Failure Mode and Effect Analysis (FMEA)

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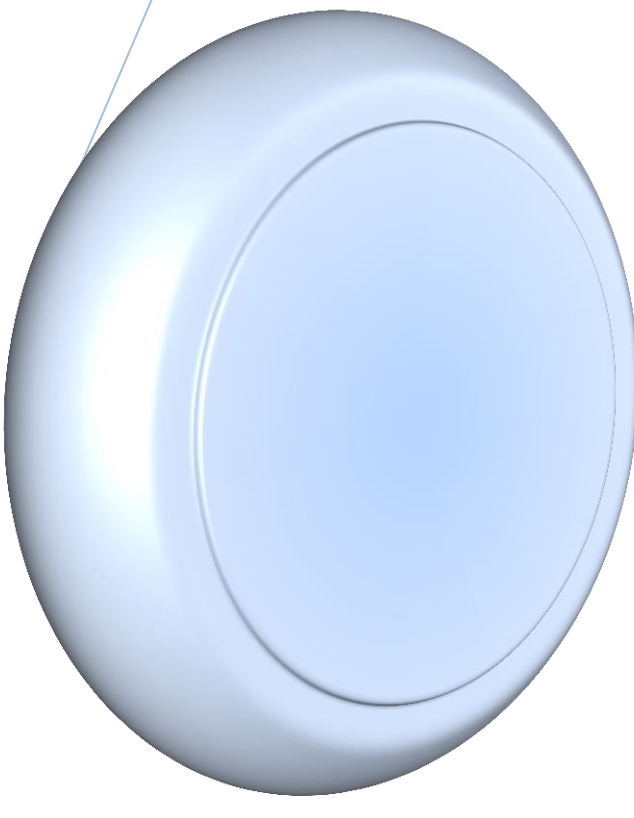


Introduction

Failure is a state or condition of a system, process or product not meeting a desirable or intended objective. It is the termination of the ability of a system or product in performing its required purpose, with an overall effect on the users.

Failure mode refers to the means or ways in which a system, process or product might fail. **Effect analysis** is the decomposition of those failures into components or segments for careful examination. Altogether, **Failure Mode and Effect Analysis (FMEA),** refers to a step-wise approach in systematically analyzing all component failures in systems, methods, processes and products, and identifying the resulting effect on the system, process and/or product, which have an overall impact on the end users, with the sole aim of proffering workable solutions to them.

FMEA is used in design process to forecast and build-in failure resistance in processes and systems. It is a living document of knowledge and actions relating to failure risks for use in continuous process and/or system improvement.

Failure Mode and Effect Analysis (FMEA) takes into account the seriousness of failures and how frequently they occur. Thus, it works to eliminate or reduce failures, starting with the most urgent. It is most effectively applied before failure occurs.

Classification of Failure Mode and Effect Analysis (FMEA)

Failure Mode and Effect Analysis (FMEA) can be broadly classified as Design FMEA and Process FMEA.

- **Design Failure Mode and Effect Analysis (DFMEA)**

This deals with the possibility of failures of products with consequent impact on safety and the environment. DFMEA entails building failure resistance into the system at the design stage. This involves considering factors such as material properties, noise level, components and subcomponents interaction, geometry etc.

- **Process Failure Mode and Effect Analysis (PFMEA)**

PFMEA explores possible failure in processes with consequent effects on reliability of process, customer satisfaction level, and safety hazards. This requires considering factors such as manufacturing procedures, methods of process operation, human and environmental factors, accuracy of measurements, conditions of equipment.

Importance of Failure Mode and Effect Analysis

The major importance of implementing failure mode and effect analysis includes the following;

1. Presents options for assessing and dealing with risks of failure.
2. Provides a basis for assessing performance levels and fault-detection mechanism.
3. Acts as an effective mechanism of evaluating failure effect on human safety and environment.
4. Serves to provide improvement to system design and process operation.
5. It enhances product and process reliability.
6. Increases overall satisfaction of users of products.

When to Perform Failure Mode and Effect Analysis (FMEA)

The FMEA document is an essential document throughout the design stage of a product and operation of processes. It is very important to ensure that reliability is consistently evaluated and improved when performing FMEA.

The following timings are especially important when performing FMEA.

1. During design of new products or processes.
2. When redefining the functions of an already existing product.
3. During modification of an already existing product or process.
4. When customer satisfaction is not fully met as indicated by their feedback.
5. When new policies and regulations are instituted or existing regulations are modified by regulatory bodies.

