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Root Cause Analysis – A Practice to Understanding and Control the Failure Management in Manufacturing Industry

Joymalya Bhattacharya, M.Pharm (Pharmaceutics), MBA (HRM), M.Phil (Management)
Senior Chemist, Albert David Limited.5/11,D.Gupta lane, Kolkata-700 050, India

ABSTRACT: *This paper seeks to examine the root cause analysis management for a manufacturing industry. Root cause analysis is one cause of the best processes to eliminate failure management in industry. This paper highlights about the tools which are use in root cause analysis and the methodology of root cause analysis. The procedural approach is one of the most important thinking for root analysis, because without selecting perfect tools it is not possible to analysis the perfect root cause.*

KEYWORDS: *Root cause analysis (RCA), Failure modes and effects analysis (FMEA), Fishbone Diagram*

I. INTRODUCTION OF ROOT CAUSE ANALYSIS

Root Cause is the fundamental breakdown or failure of a process which, when resolved, prevents a recurrence of the problem Root cause analysis is a problem solving process for conducting an investigation into an identified incident, problem, concern or non-conformity. Root cause analysis is a completely separate process to incident management and immediate corrective action, although they are often completed in close proximity. Root cause analysis requires the investigator(s) to look beyond the solution to the immediate problem and understand the fundamental or underlying cause(s) of the situation and put them right, thereby preventing re-occurrence of the same issue. This may involve the identification and management of processes, procedures, activities, inactivity, behaviors or conditions.

The benefits of comprehensive root cause analysis include:

- Identification of permanent solutions
- Prevention of recurring failures
- Introduction of a logical problem solving process applicable to issues and non-conformities of all sizes

Root Cause Analysis is a method that is used to address a problem or non-conformance, in order to get to the "root cause" of the problem. It is used to correct or eliminate the cause, and prevent the problem from recurring. RootCausc is the fundamental breakdown or failure of a process which, when resolved, prevents a recurrence of the problem.

II. METHODOLOGY OF ROOT CAUSE ANALYSIS

The root cause management strategy is established through the following methodology:

- Investigation of the incident
- Identification of the root cause by using Root cause analysis tools
- Effect of that cause
- Corrective actions to prevent recurrence
- Approval of corrective actions
- Implementation of actions
- Training of personnel on root cause management system
- Closure of the root cause by Root cause analysis Team leader

III. Benefits of Root Cause Analysis

- The removal of reoccurring failures
- Empowerment of the maintenance staff
- The development of the "close to zero tolerance culture"
- Recording of failure data
- Improved understanding on failure mechanism Reliability and cost improvement

- Higher customer satisfaction
- Root cause analysis is a learning process to follow for thorough understandings of relationships, causes and effect and solutions. By practicing Root cause analysis, eliminate taking action on possible causes, and delay a response to the last responsible moment when the actual root cause of an effect is identified.

IV. PROCEDURAL APPROACH OF ROOT CAUSE ANALYSIS

Step 1: Select tool:
After deciding the objectives select the most appropriate Root cause analysis tools/Methods
Step 2: Collect data:
Data shall be collected on the basis of:
a. How many readings do we need?
b. Over what period should we collect the data?
c. How should we stratify the data?
d. What sampling or measurement methods should we use?
e. Who should collect the data, when should they collect it and that process should they collect it from?
Step 3: Analyze data using Root cause analysis tools/Methods:
In this step, we analyze the data using the tool selected in Step 2.
Procedure of carry out Root Cause Analysis:
Root cause Analysis is asking why the problem occurs. And then continuing to ask why that happens until we reach the fundamental process element that failed.
Step 4: Consider results & derive conclusions:
We shall consider the results of the previous step in conjunction with other information &experience and draw conclusions.
Step 5: Act
In this step, we shall take some specific action.

- Understood the situation for improvement of targets.
- We shall identified the cause of a problem to counter measures for prevent re-occurrence.
- Confirm the results & standardize.
- Found dispute by inspection
- Adjust the process to bring it within the control limits.

