Whitepaper | SCALE®

AIHS Endorsed Professional Development

SCALE®: Improving Effectiveness of Controls Through Advanced Incident Analysis

A Blueprint for Reducing Serious Injury and Fatality Potential Across High-Hazard Industries

Incident Analytics™

www.incidentanalytics.com.au

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Executive Summary

Serious injuries and fatalities remain a persistent challenge in high-hazard industries, despite decades of investment in safety systems and training.

Traditional incident investigation models often focus on procedural or human error, missing the deeper systemic factors that undermine control effectiveness.

SCALE® Incident Analysis was developed in response to these limitations, grounded in extensive research including:

- Over **10,000 incident reviews**
- **Peer-reviewed research** encompassing 765 studies across multiple sectors
- A review of the most common investigation models
- Practitioner insights from a **cross-industry survey**

This evidence base highlights consistent gaps in existing models - particularly around control reliability, severity prioritisation, and organisational learning.

SCALE® offers a structured, severity-driven approach that integrates human, organisational, and control dimensions. It enables more consistent, system-aware investigations and supports strategic decision-making to reduce serious injury and fatality exposure.

> SCALE ® analysis technology helps determine which incidents need deep-dive analysis. It is built on a robust methodology that enables organisations to better understand the effectiveness of controls and the operational, and system factors that contribute to the conditions for unplanned events to occur.

Severity

Assess severity and risk context

Is there potential for a serious incident and what was the specific high risk task context?

Controls

Determine ineffective controls

Which critical controls would have stopped an incident from happening?

Antecedents

Analyse causes

Which human, operational, and organisational system factors helped to set the scene for the incident?

Learning

Make sense of findings and prioritise

Which factors should be prioritised to resolve the issue?

Exposure

Develop actions to strengthen controls

Which actions will have the greatest impact on exposure and reduce the potential for a repeat event?

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Why Traditional Investigations Fall Short: The Case for a New Approach

Despite widespread adoption of established investigation methods, high-hazard industries continue to struggle with preventing repeat serious injuries and fatalities.

The following five systemic challenges consistently undermine the effectiveness of incident analysis and risk prevention:

1

Inadequate Focus on Control Effectiveness

Investigations frequently emphasise human error or procedural non-compliance, while overlooking whether critical controls were well-designed, enabled, and functioning reliably. This leads to repeated incidents where controls exist but fail in practice.

2

Misclassification of Serious Risks

Incidents with serious injury or fatality potential are often misclassified due to subjective or inconsistent severity assessments. This results in under-investigation of high-potential events and over-investigation of low-consequence ones.

3

Fragmented Systems Thinking

Many traditional models are complex and tailored to specific sectors, making them difficult to apply consistently. They often lack integration across human, organisational, and control dimensions, limiting their effectiveness in diverse operational contexts.

