Accident Investigation and Analysis  
- a roadmap for organisational learning -

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- Working conditions have improved enormously
- But risk acceptability has also changed greatly
- Accident numbers are decreasing, but still high
- You are the generation that shapes the future
Acidentes de trabalho graves e mortais
Valor(es) do(s) ano(s) 2014 e 1994

Fontes/Entidades: Eurostat | Entidades Nacionais, PORDATA
http://www.pordata.pt/Europa/Acidentes+de+trabalho+graves+e+mortais-1355
AGENDA

1. Basic definitions & terminology
2. Models of accident causation
3. Methods of accident investigation and analysis
4. Fundamentals of RIAAT process for dealing with accidents at work

OBJECTIVE

To address ways of investigating and analysing accidents that also promote organisational learning and, therefore, are aligned with modern safety management thinking.
Reference literature on the topic

1. Basics & terminology (1)

Accident

✓ Randomness / unplanned / sudden event
✓ Energy transfer (some kind of “contact”)
✓ Specific consequence: injury to people, damage to property or the environment

Near-miss or dangerous occurrence

Undesired occurrence that *may have had* critical effects, *i.e.*, the damaging consequences are not actually present – it only has the potential to cause them.
1. Basics & terminology (2)

**Investigation** – means a search for factual accident data; implies a systematic search of the relevant facts; it is essentially about fact-finding and the identification of observable elements (data)

**Analysis** – holds the need to interpret data and to establish causal links

>> search for logical explanations rather than facts and events

>> a certain amount of information might be inferred

*Investigation and Analysis can be seen as iterative processes, which are complementary to each other*
1. Basics & terminology (3)

Learning

“the processes related to establishing new knowledge aiming to implement changes to, or gaining deeper comprehension of, and/or confirming the basis for current practices” (Njå & Braut, 2010)

learning implies change
2. Models of accident causation
Accident Prevention
relationship between models and methods

Models (theories)
To explain the accident mechanism (causation theories)

Methods (tools)
To help a user performing a specific task

Risk Assessment (pro-active monitoring)
Accident Investigation & Analysis (reactive monitoring)
Multi-causality (current approaches)

Not a single cause (or a single sequence), but rather the interaction of multiple causes

Sequential – chain of events

Heinrich (1931) – Domino theory
Bird (1974) – Loss Control (modified domino)

Haddon (1973) – Energy model

Kjellén (1984) – Deviation model

Epidemiological

Turner (1978) – Incubation/Trigger Event Theory

Reason (1990, 1997) – “Swiss Cheese” Model
Organisational Accidents

Systems approach

Rasmussen (1997)
Svedung & Rasmussen (2002)

HIERARCHICAL MODEL OF SOCIO-TECHNICAL SYSTEMS

(Rasmussen, 1997)
Reason model (1997) – Organisational Accidents
Reason model (1997) – Organisational Accidents
Key concepts

We find multiple failures within an organisation. When combined with each other, these failures can result in an accident

Active Failures – their effects are felt immediately. They play an “active” roll on the accident occurrence. Usually are easy to identify and represent the “immediate causes”
e.g.: technical failure from equipment or materials, or human error from worker,
Latent failures (or latent conditions) – their pernicious consequences are not immediately visible, and are not immediately associated with the accident. These are normally weaknesses in the organisation which facilitate the occurrence of active failures. They can be “dormant” in the system for long periods without being detected. Only become evident in the aftermath of an accident, when combined with other factors. e.g.: insufficient supervision, poor maintenance, ill designed machines or tools, bad procedures, poor management, etc.
In summary: the model considers 3 levels of concern:

1- **Organisation & management**: the weak points within the organisation – the latent conditions

2- **Working environment**: it will influence or promote unsafe behaviours

3- **People**: unsafe acts, or behaviours from workers

These factors, combined with technical failures and poor barriers (defences) can result in an accident or near-miss
Physical

Fences, machine guards, electrical insulation, gas detectors, ventilation systems, PPE, etc.

Most commonly >> “active” failures

Administrative

Norms, warnings, rules, safety procedures, work permits, etc.