V. TOOLS/METHODS USED IN ROOT CAUSE ANALYSIS

- **Events and Causal Factor Charting**

This is a complicated process that first identifies a sequence of events and aligns the events with the conditions that caused them. These events and respective condition are aligned along a time line. Events and conditions that have evidence are shown in a solid line but evidence is not listed; all other observations are shown in dashed lines. After this representation of the problem is complete, an assessment is made by "walking" the chart and asking if the problem would be different if the events or conditions were changed. This leads to identifying causal factors such as training not adequate, management less than adequate, or barrier failed, which are identified by evaluating a tree diagram. Events and Causal Factor Charting can provide the time line to help discover the action causes, and is generally inefficient and ineffective because it mixes storytelling with conditional causes, thus it produces complicated relationships that are not necessarily causal and this only serves to add confusion rather than clarity. Instead of identifying the many causal relationships of a given event, events and causal factor charting resorts to categorizing the important causes as causal factors, which are then evaluated as solution candidates using the same method as the categorization schemes. Events and Causal Factor Charting does not follow the principles of cause and effect.

- **Change Analysis**

This is a six-step process that describes the event or problem, then describes the same situation without the problem, compares the two situations, documents all the differences, analyzes the differences, and identifies the consequences of the differences.The results of the change analysis identifies the cause of the change and will frequently be tied to the passage of time and, therefore, easily fits into an events and causal factors chart, showing when and what existed before, during, and after the change.Change analysis is nearly always used in conjunction with another RCA method to provide a specific cause, not necessarily a root cause.Change Analysis is a very good tool to help determine specific causes or causal elements, but it does not provide a clear

understanding of the causal relationships of a given event. Unfortunately, many people who use this method simply ask why the change occurred and fail to complete a comprehensive analysis.

- **Barrier Analysis**

This incident analysis identifies barriers used to protect a target from harm and analyzes the event to see if the barriers held, failed, or were compromised in some way by tracing the path to the threat from the harmful action to the target.Barrier analysis can provide an excellent tool for determining where to start your root cause analysis, but it is not a method for finding effective solutions because it does not identify why a barrier failed or was missing. This is beyond the scope of the barrier analysis. To determine root causes, the findings of the barrier analysis must be fed into a principle based method to discover why the barrier failed.

- **Storytelling**

This is not really a root cause analysis method but is often passed off as one, so it is included for completeness. It is the single most common incident investigation method and is used by nearly every business and government entity. It typically uses predefined forms that include problem definition, a description of the event, who made a mistake, and what is going to be done to prevent recurrence. There is often a short list of root causes to choose from so a Pareto chart can be created to show where most problems originate.

Also known as the fill-out-a-form method, storytelling should never be used to find effective solutions. The primary difficulty with this approach is that you are relying completely on the experience and judgment of the report authors in assuring that the recommended solutions connect to the causes of the problems. Because they do not know, let alone follow, the principles of causation, the authors often fail to find effective solutions.

The primary purpose of this method is to document the investigation findings and corrective actions. These forms usually do a good job of capturing the what, when, and where of the event, but little or no analysis occurs. Consequently, the corrective actions fail to prevent recurrence most of the time.

With such poor results, you might be wondering why organizations continue to use this method. The answer is two fold. First, most organizations do not measure the effectiveness of their corrective actions, so they don't know they are ineffective. Second, there is a false belief that everyone is a good problem solver, and all they need to do is document it on a form. For those organizations that recognize they are having repeat events, a more detailed form is often created that forces the users to follow a specified line of questions with the belief that an effective solution will emerge.

This is a false promise because the human thinking process cannot be reduced to a form. In our attempt to standardize the thinking process, we restrict our thinking to a predefined set of causes and solutions. The form tacitly signals the user to turn off their mind, fill in the blanks, and check the boxes. Because effective problem solving has been short circuited, the reports are incomplete and the problems keep occurring.

- **Fault Tree Analysis**

Fault Tree Analysis (FTA) is a quantitative causal diagram used to identify possible failures in a system. It is a common engineering tool used in the design stages of a project and works well to identify possible causal relationships.