4

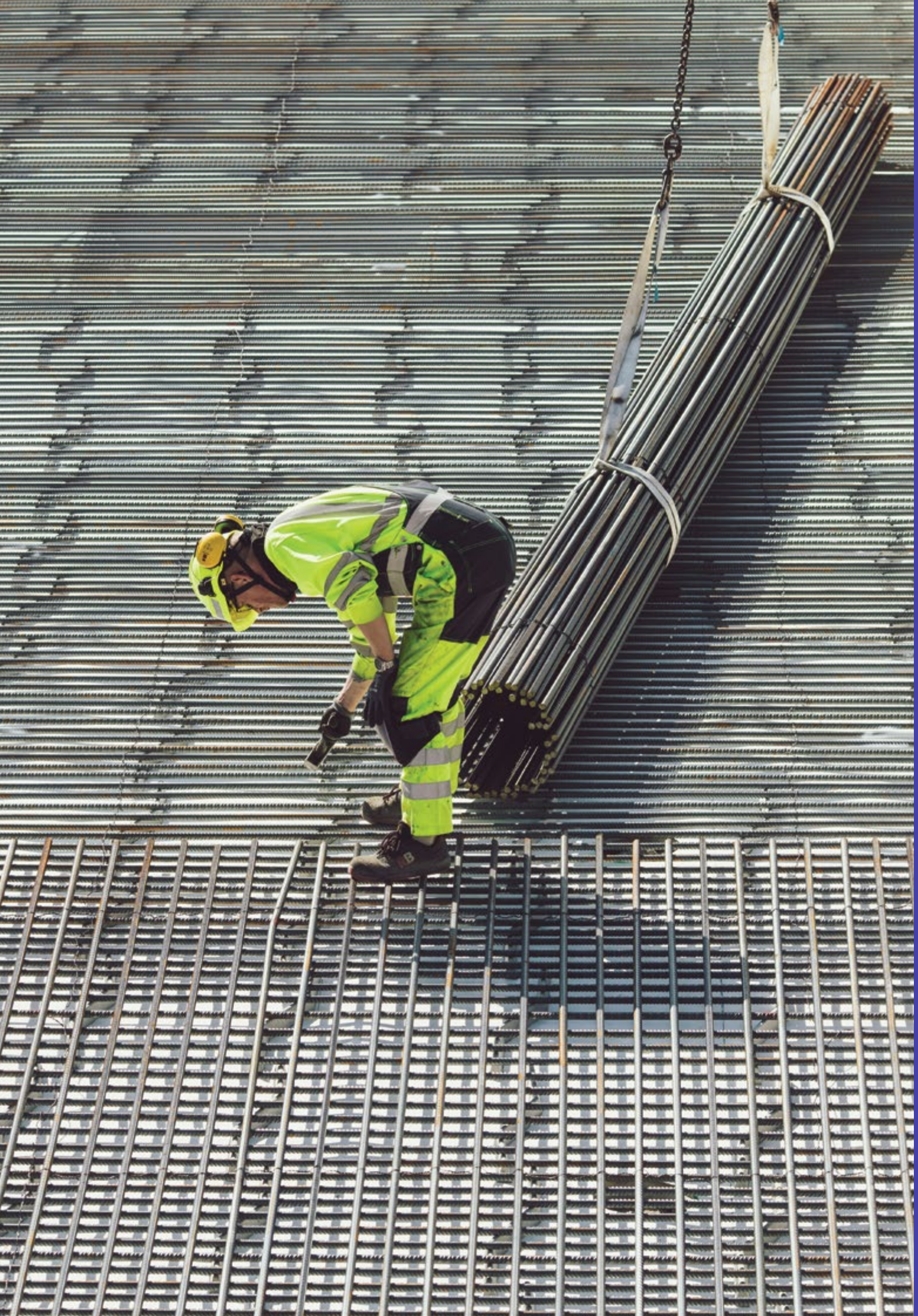
Poor Organisational Learning

Findings from investigations frequently remain surface-level, failing to uncover deeper organisational and operational factors. As a result, lessons learned rarely translate into meaningful systemic change.

5

Lack of Cross-Sector Usability

Existing methodologies are not easily transferable across industries, which limits their scalability and relevance in varied environments.



Insights from Academic Research

Incident Analytics' collective research draws on peer-reviewed academic studies, extensive practice-based application, and cross-sector survey feedback to examine why traditional approaches to incident investigation often fall short.

Foundational research was undertaken in collaboration with Federation University to better understand strengths and limitations of accident causation methods. Their academic reviews offer critical insights into the systemic limitations of current approaches and outline opportunities for improvement.

[1] Porter, J.E., Dabkow, Fernando, A. and Seaward, L., 2025. An analysis of systemic incident investigation methodologies applied in serious injury or fatality events: A rapid systematic review. Public Health in Practice, 9, p.100598. https://federation.edu.au/__data/assets/pdf_file/0007/628882/Porter,-Dabrowsky-2025-rapid-review-Methodologies-for-injury-Abstract.pdf

[2] Dabkowski, E., Porter, J.E., Smith, W., Fernando, A. and Seaward, L. (2025) 'An umbrella review of systemic accident causation factors relating to serious injuries and fatalities in the workplace', SSRN Electronic Journal. Available at: http://dx.doi.org/10.2139/ssrn.4675522 (Accessed: 14 November 2025).

