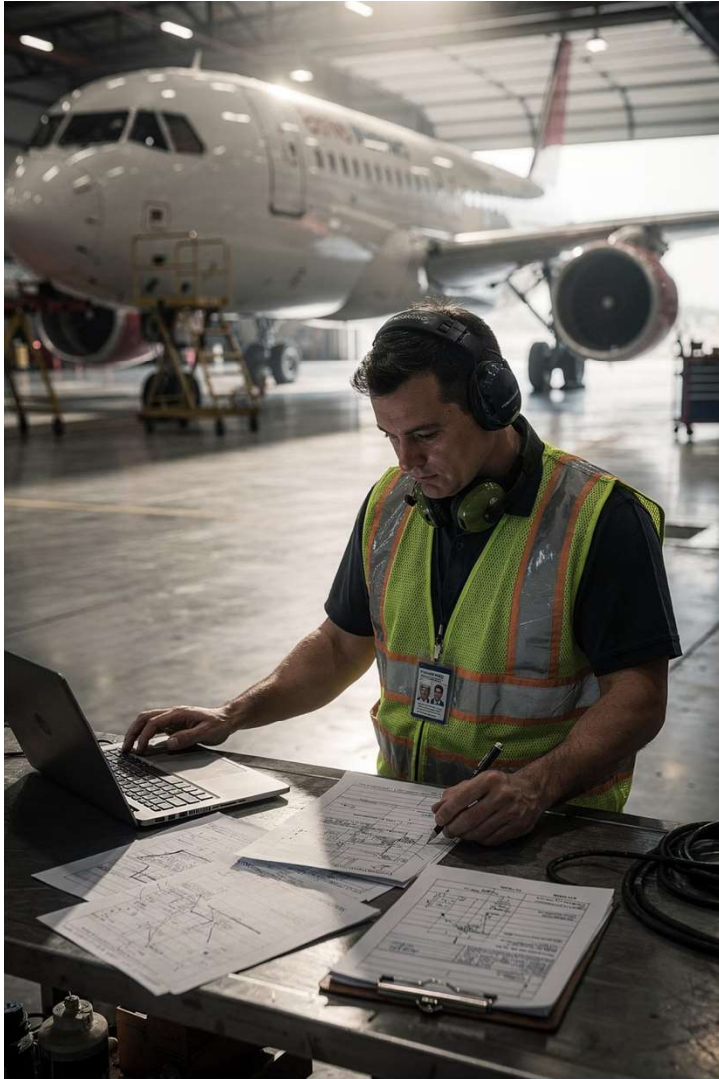




Root Cause Analysis Methods in Aviation

A comprehensive guide to the well-established RCA methods used to determine the root cause of occurrences, accidents, incidents, audit findings, safety events, and operational problems. In aviation, the choice of method depends on the complexity of the issue.

AVIATION SAFETY

SMS INVESTIGATIONS

1. The 5 Whys Method

The simplest and most widely used RCA technique — ask "Why?" repeatedly (usually five times) until the underlying cause is identified.

Example: Incorrect Load Sheet

- Why? → Load sheet calculated incorrectly
- Why? → Dispatcher entered wrong passenger count
- Why? → Reconciliation procedure not followed
- Why? → Dispatcher not trained on new process
- Why? → Training program excluded dispatch personnel