It requires the use of specific data regarding known failure rates of components. Causal relationships can be identified with "and" and "or" relationships or various combinations thereof.

It is not normally used as a root cause analysis method, primarily because it does not work well when human actions are inserted as a cause. This is because the wide variance of possible human failure rates prevents accurate results. But it works extremely well at defining engineered systems and can be used to supplement an RCA in the following ways:

- Finding causes by reviewing the assumptions and design decisions made during the system's original design.
- Determining if certain causal scenarios are probable

- **Failure Modes and Effect Analysis**

Failure modes and effects analysis (FMEA) is similar to fault tree analysis in that it is primarily used in the design of engineered systems rather than root cause analysis. Like the name implies, it identifies a component, subjectively lists all the possible failures (modes) that could happen, and then makes an assessment of the consequences (effect) of each failure. Sometimes a relative score is given to how critical the failure mode is to the operability of the system or component. FMEA is sometimes used to find the cause of a component failure. Like many of the other tools discussed herein, it can be used to help you find a causal element within a Reality chart. However, it does not work well on systems or complex problems because it cannot show evidence-based causal relationships beyond the specific failure mode being analyzed.

VI. DIAGRAM AND CHARTS USED IN ROOT CAUSE ANALYSIS

- Pareto diagram

Description: a diagram which associated with undesirable events associated with items such as quality (c.g. number of defects or non- conforming products), productivity, cost, safety and so on arc stratified according to their causes or manifestations and plotted in order of importance.

Method of use: There may be a large number of undesirable phenomena or causes of trouble. The Pareto diagram makes it easy to see which of these have the most serious effect on quality, productivity, cost, safety etc., together with their relative proportions

Figure 1Example of Pareto diagram

- Graphs

Description: Diagrams for plotting data and showing temporal changes, Statistical breakdowns and relationships between different quantities.

Method of use: Used for organizing data. Use line graphs for showing time trends, bar graphs for comparing quantities and pie charts for showing relative proportions

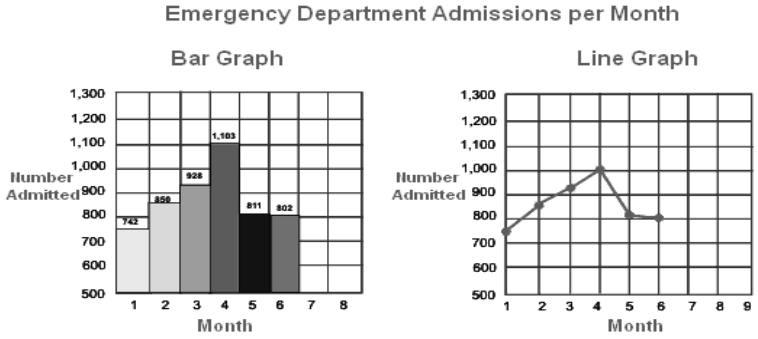

Figure 2 Examples of Graphs

- Check sheets

Description: Forms specially prepared to enable data to be collected simply by making check marks.

Method of use: Used for tallying the occurrences of the defects or causes being addressed and graphing of charting them directly.

- Histograms

Description: Prepared by dividing the data range into subgroups and counting the number of points in each subgroup. The number of points (the frequency) is then plotted as a height on the diagram.

Method of use: Prepare separate, stratified histograms for each of the 4Ms and examine the relationships between tile shapes of the distributions and the specifications.

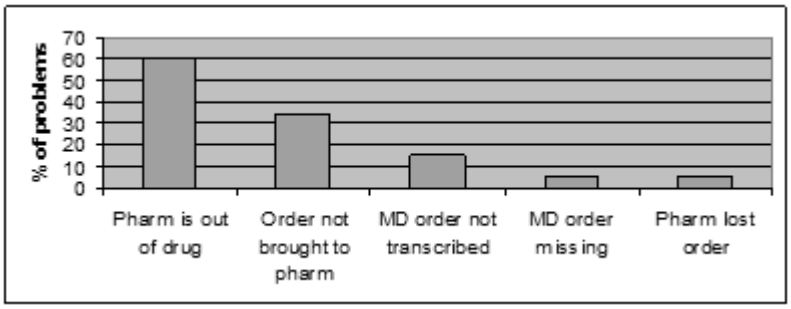

Figure 3 Examples of Histograms

- Scatter diagrams

Description: Prepared by plotting paired sets of data. If investigating dependence, set the independent variable on the x-axis and the dependent variable on the y-axis.