01

Rapid Systematic Review of Incident Investigation Models

This peer-reviewed academic journal paper[1] critically reviews four dominant systemic accident causation models - AcciMap, HFACS, STAMP, and FRAM - across multiple industries. While these frameworks have advanced systems thinking, the review found they are often complex, sector-specific, and narrowly focused on errors and malfunctions. In one study, unsafe supervision was identified in 87.1% of cases, and unsafe acts in 90.5%, yet organisational influences were only recognised in 56% of incidents.

The findings suggest that current models often fail to capture the full spectrum of contributing factors - particularly those related to control reliability and upstream organisational dynamics.

02

Umbrella Review of Systemic Accident Causation

The umbrella review[2] synthesised findings from 13 systematic reviews encompassing over 765 primary studies across mining, aviation, construction, maritime, and healthcare. The review identified fatigue, poor supervision, inadequate reporting, and control failures as consistent contributors to serious workplace incidents. The review calls for a shift away from root cause analysis toward models that capture the interplay between human, technological, and organisational systems.

Together, these reviews highlight the urgent need for more integrated, control-focused, and cognitively aware approaches to incident analysis. Moving beyond root cause frameworks toward systemic, cross-sector methodologies is essential for reducing serious injury and fatality potential in complex work environments.

> "SCALE® uses systemic techniques to provide a deeper understanding of how multiple factors contribute to the severity of an event, aiding in reducing the incidence of serious injuries and fatalities."
>
> Federation University

Opinion on ICAM vs SCALE:

ICAM is a commonly used method for investigating serious incidents, especially for uncovering systemic factors. For experienced users, it provides a solid foundation - but it doesn't apply a severity lens or deeply assess control reliability and cognitive influences.

SCALE® builds on this by adding depth where ICAM leaves off. It introduces severity-driven analysis, evaluates critical control enablement, evaluates control health and integrates cognitive hazard insights. For ICAM practitioners, SCALE® offers a strategic extension - enhancing control-focused learning and delivering sharper, governance-ready outcomes.

Case study: Transforming Critical Risk Management

A subsidiary of a global resource company applied SCALE® diagnostics to relaunch its critical control framework and engage its workforce over four years. Outcomes included:

- Improved incident classification and investigation quality
- Used SCALE® to inform bow-tie analysis
- Strengthened governance and assurance processes
- Enhanced supervisor capability in hazard management
- Introduction of control verification and critical risk ownership
- A measured 30% reduction in SIF exposure