General Procedures for Implementing FMEA

Although the implementation of FMEA depends on the nature of industry, this general steps are required and could be tailored to a specific industrial application. These steps include:

- **Product/Process Description**

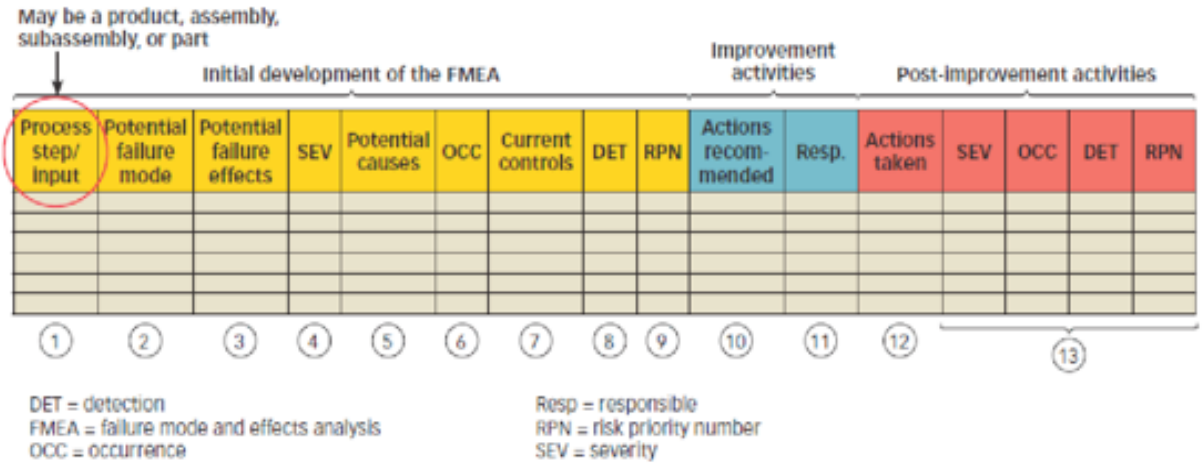
This involves understanding the product or process being considered. This helps the process owner or engineer identify products and processes that falls within the function intended and those that fall outside.

- **Block Flowchart Creation**

A block diagram of the product or process is next developed. This shows how the process steps or components are connected.

- **Function Identification**

The function of the product or process is clearly and accurately identified. Questions about the purpose of the products or processes are asked.



- **Failure Modes Identification**

This involves listing ways in which failure could occur. Examples of these modes include cracking, breakage, deformation, rusting etc.

- **Consequence Identification**

What are the effects of failure on the overall products and/or systems and related processes, the environment and users? What happens when the failure occur? These questions should be asked by the process engineer to enhance better preparation. Examples of failure effect include excessive sound (noise), inappropriate odor, degraded performance etc.

- **Determination of the Effect of Seriousness**

This is termed as the Severity rating (S), usually rated on a scale from 1 to 10, where 1 represents insignificance and 10 shows catastrophic effect. This enables the process engineer to prioritize the failures and work on the main issues first.

- **Cause Determination**

The potential causes of each failure mode are next determined. Failure cause may be defined as a weakness in design that may result in a failure. The potential root causes for each mode should be determined and documented. These causes include incorrect algorithms, overloading, inappropriate operating conditions, contamination etc.

- **Occurrence Rating (O) Determination**

This estimates the likelihood of failure occurring during the lifetime of the product or process. It is rated on a scale of 1 to 10. 1 represents extreme unlikeliness and 10 indicates that failure will definitely occur.

- **Control Measure Identification**

This involves identifying procedures, mechanisms or methods in place that helps prevent failure from reaching the users. These measures may either prevent the cause from occurring or reduce the effect before getting to the users of the product.

- **Determination of the Detection Rating (D)**

This rating describes how effective the controls can detect the cause of failure or failure mode after occurrence but before the user is affected. It is rated on a scale of 1 to 10, with 1 representing control absolutely certain to detect the problem and 10 representing control certainly not going to detect the problem.

- **Risk Priority Number (RPN) Calculation**

This is calculated as Severity (S) multiplied by Occurrence (O) and Detection (D)**RPN = S x O x D** This number helps the process engineer to provide guidance to potential failure, ranking in the order that they should be addressed.

- **Identification of Recommended Actions**

These actions may include designs or changes in process steps to lower severity or occurrence.

- **Assigning Responsibility and Deadlines**

This is done to enhance tracking of progress and speed of delivery.

- **Results Determination**

As the actions are taken, the dates of application of actions and results achieved should be noted. The RPN, Severity (S), Occurrence (O) and Detection (D) should be filled appropriately.

- **Re-assessment**

Regular re-assessment of the RPN, Severity (S), Occurrence (O) and Detection (D) should be noted.

About the Author

Olanrewaju, Adebayo Bamidele *is a Lead Auditor of ISO 9001, FSSC 22000 / ISO 22000, 14001, 45001, Certified Six Sigma Master Black Belt (CSSMBB), process engineer, and quality management professional with strong working experience and proven skills in manufacturing excellence, ISO management systems implementation, lean / digital manufacturing, and project management. He is an author of over 15 books and has published over 45 online courses on various e-learning platforms including Udemy, Alison, Learndesk & Study Plex.*

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