Method of use: Collect paired sets of data on causes and effects and use scatter diagrams to check for correlation between the sets of data.

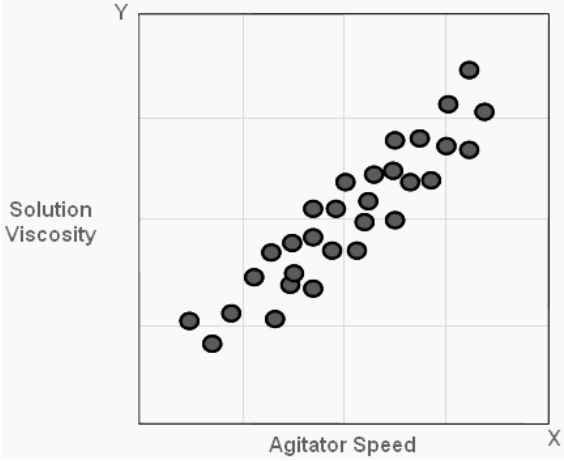

Figure 4 Examples of Scatter diagrams

- Control charts

Description: Prepared by plotting time along the horizontal axis and a characteristic value on the vertical axis. Unlike line graphs they also show the control limit lines.

Method of use: Use to check whether there are too many chronic detects, too much variation, values lying outside the control limits *or* undesirable trends or cycles. Control charts are used to assess whether a process is stable and in-control; not whether it is in-spec.

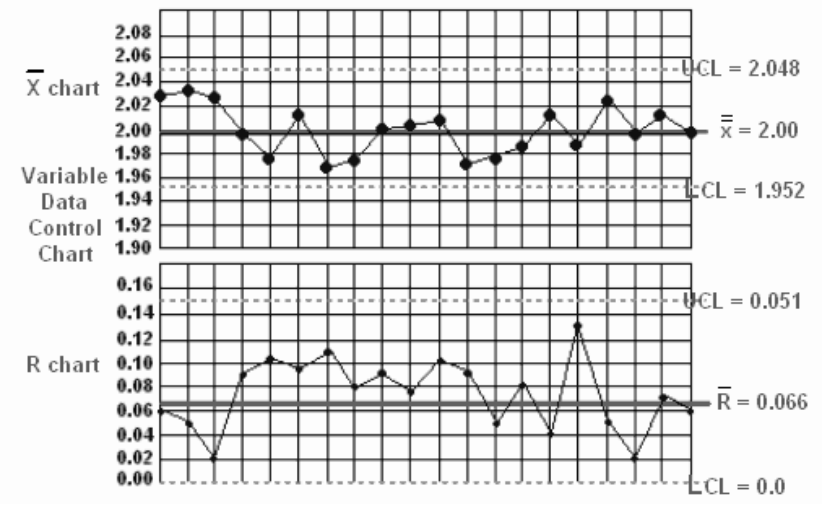

Figure 5 Examples of Control charts

VII. FISH BONE DIAGRAM –VERY COMMON TOOL USED IN ROOT CAUSE ANALYSIS

- **How to Use the Fishbone Tool for Root Cause Analysis**

Root cause analysis is a structured team process that assists in identifying underlying factors or causes of an adverse event or near-miss. Understanding the contributing factors or causes of a system failure can help develop actions that sustain the correction.

