**Educational Objective 1**

Describe root cause analysis and the steps in the root cause analysis process.

**Key Words and Phrases Root cause**

Root cause analysis (RCA)

Causal factors

**Review Questions**

* 1. Identify the purpose of root cause analysis.
  2. Identify the four basic characteristics of root causes.
  3. Identify the sources of organizational causes of loss.
  4. Identify the five broadly defined root cause analysis approaches.
  5. Identify the purpose of casual factors charting.

**Educational Objective 2**

Explain how an organization can use failure mode and effects analysis (FMEA) to assess and mitigate risk.

**Key Words and Phrases**

Failure mode and effects analysis (FMEA)

Failure mode

Effects analysis

Indenture Level

Local Effect

Next-higher-level effect

End Effect

Criticality analysis

Risk priority number (RPN)

Criticality

Fault tree analysis (FTA)

**Review Questions**

2-1. Identify the outputs of failure mode and effects analysis (FMEA).

2-2. Identify the steps in the FMEA process.

2-3. Identify examples of types of FMEA.

2-4. Identify the components of a risk priority number.

2-5. Identify the advantages of using FMEA.

2-6. Identify the disadvantages of using FMEA.

**Educational Objective 3**

Explain how an organization can use fault tree analysis (FTA) to determine the causes of a risk event.

**Review Questions**

3-1. Identify the goals of fault tree analysis.

3-2. Identify the function of a fault tree's gates.

3-3. Identify the function of a fault tree's rectangles.

3-4. Explain what an "or" gate signifies.

3-5. Identify the characteristics of a fault tree that encourage sound loss control decisions.

3-6. Identify the limitations of fault tree analysis.

**Educational Objective 4**

Explain how an organization can use a "5 Whys" analysis and fishbone (Ishikawa) diagram to determine the causes of a risk event.

**Review Questions**

4-1. Describe a "5 Whys" analysis.

4-2. Identify the steps in a 5 Whys analysis.

4-3. Identify the advantages of a 5 Whys analysis.

4-4. Identify the disadvantages of a 5 Whys analysis.

4-5. Identify the categories included in the 6 Ms group of categories.

4-6. Identify the steps in developing a fishbone diagram.

**Answers to Assignment 2 Questions**

NOTE: These answers are provided to give students a basic understanding of acceptable types of responses. They often are not the only valid answers and are not intended to provide an exhaustive response to the questions.

**Educational Objective 1**

* 1. The purpose of root cause analysis is to determine the underlying cause of a harmful event.

1-2. These are the four basic characteristics of root causes:

• A root cause is expressed as a specific underlying cause, not as a generalization.

• A root cause can be reasonably identified.

• A root cause must be expressed as something that can be modified.

• A root cause must produce effective recommendations for prevention of future accidents that stem from the root cause.

1-3. Organizational causes of loss stem from faulty systems, processes, or policies (such as procedures that do not make it clear which maintenance employee is responsible for checking and maintain­ing the manufacturer's production line).

1-4. These are the five broadly defined root cause analysis approaches:

• Safety-based

• Production-based

• Process-based

• Failure-based

• Systems-based

1-5. The purpose of causal factors charting is to provide the structure to organize and analyze the data gathered during the investigation. It also helps to identify gaps and deficiencies in knowledge as the investigation progresses.

**Educational Objective 2**

2-1. These are the outputs of failure mode and effects analysis (FMEA):

• Improvement in the design of procedures and processes

• Minimization or elimination of design characteristics that contribute to failure

• Development of system requirements that reduce the likelihood of failures

• Identification of human error modes and their effects

• Development of systems to track and manage potential future design problems

2-2. These are the steps in the FMEA process:

• Define FMEA study in scope and objective(s)

• Assemble team to perform FMEA

• Break down system into components

• Define function of each component

• For each component listed, identify the way each part could conceivably fail, the mechanism that might produce those failure modes, the effect if failure occurs, the extent of failure, and when/how failure is detected

• Develop provisions in design to compensate for failure

2-3. These are examples of types of FMEA:

• Concept

• Design

• Process

• Equipment

• Service

• System

• Software

2-4. These are the components of a risk priority number:

• Consequence rankings

• Occurrence rankings

• Detection rankings

2-5. These are the advantages of using FMEA:

• It is widely applicable to human, equipment, and system failure modes and to hardware and software procedures.