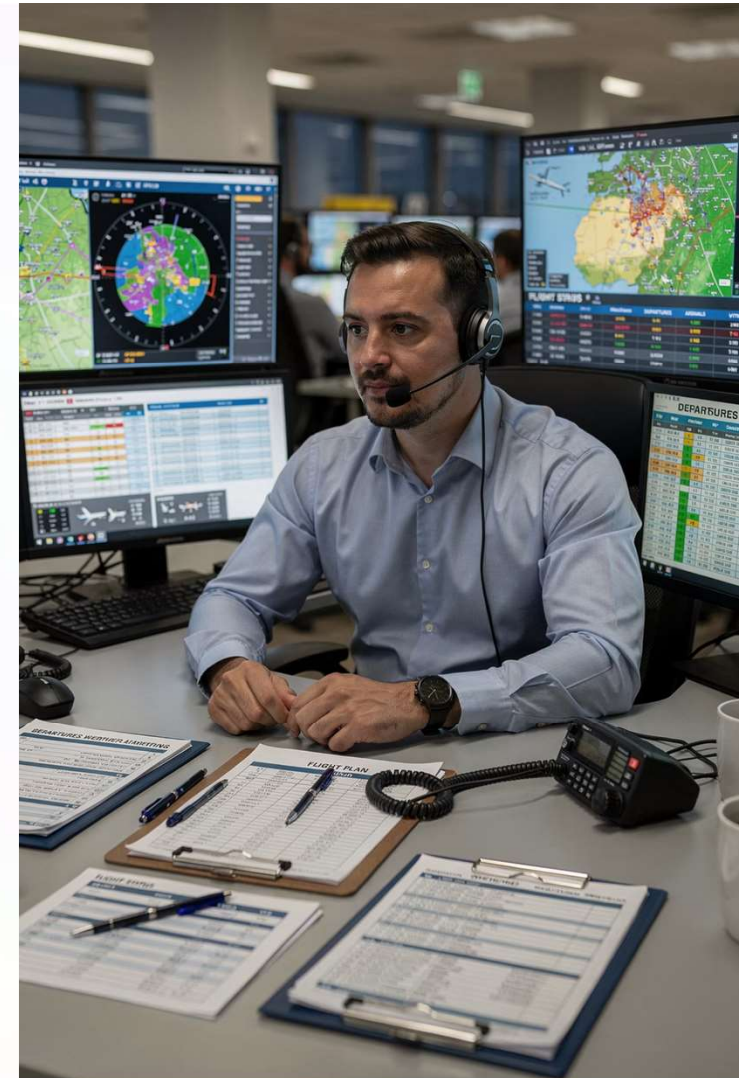
Root Cause: Inadequate change management and training process.

Advantages

- Simple, fast, and easy to use during investigations
- Suitable for small and medium-sized events

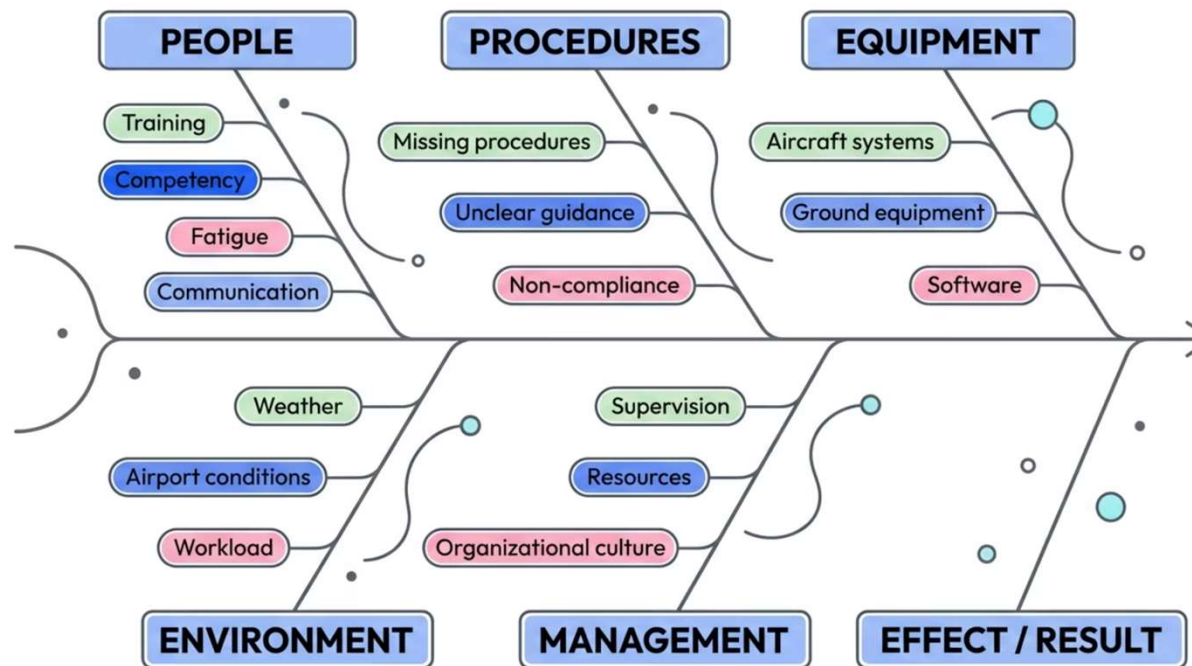
Limitations

- Can oversimplify complex events
- Depends heavily on investigator experience



2. Fishbone Diagram (Ishikawa / Cause-and-Effect)

Used to systematically identify all possible contributing factors. Frequently used in SMS investigations, it is excellent for brainstorming and helps identify multiple contributing causes.