A cause and effect diagram, often called a "fishbone" diagram, can help in brainstorming to identify possible causes of a problem and in sorting ideas into useful categories. A fishbone diagram is a visual way to look at cause and effect. It is a more structured approach than some other tools available for brainstorming causes of a problem (e.g., the Five Whys tool). The problem or effect is displayed at the head or mouth of the fish. Possible contributing causes are listed on the smaller "bones" under various cause categories. A fishbone diagram can be helpful in identifying possible causes for a problem that might not otherwise be considered by directing the team to look at the categories and think of alternative causes. Include team members who have personal knowledge of the processes and systems involved in the problem or event to be investigated.

Directions:

The team using the fishbone diagram tool should carry out the steps listed below.

● Agree on the problem statement (also referred to as the effect). This is written at the mouth of the "fish." Be as clear and specific as you can about the problem. Beware of defining the problem in terms of a solution (e.g., we need more of something).

● Agree on the major categories of causes of the problem (written as branches from the main arrow). Major categories often include: equipment or supply factors, environmental factors, rules/policy/procedure factors, and people/staff factors.

● Brainstorm all the possible causes of the problem. Ask "Why does this happen?" As each idea is given, the facilitator writes the causal factor as a branch from the appropriate category (places it on the fishbone diagram). Causes can be written in several places if they relate to several categories.

● Again asks "Why does this happen?" about each cause. Write sub-causes branching off the cause branches.

● Continues to ask "Why?" and generate deeper levels of causes and continue organizing them under related causes or categories. This will help you to identify and then address root causes to prevent future problems.

Tips:

● Use the fishbone diagram tool to keep the team focused on the causes of the problem, rather than the symptoms.

● Consider drawing your fish on a flip chart or large dry erase board.

● Make sure to leave enough space between the major categories on the diagram so that you can add minor detailed causes later.

● When you are brainstorming causes, consider having team members write each cause on sticky notes, going around the group asking each person for one cause. Continue going through the rounds, getting more causes, until all ideas are exhausted.

● Encourage each person to participate in the brainstorming activity and to voice their own opinions.

● Note that the "five-whys" technique is often used in conjunction with the fishbone diagram – keep asking why until you get to the root cause.

● To help identify the root causes from all the ideas generated, consider a multi-voting technique such as having each team member identify the top three root causes. Ask each team member to place three tally marks or colored sticky dots on the fishbone next to what they believe are the root causes that could potentially be addressed.

The root causes of the event are the underlying process and system problems that allowed the contributing factors to culminate in a harmful event. As this example illustrates, there can be more than one root cause. Once you have identified root causes and contributing factors, you will then need to address each root cause and contributing factor as appropriate. For additional guidance on following up on your fishbone diagram findings, see the Guidance for Performing RCA with Performance Improvement Projects tool.

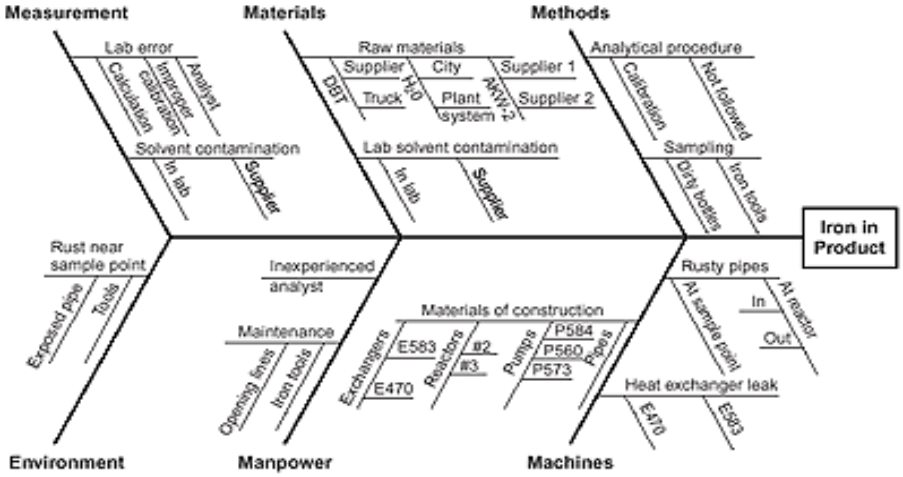

Figure 6 Fishbone Diagram

VIII. CONCLUSION

To be effective, root cause analysis must be performed systematically, usually as part of an investigation, with conclusions and root causes that are identified backed up by documented evidence. Usually a team effort is required. Aiming performance improvement measures at root causes is more effective than merely treating the symptoms of a problem. To be effective, RCA must be performed systematically, with conclusions and causes backed up by documented evidence. There is usually more than one root cause for any given problem. To be effective the analysis must establish all known causal relationships between the root cause(s) and the defined problem