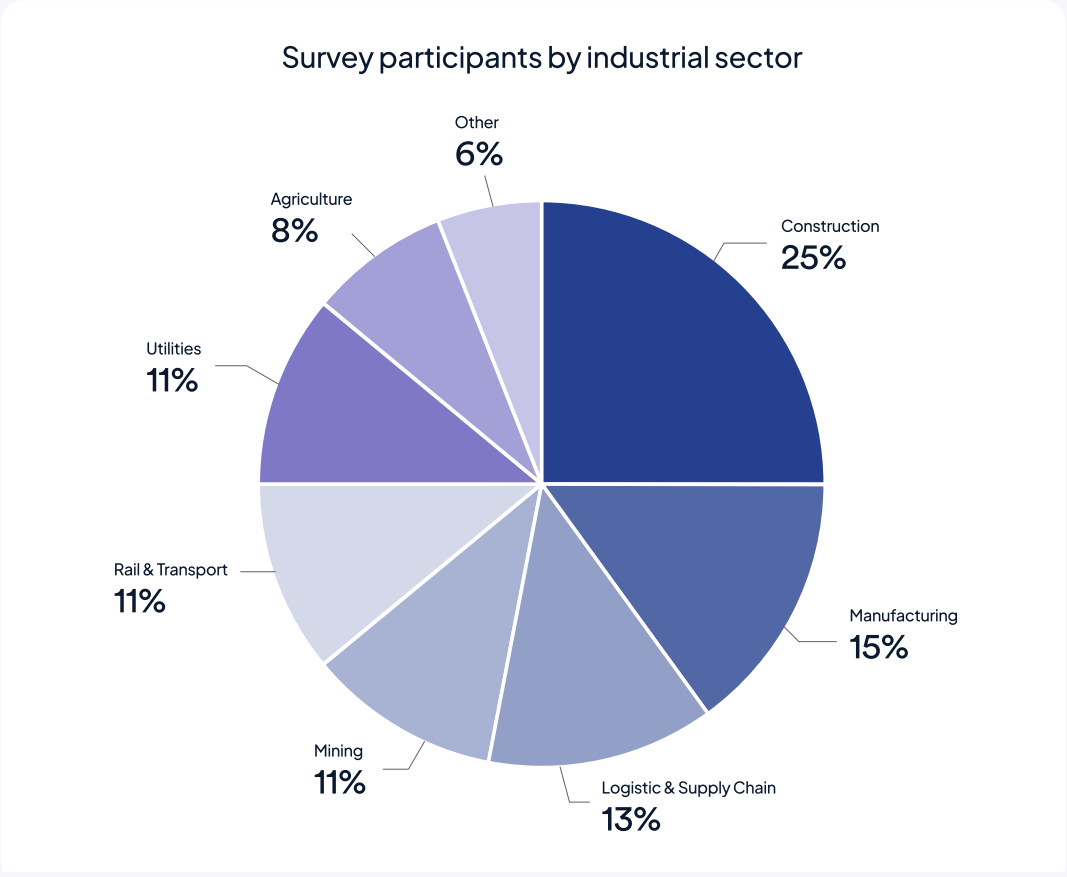
> "Over a four-year period, a global resource subsidiary used SCALE® diagnostics to relaunch its critical control framework – resulting in stronger governance, improved investigation quality, and a 30% reduction in serious injury and fatality exposure through targeted workforce engagement and control verification."

What Investigators Really Think

Further to academic research, a cross-sector survey [3] was undertaken to capture the practical experiences of professionals involved in incident investigations.

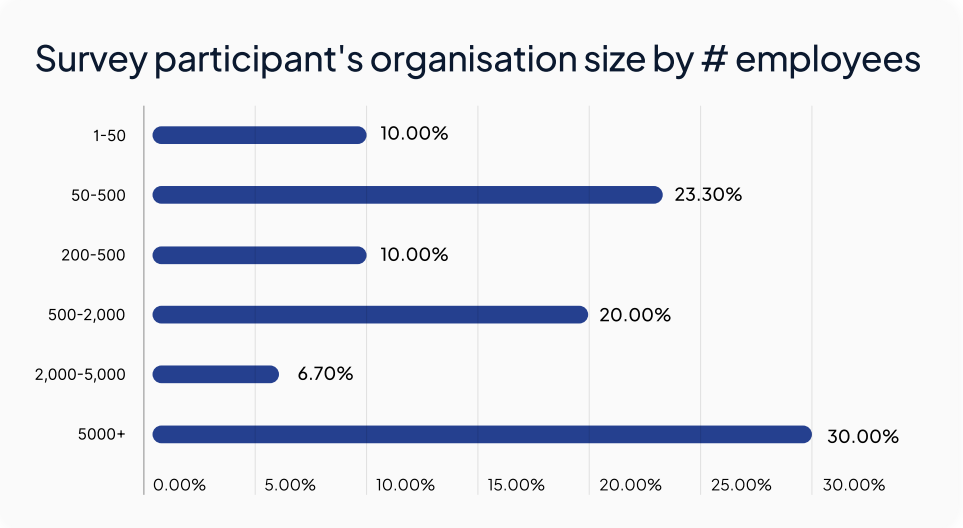
Participants represented a wide range of industries and organisational sizes, reflecting the broad applicability of investigation practices across varied operational contexts.

The following is an extract of key insights from the survey, offering a practitioner-informed perspective on current methods, challenges, and opportunities for improvement.