3. Fault Tree Analysis (FTA)

A **top-down logical method** that starts with the undesired event and works backward using logical AND/OR gates to determine combinations of failures.

Example: Runway Excursion

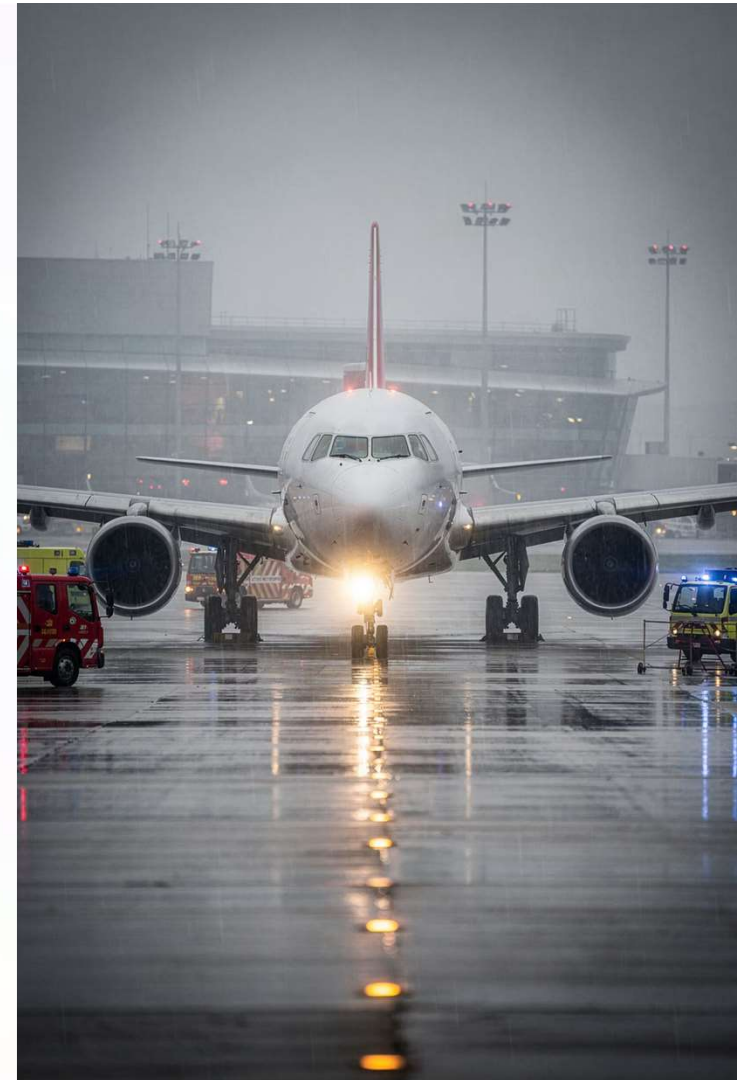
- Unstable approach
- Wet runway
- Incorrect braking action report
- Crew decision-making

Advantages

- Very effective for complex technical events
- Quantifies risk pathways

Common Use

- Engineering investigations
- Aircraft system failures
- Safety risk assessments



4. Barrier Analysis

One of the most useful methods in aviation SMS. The investigator examines what hazard existed, what barriers should have prevented the event, which barriers failed, and why they failed. Directly linked to Safety Management Systems and helps identify corrective actions.