IX. Appendix

Root Cause Analysis Template

Root Cause Analysis for <Project name>

Section 1. Symptoms

In this section list all the points of pain that have led to this project request. Knowing this enables you and your team to prioritize project goals and determine what the scope of the project will be given your time limits, skills, and other relevant constraints.

- A symptom is a point of pain for users.
- List all the complaints from your team, clients, other users, and your own observations.
- Do not include underlying system problems here—those go in the next section.
- If your team is proposing a new system that is an opportunity to improve services or take advantage of an opportunity to make money, then your symptoms should be what is lacking or a cause of dissatisfaction with an existing system or a competitor.

Section 2. Problem Chain

In this section list all the problems associated with each of the symptoms above. A series of problems underlying symptoms is called a problem chain.

- List all the problems that are the likely cause of each of the symptoms above.
- Symptom 1 Xxxxxxxxx
    - Problem a
    - Problem b
    - Problem c
    - Etc.

- List at least one underlying problem for each symptom.
- Group symptoms when an underlying problem is the likely cause of several symptoms.
- Symptom 1, Symptom 3 & Symptom 4
  - Problem b
  - Problem c
  - Problem f

NOTE: Remember to ask "Why" after identifying each symptom. This will enable you to determine if there is another symptom or if you have found the root cause.

Section 3. Root Cause(s)

- List the major causes that underlie the problems above.
- Depending on your situation there may be one or more root causes.
- List all the root causes you consider viable as a basis for discussion with your clients

Section 4. Summary of Potential Solutions

List all potential solutions to the root cause, problems you identified in Section 3.

- Will you be replacing a manual system with an automated system?
- Will you create a new system?
- Will you up-grade an existing system?

Section 5a.Your System Solution 1

For each potential solution listed in Section 4 make a bulleted list of the associated general objectives and performance criteria. Whether you include constraints for each of your solutions, as shown belowor a single final section on constraints depends on your situation. If the constraints apply to all of your suggested solutions, the single section on constraints makes more sense than repeating the same constraints for every single solution.

- Objectives for Solution 1
  - Xxxxxxx
  - Xxxxxxxx
  - Xxxxxxxx
  - Etc.
- Measurable Performance Criteria for Solution 1
  - Xxxxxxx
  - Xxxxxxxx
  - Xxxxxxxx
  - Etc.
- Constraints for Solution 1
  - Xxxxxxx
  - Xxxxxxxx
  - Xxxxxxxx
  - Etc.

NOTE: Collaborate with your team to develop this list. Doing so should lead to a clear consensus about the project scope. This will enable a clear understanding of the time and skill constraints associated with your project.

Section 5b.Your System Solution 2 (if you suggest more than 1)

For your 2nd potential solution, listed in Section 4, make a bulleted list of the objectives and measurable performance criteria.

- Objectives for Solution 2
  - Xxxxxxx
  - Xxxxxxxx
  - Etc.
- Measurable Performance Criteria for Solution 2

- Xxxxxxx
- Xxxxxxxx
- Etc.

- Constraints for Solution 2
  - Xxxxxxx
  - Xxxxxxxx
  - Etc.

NOTE: Again, collaborate with your team to develop this list.

Section 6. Constraints

Constraints will limit your scope. If they are different for each potential solution, then include your constraints in each of the 5x sections. If they are the same for all solutions, list them here, rather than repeat the same constraints in the above format.

- Constraints for all Solutions
  - Xxxxxxx
  - Xxxxxxxx
  - Etc.

NOTE: Collaborating early and often with your team enables informed decision-making and sets reasonable project expectations.

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