Industry and Experience

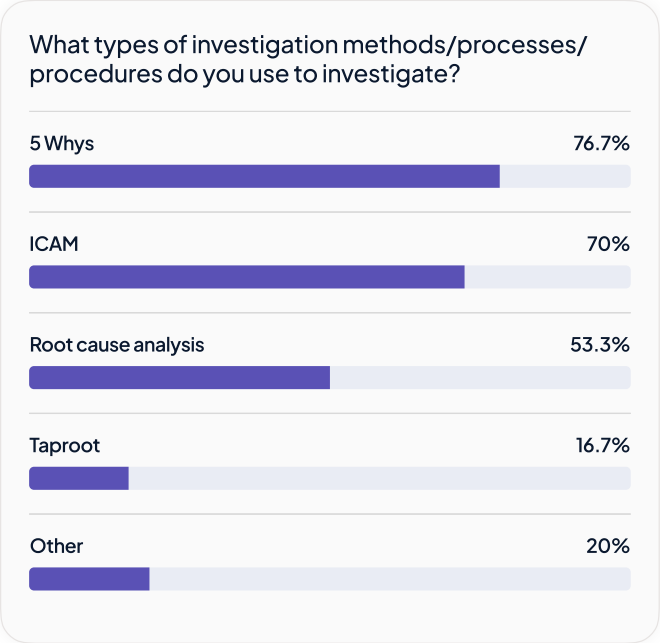
Respondents represented organisations of all sizes, from small teams to enterprises with over 5,000 employees. Notably, 67.7% had participated in 16 or more investigations, indicating a high level of experience. Their roles spanned across causal analysis, response planning and risk control design highlighting the multifaceted nature of investigation work.



[3] Rose Street Digital (2025) Incident Investigation: How Effective Are They Really? [online] [Access September 2024] Rose Street Digital.

Methods of Training

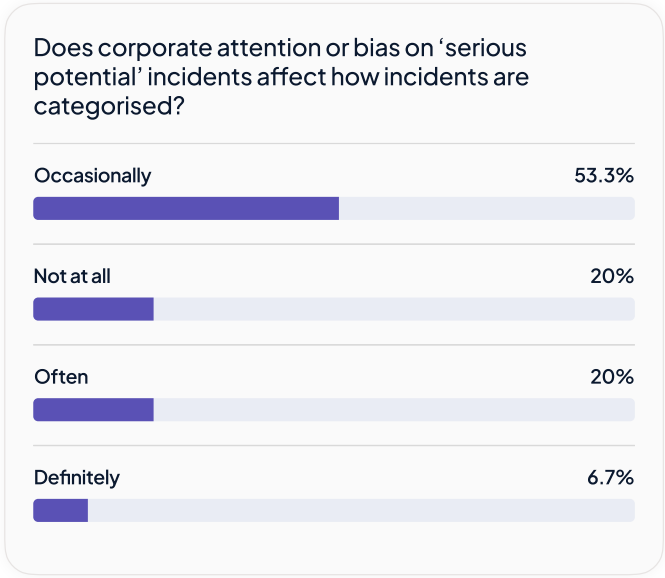
The most commonly used methods were 5 Whys, ICAM and Root Cause Analysis. Most participants had received formal classroom training and on-the-job instruction. Despite this, concerns were raised about misclassification of incidents and a tendency to overlook deeper organisational factors. Several respondents noted that investigations often stop short of exploring systemic issues such as poor work design or cultural drivers of unsafe behaviour.



> "Most investigations stop short of examining underlying systemic organisational factors that result in poor work design. There remains a reluctance to really dig and uncover the factors that motivate behaviour or encourage unsafe acts."
>
> Survey Participant

Categorisation and Bias

Incident severity is most often assessed using a risk matrix. However, consistency in categorisation was rated only 6.6 out of 10, with over half of respondents reporting occasional corporate bias, and nearly 20% noting frequent bias. This suggests a need for more objective and learning-focused reporting systems.



