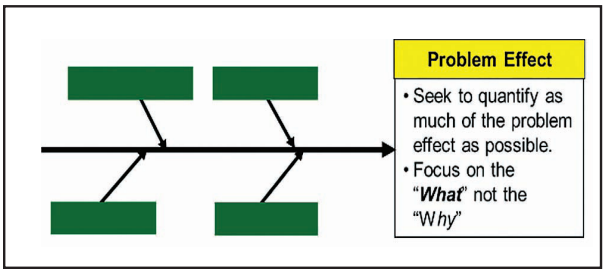

Figure 3

b. Customize the categories per the nature of the problem.
c. If there is insufficient data or knowledge of the problem, use the generic categories to get started.

4. Brainstorm all possible causes of the problem for each category, adding additional levels of branching (keep asking "why" for each cause identified).
   a. Work each branch successively, asking "why?" then, what causes this cause?

5. In a Subject Matter Expert (SME) team setting, begin classifying all causes of the problem within each category.
   a. Analyze each branch successively, drawing conclusions regarding the nature of each cause.
   b Test, validate and "cull" the contributing from the possible.
   c Further "cull" the "root-causes" from the contributing using the criteria for a "root-cause."
   - If cause is removed, problem goes away.
   - If cause is corrected, there is no reoccurrence.
   - If inconclusive, seek corroborating data to support or conflicting-alibi data to refute root-cause conclusion(s).

6. Perform a "sanity check" with peer SMEs and stakeholders to validate completeness of root-cause analysis and conclusions (see **Fig. 4**).

DEPLOYING RCA METHODOLOGY AND TOOLS

RCA is a powerful "critical-thinking" methodology for finding lasting solutions to problems, both simple and complex. The framework outlined within this RP defines the best practice steps for defining a problem, collecting and analyzing data, identifying root causes, and ultimately leading to counter-measure solutions that eliminate root causes at their source.

The basic RCA tools presented herein provide a baseline for adressing simple issues and beginning to develop a systemic approach, whereas more complex problems would require more robust tools that may be addressed in future RP development.

Whether the problem type is simple or complex, the RCA methodology, when followed, results in the effective solutions that also accomplish the overall objective of RCA, which is to achieve and sustain service and product quality that meets and exceeds the mission at hand. With that in mind, the following items summarize the recommended approach to

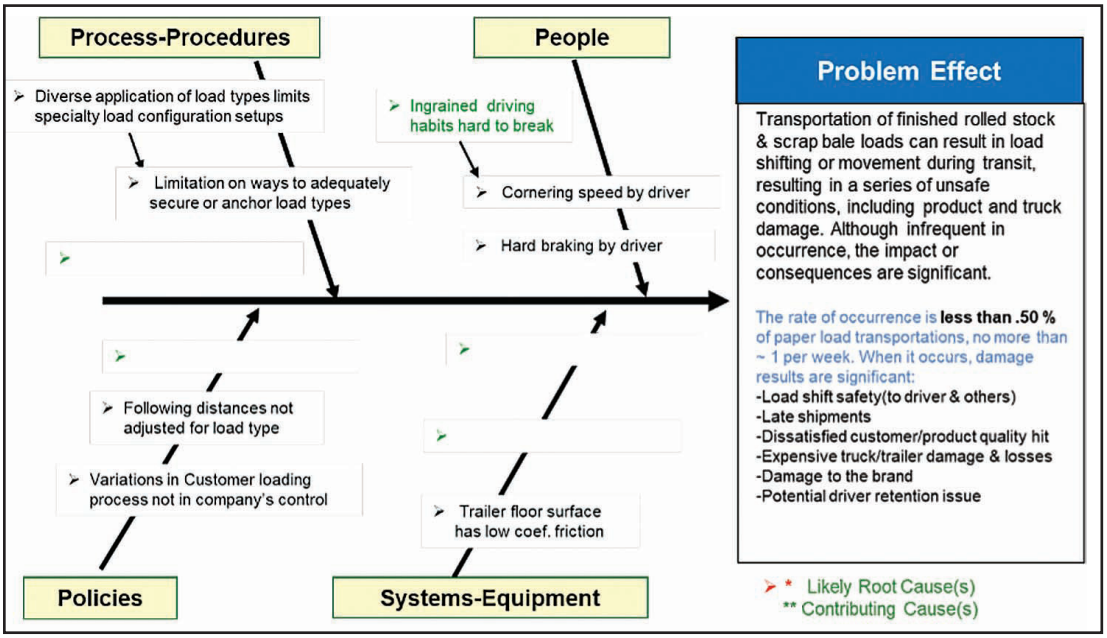

Figure 4

© 2024—TMC/ATA

getting started with RCA:

- Make RCA a leader-lead effort, ensuring sponsorship is in place to provide the resources, time and support necessary for its successful implementation. Disciplined patience is a must.
- Coordinate the use and deployment of RCA with any existing CI or QA/QC initiatives already in place. Ultimately, RCA is not a means in itself, but a feeder of solutions to be standardized within the organization via Standard Operation Procedures or SOP's.
- Invest in RCA training for everyone in the organization, by providing the basics, and by offering more advanced tools training as teams and individuals grow their need for more advanced capability to tackle complex problem type scenarios.

© 2024—TMC/ATA