• When used early in the design phase, it can reduce costly equipment modifications.

• It can improve the quality, reliability, and safety of a product or process, as well as improve an organization's image and competitiveness by possibly reducing scrap in production.

• It emphasizes problem prevention by identifying problems early in the process and eliminating potential failure modes.

2-6. These are the disadvantages of using FMEA:

• When used as a top-down tool, FMEA may only identify major failure modes in a system.

• Other analysis methods might be better suited for this type of analysis. When used as a bot­tom-up tool, it can complement other methods, such as fault tree analysis, and identify more failure modes resulting in top-level symptoms.

• Analyzing complex multilayered systems can be difficult and tedious with FMEA, and studies that are not adequately controlled and focused can be time-consuming and costly.

**Educational Objective 3**

3-1. The goals of fault tree analysis are to examine the conditions that may have led to or influenced a

risk event, identify potential accidents, and predict the most likely system failures.

3-2. The function of a fault tree's gates is to represent the causal relationships between events.

3-3. The function of a fault tree's rectangles is to depict events.

3-4. An "or" gate signifies that any one of the events leading to the gate is sufficient to cause that

event.

3-5. To encourage sound loss control decisions, a fault tree must be as complete and accurate as possible. An incomplete fault tree may entirely omit a chain of events that would make loss control measures applied to some other tree branch ineffective.

3-6. These are the limitations of fault tree analysis:

• If a high degree of certainty does not exist concerning the probabilities of the underlying or base events, the probability of the top event may also be uncertain.

• Important pathways to the top event might not be explored if all causal events are not in­cluded in the fault tree.

• Because a fault tree is static, it may need to be reconstructed in the future if circumstances or procedures change.

• Human error is difficult to characterize in a fault tree.

• "Domino effects" or conditional failures are not easily included in a fault tree.

**Educational Objective 4**

4-1. A 5 Whys analysis is a specific root cause analysis technique used primarily for problems involving human factors, such as lack of managerial oversight.

4-2. These are the steps in a 5 Whys analysis:

• The specific problem under investigation is described completely.

• The investigator asks why that particular problem occurred and determines the answer.

• If the answer does not reveal the problem's root cause, the investigator determines why the problem embodied by the determination made in Step 2 occurred.

• The investigator repeats the previous two steps until the root cause of the original problem has been determined.

4-3. These are the advantages of a 5 Whys analysis:

• It can determine the root cause of a problem.

• When several root causes are found, it can help determine the relationship among them.

• It usually does not require statistical analysis or data collection.

4-4. These are the disadvantages of a 5 Whys analysis:

• Investigators tend to stop the analysis after the first determination rather than asking additional questions to discover a problem's root cause.

• Investigators tend to focus on only one answer to each question.

• Organizations sometimes do not help the investigator ask the right why questions.

• An uninformed investigator cannot ask relevant questions.

• Different investigators will discover different causes for the same problem.

4-5. These are the categories included in the 6 Ms group of categories:

• Machine (technology)

• Method (process)

• Materials

• Manpower (physical work)/mind power (brain work)

• Measurement (inspection)

• Milieu/Mother Nature (environment)

4-6. These are the steps in developing a fishbone diagram:

• Team agrees on a problem statement.

• Facilitator writes statement on the far-right-hand side of the diagram, draws a box or circle around it, and draws a horizontal arrow across the center of the page that points to the state­ment.

• Team brainstorms the major categories of causes of the problem.

• Facilitator depicts the categories of causes as branches emanating from the main arrow.

• Team members brainstorm possible specific causes of the problem, using techniques such as the 5 Whys analysis.

• Facilitator writes each specific cause as a branch from the appropriate category. Causes can be assigned to any category to which they relate.

• For each of the specific causes listed in the previous step, the team again asks, "Why did this happen?" The facilitator writes the sub-causes as branches from the causes. The team contin­ues to ask why to generate deeper levels of causes. As the layers of branches are drawn on the diagram, causal relationships are revealed.

• Before moving to the final step, the team should focus on areas of the diagram with the fewest ideas.

• Once the team has determined the root cause(s), remedies are developed and implemented to prevent recurrence of the problem described in the original statement.