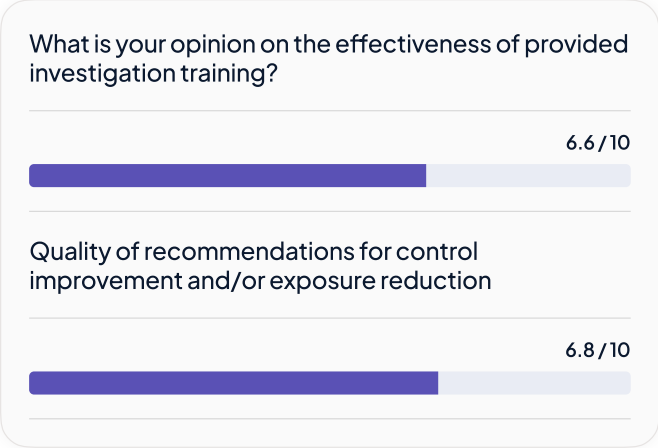
> "Reporting needs to become something people want to do if they know learning (not blame) is the company's motivation."
>
> Survey Participant

Effectiveness and Improvement

Investigation training effectiveness was rated 6.6/10, pointing to challenges with one-time workshop-based training without on-the-job coaching follow-up or periodic expert validation of investigation quality. Senior safety leaders also report that investigation training programs rarely account for variability in safety advisor experience, leading to poor application of key training concepts.

The usefulness of insights and recommendations from investigations averaged 6.8/10, and Incident Analytics own database of investigation assessments suggests this rating may be somewhat optimistic. This points to opportunities for improving both the depth of analysis and the practical value of investigation outcomes.

Overall, the survey underscores a strong desire among practitioners for more consistent, transparent, and system-aware investigation processes, aligned with the complexity of modern work environments.



> "For incident outcomes to change for the better,we need consistent investigations that are performed without corporate bias."
>
> Survey Participant

Closing the Gaps: SCALE® Incident Analysis Method

The convergence of academic research and practitioner feedback reveals persistent gaps in current incident investigation practices – in consistency and depth of causal analysis, addressing systemic factors, and the comprehensiveness and effectiveness of corrective actions.

SCALE® was developed to respond to these challenges, offering a structured, scalable approach that integrates human, organisational, and control dimensions. It aims to support deeper analysis, enable strategic learning, and improve the effectiveness of safety governance in complex environments.

SCALE® employs a taxonomy of factors that provide both deep and broad analysis of why serious incidents occur, and a sequencing of the analytical process that reveals dependent causal contributors and builds insights in a logical sequence.

1. Severity Assessment

Determine the potential impact of each incident.

2. Control Analysis

Identify which controls failed and why.

3. Antecedent Analysis

Examine human, operational, and organisational factors that set the stage for incidents.

4. Learning & Prioritisation

Translate insights into corrective actions that address both implementation challenges and control design.

5. Exposure Reduction

Prioritise interventions to reduce the frequency and severity of future incidents.

Applications of SCALE®

SCALE® has been thoroughly tested in high-hazard industries across over 10,000 incidents[4], demonstrating versatility and impact across several domains:

Incident Categorisation

Executive teams and boards need reliable information to make decisions on and provide necessary resources to effect change. Our research indicates that up to 5 in 6 HiPo (SIFp) events are mis-categorised by organisations. The built-in decision tree process ensures consistent and accurate identification of incidents with serious or fatal potential, which facilitates better targeting of investigation effort.

Control Effectiveness

Too often organisations over rely on controls that are human-dependant and are unaware of how susceptible their so-called critical controls are to human error. The built-in control health assessment provides a 360–degree view of controls as designed and as implemented. When control reliability is thoroughly analysed from incidents and control verifications, Risk Owners are better informed, and a more thorough and accurate Bow-Tie analysis of risks is possible.

Serious Incident Reviews

SCALE® is, in effect, an accident and causation analysis method and lends itself well to the review of to serious incident analysis. The comprehensive framework and taxonomy analyses control failures, human factors, operational management, and organisational influences. These are prioritised for their impact on exposure, and operational leaders can make better-informed decisions about where to invest their effort. Quite often, the method has been applied to the review of hi-potential or near-miss incident investigations.

