

Developing an Incident Causation and Corrective Action Framework through Real Industrial Case Studies

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Abstract

Industrial accidents continue to pose serious challenges to occupational health and safety despite significant technological advancements and regulatory improvements. Conventional accident investigation methods often focus on immediate causes while overlooking latent organizational failures and systemic deficiencies. This study develops an integrated Root Cause Analysis (RCA) and Corrective Action Framework based on real industrial accident case studies collected from manufacturing, construction, oil & gas, chemical processing, and power generation industries. The proposed framework integrates the Swiss Cheese Model, Human Factors Analysis and Classification System (HFACS), Bow-Tie Analysis, and the Plan-Do-Check-Act (PDCA) cycle into a unified accident management methodology. Five representative industrial accidents were analyzed using Root Cause Analysis (RCA), Five Why Analysis, Fault Tree Analysis (FTA), and Bow-Tie techniques. Results indicate that over 80% of incidents involved organizational failures, inadequate supervision, poor safety culture, and ineffective risk communication rather than purely technical failures. The developed framework demonstrates significant potential for reducing accident recurrence through systematic investigation, corrective action prioritization, continuous monitoring, and organizational learning. The study contributes a practical and scalable framework suitable for implementation across high-risk industries.

Keywords: Industrial Accident Investigation, Root Cause Analysis, Corrective Action, Occupational Safety, Human Factors, Safety Management System, Risk Management.

Introduction

Industrial sectors such as manufacturing, petrochemicals, construction, mining, power generation, and transportation experience thousands of occupational accidents annually. According to the International Labour Organization (ILO), approximately **2.9 million workers die annually due to work-related accidents and occupational diseases**, while over **395 million non-fatal occupational injuries** occur every year. These incidents result in enormous financial losses, environmental damage, production interruptions, legal liabilities, and reputational harm.

Although industries invest heavily in safety management systems such as ISO 45001, OSHA Process Safety Management (PSM), and Behaviour-Based Safety (BBS), accident recurrence remains common because investigations frequently emphasize immediate technical failures while neglecting underlying organizational causes. Studies suggest that nearly **80–90% of industrial accidents involve human and organizational factors**.

This research proposes an integrated incident causation and corrective action framework using evidence derived from real industrial accident case studies to enhance accident prevention and organizational learning.

Literature Review

This section would review major accident causation theories and investigation methods, including:

- Heinrich's Domino Theory
- Bird's Loss Causation Model
- Swiss Cheese Model
- Human Factors Analysis and Classification System (HFACS)
- Five Why Analysis
- Fault Tree Analysis (FTA)
- Event Tree Analysis (ETA)
- Bow-Tie Analysis
- Tripod Beta Method
- AcciMap Framework
- ISO 45001 Corrective Action Requirements
- OSHA Accident Investigation Guidelines

A synthesis of recent studies (2020–2026) would identify a gap: many investigations stop at identifying root causes without providing an integrated, organization-wide corrective action framework.

Research Objectives

1. To identify immediate and root causes of industrial accidents using established investigation techniques.
2. To classify organizational, technical, environmental, and human factors contributing to incidents.
3. To develop a comprehensive corrective action framework based on real industrial case studies.
4. To prioritize corrective actions using risk-based principles.
5. To validate the applicability of the framework across multiple industrial sectors.

Research Questions

- What are the dominant causes of industrial accidents?
- Which organizational failures most frequently contribute to accidents?
- How can corrective actions be prioritized to reduce recurrence?
- Can a unified investigation framework improve organizational safety performance?

Research Hypotheses

- **H1:** Human and organizational factors significantly contribute to industrial incidents.
- **H2:** Systematic root cause analysis improves the effectiveness of corrective actions.
- **H3:** The proposed framework significantly enhances organizational learning and accident prevention.
- **H4:** Integrated corrective action planning reduces repeat incidents.

Conceptual Framework

The proposed framework integrates:

- Incident Reporting
- Evidence Collection

- Root Cause Analysis
- Risk Assessment
- Corrective Action Planning
- Preventive Action Implementation
- Effectiveness Verification
- Organizational Learning
- Continuous Improvement (PDCA)

Research Methodology

- **Research Design:** Mixed-method (qualitative + quantitative)
- **Approach:** Multiple industrial case study analysis
- **Industries Covered:** Manufacturing, Construction, Chemical, Oil & Gas, Power Generation
- **Sample:** Five major industrial accident cases
- **Data Sources:** Accident reports, interviews, safety audits, maintenance records, witness statements
- **Analytical Tools:** Five Why Analysis, Fault Tree Analysis (FTA), Bow-Tie Analysis, HFACS, Risk Matrix

Real Industrial Case Studies

The paper would include detailed analyses of five representative incidents, such as:

1. Chemical plant toxic gas leak.
2. Construction site fall from height.
3. Manufacturing machinery entanglement.
4. Oil & gas pipeline fire/explosion.
5. Power plant electrical arc flash incident.

For each case, document:

- Incident description
- Immediate causes
- Root causes
- Contributing factors
- Existing controls
- Corrective actions
- Preventive measures
- Lessons learned

Data Analysis

Analyze causes by category (human, organizational, technical, environmental), compare case studies, and evaluate the effectiveness of implemented corrective actions. Statistical methods such as descriptive analysis, chi-square tests, and reliability analysis can support quantitative findings where survey data are collected.

Proposed Incident Causation and Corrective Action Framework

The framework consists of seven stages:

1. Incident Detection and Reporting
2. Evidence Collection and Preservation
3. Root Cause Analysis
4. Risk Evaluation and Prioritization
5. Corrective and Preventive Action (CAPA) Planning
6. Implementation and Verification
7. Organizational Learning and Continuous Improvement

Discussion

Discuss how integrated investigation methods reveal latent organizational failures, compare findings with prior studies, and explain how combining RCA, HFACS, Bow-Tie Analysis, and PDCA supports sustainable safety improvement across industries.

Practical Implications

- Supports ISO 45001 compliance.
- Improves accident investigation quality.
- Strengthens safety culture.
- Reduces accident recurrence.
- Enhances regulatory compliance.
- Facilitates organizational learning and knowledge management.

Conclusion

An integrated incident causation and corrective action framework enables organizations to move beyond identifying immediate causes and address systemic weaknesses. By combining structured investigation techniques with continuous improvement principles, industries can reduce repeat incidents, improve safety performance, and foster a proactive safety culture. The proposed framework is adaptable across high-risk sectors and provides a practical foundation for future research, including AI-assisted incident investigation and predictive safety analytics.

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