Problem Definition & Design Thinking

Title: Root Cause Analysis for Equipment Failures

Problem Statement

In spite of standard maintenance practices, equipment breakdowns in manufacturing, energy, and process industries continue to occur unexpectedly—resulting in downtime, safety risks, and delays in production. Conventional troubleshooting methods often address only the visible symptoms (e.g., replacing faulty parts), rather than identifying and eliminating the true root causes.

A **Root Cause Analysis (RCA)** methodology enables organizations to systematically investigate failures by analyzing human, mechanical, procedural, and environmental factors. The central challenge is:

> **"How can a structured RCA framework be applied to accurately identify, analyze, and eliminate the root causes of equipment failures—ensuring long-term reliability, operational efficiency, and sustainable cost reduction?"**

Target Audience

- **Maintenance Engineers & Technicians** – Need structured tools to properly diagnose and resolve failures.
- **Operations Managers** – Aim to reduce unexpected downtime and optimize performance.
- **Reliability Engineers** – Focus on maximizing equipment performance and life cycle.
- **Safety Officers** – Seek to eliminate risks related to equipment malfunctions.
- **Plant Managers & Decision-Makers** – Demand cost-effective, long-term reliability strategies.

Objectives

- **Identify Root Causes** – Go beyond superficial symptoms to uncover the actual causes, whether related to design, process, or human behavior.
- **Prevent Recurrence** – Implement corrective actions that eliminate repeat failures.
- **Optimize Maintenance** – Transition from reactive to predictive and preventive maintenance.

- **Enhance Safety & Compliance** – Minimize hazards associated with equipment failure.

- **Reduce Operational Costs** – Cut maintenance expenses and extend equipment life.

Design Thinking Approach

Empathize

A common issue in today's industries is the use of short-term fixes due to time pressure, lack of RCA training, or poor documentation. Technicians and engineers often face recurring failures without lasting solutions, leading to inefficiency and frustration.

> **Empathy-based insights reveal the need for a simple, reliable, and data-driven RCA system that promotes repeatable problem-solving and preserves organizational knowledge.**

Key User Concerns

- **Accuracy & Trust** – Are RCA results dependable or just assumptions?

- **Complexity & Time** – Is the process too technical or time-consuming?

- **Resistance to Change** – Will teams adopt RCA or revert to "quick fixes"?

- **Data Availability** – Is failure history readily accessible and reliable?

- **Organizational Support** – Will management invest in training and tools?

- **Actionability** – Do RCA findings lead to real, sustainable solutions?

Define

The proposed solution must offer:

- A **step-by-step RCA process** using recognized tools (e.g., 5 Whys, Fishbone Diagrams, Fault Tree Analysis)

- **Collaboration tools** for cross-functional teamwork

- **Real-time integration** with IoT sensor data and maintenance records

- **User-friendly reporting dashboards** that present clear insights and KPIs

- A **central knowledge base** of failure cases and solutions

- **Visibility for managers** through dashboards showing RCA impact and ROI

Ideate

Potential solutions may include:

- **AI-powered RCA systems** that suggest likely root causes using failure history and patterns
- **Guided RCA templates** to ensure consistent analysis
- **IoT-integrated platforms** to detect anomalies early
- **AR support tools** to aid technicians in real-time diagnostics
- **Predictive analytics** to forecast and prevent future failures

Brainstormed Features

- Auto-generated RCA reports with cause and action summaries
- Mobile apps for on-site failure entry and analysis
- Gamified RCA training to increase adoption
- Real-time collaboration features across departments
- A searchable database of past incidents and corrective actions

Prototype

A **Smart RCA Assistant Tool** will be developed to:

- Capture failure data (machine, symptoms, environment)
- Provide AI-driven root cause suggestions
- Guide users through RCA techniques like 5 Whys and Fishbone
- Track corrective actions and results
- Visualize performance impact through interactive dashboards

Key Components

- A database of historical faults and causes
- AI engine for mapping symptoms to causes
- Intuitive, visual RCA workflows

- Task tracking and follow-up system
- ROI and downtime reduction tracking dashboard

Test

The tool will be piloted by maintenance teams, reliability engineers, and plant managers using real case scenarios.

Testing Objectives

- Validate the **accuracy** of AI-based root cause suggestions
- Assess **ease of use** for technicians and engineers in the field
- Measure reduction in **repeat failures**
- Compare **efficiency** with traditional RCA methods
- Evaluate **integration** with existing CMMS and ERP tools