Example: Bird Strike

Hazard: Bird strike

Barriers: Bird control program, wildlife monitoring, pilot reporting

Failed Barrier: Wildlife inspection not conducted

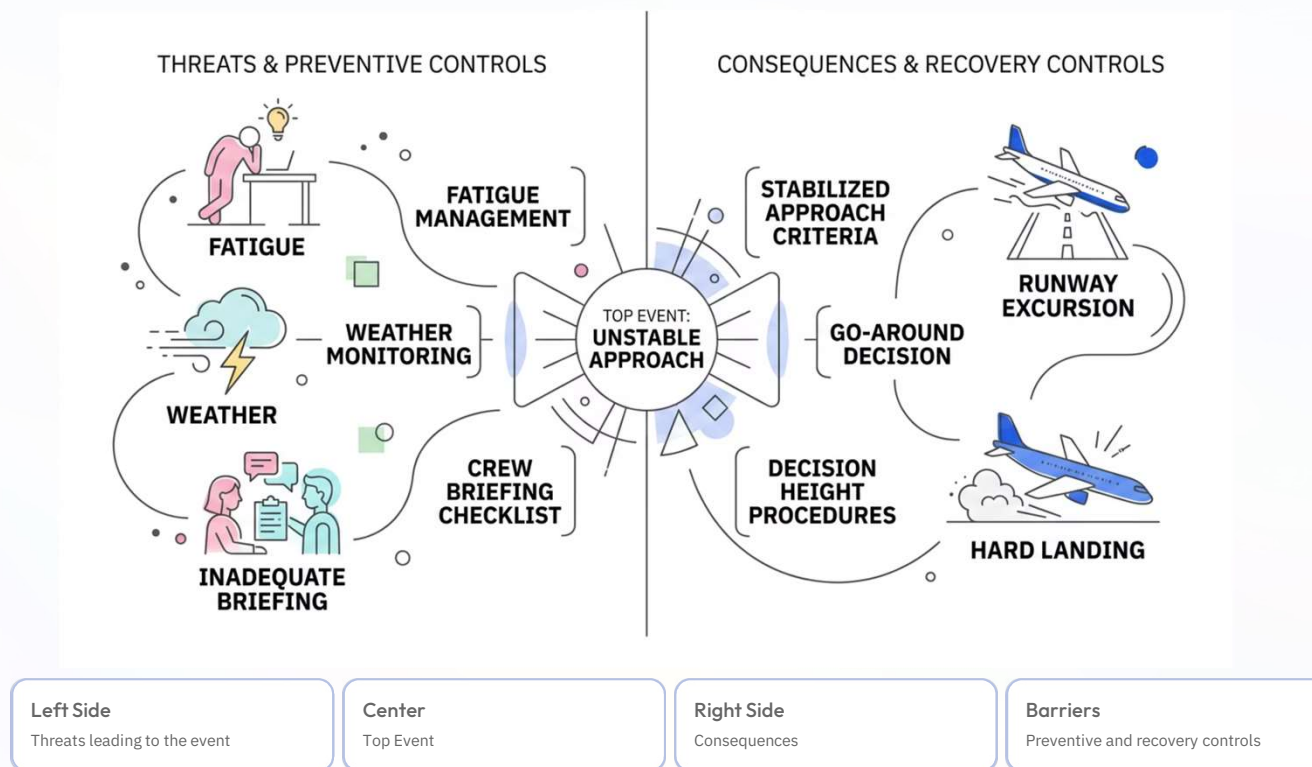
Root Cause: Lack of resources and supervision

Key Questions

- What hazard existed?
- What barriers should have prevented the event?
- Which barriers failed?
- Why did they fail?

5. Bow Tie Analysis

Very popular in modern aviation safety management. An **excellent visual tool** that links threats, a top event, and consequences while identifying both preventive and recovery controls. Directly supports risk management.



6–8. HFACS, TapRoot® & Event Charting



HFACS (Human Factors)

Based on James Reason's work. Investigates **unsafe acts** (errors, violations), **preconditions** (fatigue, stress), **supervision**, and **organizational influences**. Widely used by airlines and military operators for human performance events.



TapRoot® Method

A structured commercial RCA system covering human factors, procedures, equipment, training, and management systems. Comprehensive and produces defensible investigations. **Limitation:** Requires training and licensing.



Event & Causal Factor Charting

Creates a timeline of what happened, when, and why. Example: Maintenance error → Inspection missed → Defect undetected → Aircraft dispatch → Event. Excellent for complex investigations and accident inquiries.

Which Methods Are Most Used in Airlines?

For airline SMS investigations, the most effective approach is matching the method to the investigation type:

Investigation Type	Recommended Method
Minor occurrence	5 Whys
Internal audit finding	5 Whys + Fishbone
Safety report	Barrier Analysis
Human factors event	HFACS
Complex operational event	Event & Causal Factor Chart
Risk management	Bow Tie
Technical failure	Fault Tree Analysis
Serious incident	Combination of all applicable methods

Recommendation

For a start-up airline, adopting the following four core methods will cover approximately **90% of investigations and safety analyses** typically required by an airline SMS, aligning well with ICAO and IOSA expectations.



Bow Tie Analysis

Risk management and hazard assessments



Barrier Analysis

SMS investigations



Fishbone Diagram

Structured analysis



5 Whys

Simple investigations



Key Takeaways



Match Method to Complexity

Simple events need simple tools.
Complex events require structured, multi-method approaches.



Four Core Methods

5 Whys, Fishbone, Barrier Analysis, and Bow Tie cover ~90% of airline SMS needs.



ICAO & IOSA Aligned

The recommended framework aligns with international aviation safety standards and regulatory expectations.



A well-implemented RCA program is the foundation of a proactive Safety Management System — turning every event into an opportunity for improvement.