Most commonly >> “latent” conditions

Failures in defences can contribute in various ways: absence, existing but not known by workers, bad use, insufficient, bad design (difficult to use or uncomfortable)
3. Methods of accident investigation
Relationship between methods and underlying models

Source: adapted from Katsakiori et al. / Safety Science 47 (2009), pp 1007–1015
Investigation and Analysis of Accidents – accidents at work

http://www.hsebooks.com/Books/


adopted by the Portuguese Labour Inspectorate for official enquiries on serious accidents
English version: http://xenofonte.demi.fct.unl.pt/wait_method

RIAAT - Recording, Investigation and Analysis of Accidents at Work (2010)

AENOR: Norma UNE-EN 62740:2015
4. “RIAAT in a nutshell”

- just a brief outline of the RIAAT Process
- functions: Recording, Investigation and Analysis of Accidents
- it is a Process (or procedure) to deal with accidents at work
- accommodates the whole cycle of accident information
Motivation for RIAAT – move from “records” to (safety) learning and improvement

Basic Postulates

• To prevent, one needs to know (i.e., understand the phenomena; have reliable information)

• Knowing assumes learning

• Learning also implies the ability of new knowledge to convey changes and improvements where they are actually needed

• The effect is amplified when learning is shared across the organisation (organisational learning)
Background / Development philosophy

RIAAT resulted from the intersection of three main areas of knowledge:

- **State of Art**
  - Theory (literature review)

- **State of Art**
  - Current Practice

- **Legal requirements**
  - (information on AW)

RIAAT
Background ... Reason’s theory

Some ‘holes’ due to active failures

Defenses in depth

Other ‘holes’ due to latent conditions
Management Process, materialised by two instruments:
- a FORM (standard form). The methodology of analysis is embedded in the form (6p)
- A User’s Manual (15p); step-by-step guidance
A “process” in 4 parts

The term **process** implies:

- ✓ a set of related **activities**
- ✓ **transformation** (inputs & outputs are different)
- ✓ obtaining **added value**
Part 1 – Recording

- plain record of the accident or dangerous occurrence; it states the basic facts and circumstances
- The form is self-explanatory; and all one needs to do is filling in the applicable fields (Sections 1-3).
- This first part of the process is aligned with the ESAW / EEAT methodology (Eurostat)
Active Failures are many and diverse

Can be classified into 5 main categories (WAIT, 2011)

**HUM** – Human (behaviour, actions)

**E&B** – Equipments & Buildings (equipments, tools, structures, buildings, etc.)

**HAZ** – Hazards (hazardous substances, energies, materials and objects, etc.)

**LOR** – Living Organisms (animals, plants, micro organisms, etc.)

**NAT** – Natural Phenomena (when they are a direct cause in the accident)
Nature of active failures

(1) HUM – actions and behaviours

Bad movements; inopportunie

False moves

Slips, trips, falls (STF)

Excessive force; Cargo handling

Driving (dangerous) of vehicles or machines

Using tools (misuse, unknowing)

Loss control of a tool, or object, or machine
(2) E&B – Equipment & Buildings (structures).

Structural collapse: scaffolding, platforms
Breaking, bursting: cables, ropes
Vehicles in movement (poor condition)
Equipment and tools (defective)
Batteries, generators, electrical equipment
(3) HAZ – Hazards

Hazardous materials and substances
Flammable or explosive substances
Radioactive Materials
Particles, dust, debris, fragment
Sharp objects
Loads suspended or transported
(4) LOR – Living Organisms

Micro organisms: bacteria, viruses, bacilli
Animals: dog bite, mouse, snake
Insects: wasp sting, bee (acute allergic reaction)
Vegetation, trees: fall, tripping, allergic contact
(5) NAT – Natural phenomena

Characteristics of the land: holes, caves, abrupt slopes, trenches, water courses, etc. (fall, landslide)

Soil and slippery surfaces: snow, ice, mud, etc. (paths conditions and / or excavation sites)

Work under adverse climatic conditions: intense sun, rain, hail, strong winds, electric shock, storms, etc.
- A new “external layer” to account for OSH legal requirements
- In the spirit of the law, this is the first group of barriers
  (immaterial barriers, which need to be well implemented)
Part 2 – Investigation & Analysis (causes)

Search in 4 layers – the causes of the accident and also all underlying factors (latent) that facilitated its occurrence

- People (actions; behaviours)
- Accident
- Workplace Factors
- Management Factors; Organisational
- OSH Legislation
Part 2 – how much effort?