Control Reliability Analysis

In reviewing or creating a critical control framework, organisations can learn from historical incidents and (where available) control verification data. The identification of controls that are absent or ineffective, patterns and insights from sharp and blunt-end contributing factors, leads to a better-informed safety strategy and a clearer return on investment from control improvement initiatives.

[4] Incident Analytics Pty Ltd. (2025). A Deep Dive Into SIF Incidents, Controls, & Antecedents – Whitepaper Issue 1. Incident Analytics Pty Ltd. Available at: https://www.incidentanalytics.com.au/white-papers/what-a-review-of-10-000-incidents-revealed-about-preventing-serious-incidents [Accessed 3 Nov. 2025]

Case Study: Detecting Hidden HiPo Incident

A major water utilities company identified 68 high-potential incidents that had previously escaped executive attention. Key exposures included vehicle movement, animal attacks on lone workers, and working at height. SCALE® revealed that critical controls were bypassed 43% of the time, prompting:

- Adoption of new leading indicators
- Strengthened risk assessment
- Adaptation of critical controls
- Increased leadership engagement
- Field verification of critical controls
- Immediate containment strategies to reduce incident frequency and severity

> "Using SCALE®, a major water utilities company uncovered 68 previously undetected high-potential incidents, revealing that critical controls were bypassed 43% of the time and prompting immediate action through new leading indicators, enhanced risk assessments, and targeted contained strategies to reduce incident frequency and severity."

Learning and Adoption

AIHS Endorsed Professional Development

The SCALE® eLearning course, endorsed by the Australian Institute of Health & Safety (AIHS), equips safety professionals with the skills to apply the methodology effectively.

The course comprises six one-hour lessons:

01 Background & Key Concepts

02 Decision to Investigate

03 Controls & How They Fail

04 The Human Element

05 Upstream Factors

06 Taking Effective Action

Participants learn to identify and manage risks, investigate SIFp incidents, and improve critical controls using evidence-based techniques.

Case Study: Improving Investigation Quality

A shipping terminal operator used SCALE® to review six high-risk incident investigations. The process revealed weaknesses in control implementation and led to:

- Redesign of behavioural controls
- Increased supervisory presence during high-volume periods
- Enhanced investigation capability
- Improved incident severity classification
- More frequent verification of targeted controls

> "By applying SCALE® to six high-risk investigations, a shipping terminal operator uncovered critical control gaps – leading to redesigned behavioural controls, stronger supervisory presence, and improved incident classification and verification"

Concluding Remarks

Developed through extensive research-including peer-reviewed academic reviews, systematic studies, and an analysis of over 10,000 incidents-SCALE® addresses persistent limitations in conventional investigation models. It places control effectiveness at the centre of incident analysis and offers a structured, scalable approach suited to the complexity of modern work environments.

The methodology is supported by formal training and professional development, including an eLearning program endorsed by the Australian Institute of Health & Safety (AIHS). This ensures consistent application and builds capability across safety teams and leadership.

Key features include:

Severity-Potential Filter
Prioritises investigation effort based on potential impact

Control-Centric Focus
Examines control reliability and systemic breakdowns

Structured Framework
Anchored in Severity, Controls, Antecedents, Learning, and Exposure

Cross-Sector Applicability
Applied across high-hazard sectors such as mining, utilities, transport, and agriculture

Scalable and Actionable
Supports consistent reporting and governance

Learning-Oriented
Encourages continuous improvement and system-level insights

As operational environments grow more complex, the need for robust, evidence-based approaches to incident analysis becomes increasingly important. SCALE® contributes to this need by supporting deeper understanding of control performance and enabling more informed safety decisions.

Incident Analytics™

Uncover hidden risks, improve controls & prevent serious incidents.

We are a risk management research & data analytics company supporting high-hazard industries including mining, utilities, and transport.

Our research and analysis technology gives senior leaders and safety professionals the business intelligence to help improve safety performance.

We hope our work helps to inform your safety strategies in the workplace. To learn more about Incident Analytics go to our website, or get in touch to see what we can do for your business.

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