3 níveis análise

Basic
Medium
In-depth

Decision tree for deciding the level of investigation
### Part 2 – Investigation & Analysis (causes)

#### Analysis of Human Failures and Individual factors - IND

The Manual provides classification lists for each category of factors

1. **Workplace Factors - WPF**

   - **WPF**
   - **IND**

   2 pages
Analysis of human failures (errors & violations)

- Unsafe Acts
  - Errors [1]
    - Slips & Lapses [1A]
      (Unintended action - automatic mode)
    - Mistakes [1B]
      (Intended action)
  - Violations [2]
    (Intended action)
  - Routine - “to cut corners”
    Optimisation
    Necessary
    Exceptional
- Rule-based Mistakes (type R)
  Misapplication of a good rule
  Application of a bad rule
- Knowledge-based Mistakes (type K)
  Takes many variable forms

Human Error Types/ taxonomy (adapted from Reason, 1990, p.207)
Reason classification for **error types**

Error Types

The error types can be classified into the following levels of “cognitive performance”:

**Slips and Lapses** – Unintended actions. Slips refer to attentional or perceptual failures in observable actions, while lapses are internal mental events, generally involving memory failures.

**Rule-based mistakes (R type)** – Intended actions. These errors are “mistakes” associated with behaviors that require application of rules or procedures. A typical question to make to characterize performance at this level is whether the procedure or rule exists.

**Knowledge-based mistakes (K type)** – These errors are “mistakes” at the level of individual knowledge; they occur when a worker faces new situations, for which he has no rules or applicable knowledge. These are linked, for instance, with difficult diagnosis.
### Management & Organisational Conditions – M&O

#### Part 2 – (continuation)

<table>
<thead>
<tr>
<th>Section 7</th>
<th>Organisational &amp; Management Factors (OMF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(These factors are individually evaluated and more than one may apply simultaneously)</td>
</tr>
<tr>
<td>7.1 Factors</td>
<td>What organizational and management factors or conditions may have led to the previous workplace failure? (e.g., management for contractors, level of supervision, maintenance management, training policy, safety policy, etc.)</td>
</tr>
<tr>
<td></td>
<td>Purchasing policy (purchase of equipment)</td>
</tr>
<tr>
<td></td>
<td>Level of supervision (supervision)</td>
</tr>
<tr>
<td></td>
<td>Identification (identification)</td>
</tr>
</tbody>
</table>

#### Management Improvement and Control

<table>
<thead>
<tr>
<th>7.2 Management Improvement and Control</th>
<th>What corrective actions are needed to improve the management of safety?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 - Purchase identical/uniform equipment</td>
</tr>
<tr>
<td></td>
<td>2 - Create checklists for dangerous tasks</td>
</tr>
<tr>
<td></td>
<td>3 - Provide continuous training to workers (to be discussed with management)</td>
</tr>
</tbody>
</table>

#### Legal OSH (legislation)

<table>
<thead>
<tr>
<th>Section 8</th>
<th>Legal Factors - H.S. Legislation</th>
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<tbody>
<tr>
<td></td>
<td>© Check if any of the factors identified in sections 6-7 constitute a legal breach, and/or if the applicable laws, by Table 1, cause or a problem (in the industry).</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Legal Issues</th>
<th>1 - Law/Regulation</th>
<th>2 - Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Law and Regulation</td>
<td>Description</td>
</tr>
<tr>
<td>1</td>
<td>Decrease 502005, of 2010, 2018</td>
<td>Establishes the minimum safety requirements of work equipment, particular hazards mobile equipment and equipment for lifting loads. Defines rules on the use of such equipment.</td>
</tr>
<tr>
<td></td>
<td>Law 502005, of 17th September 2007</td>
<td>Establishes mandatory check of work equipment at the beginning of its use, at regular intervals and before it is used again. Establishes penalties for safety failings.</td>
</tr>
</tbody>
</table>

...all above is necessary
Part 3 – Plan of Action

Aim
1) To ensure that all applicable **Risk Assessments** (RA) are complete and/or are reviewed in the light of this particular case

2) To establish an adequate (and sufficient) **Plan of Action**, based on “ALARP” – *As Low As Reasonably Practicable*
The ALARP principle

Prevention and Protection measures should help to reduce risk to a level “As Low As Reasonably Practicable”
Aim

1) To ensure that the important lessons are extracted and that knowledge is used. In this section, the RIAAT Form prompts the investigator to answer two key questions: *What was the lesson? Why? Who did learn?*

2) To make sure that the important lessons are shared with targeted people. *Whom to share? How?*
5. Concluding Remarks

Accident Investigation & Analysis

Literature is plenty of ideas, new standards, new methods, new ways, etc.,

There is no excuse for not doing it, but methods are there to help, not to dictate rules

The effort is worth doing only if it means learning
Accident Investigation and Analysis

Thank you for your attention

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