Safety Science 99 (2017) 71–79

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Experience feedback from in-depth event investigations: How to find and implement efficient remedial actions

Carl Rollenhagen [a], Helen Alm [b], Karl-Henrik Karlsson [c,*]

[a] Royal Institute of Technology, Department of Philosophy and History of Technology, 100 44 Stockholm, Sweden
[b] Vattenfall AB, Human Factors, Business Area Generation, Projects and Services, Engineering, 169 92 Stockholm, Sweden
[c] Vattenfall AB, Human Factors, Business Area Generation, Projects and Services, Engineering, 72123, Box 864, Västerås, Sweden

ARTICLE INFO

Article history:
Received 16 May 2016
Received in revised form 29 November 2016
Accepted 6 December 2016
Available online 19 December 2016

Keywords:
Accident investigation
Event analysis
Root-cause analysis
Proactive analysis
Learning from accidents

ABSTRACT

The present research focuses on the processes of identifying remedial actions subsequent to incidents at two Swedish nuclear power plants. Data from 106 in-depth analyses were analysed together with interviews with event investigators. The results and previous research in the domain indicated a need to further develop the process for identifying remedial actions. A method was developed that focuses on process descriptions and identifications of strengths and weaknesses inherent in the process(es) in which an incident occurred. The method uses a participatory approach with actors from the relevant process (es). A case study was conducted which showed promising results. The method is discussed in terms of generalising to a more process-oriented experience feedback than usually is applied.

1. Introduction

The concepts of safety management and safety management systems subsume a set of more specific activities and supporting documentation to control safety. Activities often found in safety management systems include; safety policy, description of responsibilities, safety training, auditing, risk analysis, change management, safety standards, procedures and experience feedback (Amyotte et al., 2007; ICAO, 2013; Wahlström and Rollenhagen, 2013). Among those components, experience feedback by means of incident reporting and event investigations have traditionally been perceived as constituting a basic principle for safety management. Theories and procedures developed under the heading of experience feedback have been nourished by parallel developments in many fields including quality (Juran, 1989; Deming, 1993), organizational learning (Argyris, 1992), knowledge management (Davenport, 1994) and safety culture (Reason, 1997). Also developments in Risk analysis and Human Factors (e.g. human reliability analysis) have served as inspiration for experience feedback procedures (e.g. development of categories in reporting systems, support for event analysis etc. (for a review of HRA methods, see Bell and Holroyd, 2009).

In spite of its perceived importance as being a component in safety management, the field of experience feedback is associated with a host of limiting factors that may reduce its effectiveness (Kjellén, 2000). Examples of those factors are; the degree of willingness and motivation to report weaknesses/risks, preoccupation with technological factors at the expense of human and organizational factors, lack of integration between experience feedback components and other components in safety management system, and overly focus on formal aspects at the expense of tacit/informal knowledge. These are all examples of general difficulties associated with experience feedback perceived as a broad concept but also more specific problems have been identified for specific types of experience feedback, for example regarding event analysis (e.g. accident and incident investigations) which is the topic of this study.

Accident and incident investigations is a process consisting of several stages (Johnson, 2003; Johnson and Holloway, 2003; Lindberg et al. 2010; Lundberg et al., 2009). Rollenhagen et al. (2010) found in a study of 108 accident investigators from different branches in Sweden that the time spent in later phases of accident investigations was shorter in comparison with earlier phases of planning, data collection and analysis. Also, in a study of accident investigation manuals, Lundberg et al. (2009) found that suggesting recommendations received comparatively less attention compared with data collection and analysis. Various problems associated with suggestions of remedial actions after investiga-

* Corresponding author.
E-mail addresses: Carl.rollenhagen@vattenfall.com (C. Rollenhagen), helen.alm@vattenfall.com (H. Alm), karl-henrik.karlsson@vattenfall.com (K.-H. Karlsson).

http://dx.doi.org/10.1016/j.ssci.2016.12.003
0925-7535/

tions have been observed, for instance; overly simplistic solutions used for complex problems (Naevestad, 2008) and a tendency to find a solution for a single root-cause rather than realising that events have multiple causes (Cooke and Rohleder, 2006). In some branches, attempts have been made to provide guidance for supporting efficient remedial actions (IAEA-TECDOC-1458, 2005) to meet these problems. However, by and large, the recommendation phase of accident investigation is underdeveloped both theoretically and practically. Johnson (2003: 576) states: "...a relatively large number of techniques have been proposed to support causal analysis while only a handful have been developed to help structure the identification of recommendations. Those techniques that have been developed are not widely known and tend only to be applied within particular industries..."

In the light of these and similar findings, several authors have suggested that an enhanced focus should be placed on later phases of event investigations (Rollenhagen, 2010; Lundberg et al., 2009; Lindberg et al., 2010). This suggestion served as a motivation for the present research with a quest to find more effective strategies for remedial actions after event investigations. Before more specific research questions will be formulated, we shall here first briefly discuss some of the theories and assumptions that guided the research program reported on here.

1.1. Theories and assumptions

As was mentioned above, several domains (e.g. quality, learning organisations, safety culture, human reliability analysis etc.) have influenced theories and practices for experience feedback. It is therefore possible to draw on many sources of knowledge (theoretical and empirical) in the search for developing an effective process for development of remedial actions. The following assumptions and theories formed the basis for the present research.

A first assumption is that an effective process for remedial action should not only consider observed errors and deviations but should also give room for exploring normal operation i.e. when a process functions according to plan. The rationale behind this assumption can be found in resilience engineering theory (Hollnagel et al., 2006) and others (e.g. Rasmussen, 1997; Rankin et al. 2014). In brief, the general idea is that since most processes succeed far more frequently than they fail, we can learn a lot from successes and what goes on in "normal" operation.

A second assumption is based on the idea and supporting research that safety related information preferably should be obtained and analysed in a social context that maximises knowledge sharing among relevant stakeholders (Lukic et al. 2010; Naevestad, 2008; Burke et al. 2006; Naot et al., 2004; Spielholz et al., 2007; Maslen and Hayes, 2015). This implies, in our interpretation, that the context for suggesting remedial action should consider a broader scope than usually is evoked by a specific event. To illustrate; if an event occurs and causes and contributing factors are identified for the specific event, the remedial action process should not only address the specific causes for failures identified but also address other factors that supports performance in the process in which the event occurred (even if these factors were not directly attributed to the specific event under scrutiny). A counter argument to this can be that such a broader scope at the event should be apparent in root-cause analysis since in-depth analysis should attempt to find common cause factors at a higher (system) level. However, most "root-causes" are usually derived from an analysis of apparent direct causes which become a bias toward the specific failures found in the specific event. For example, an analysis may reveal a lack of competence as a direct cause and direct attention to the general system for competence management and miss that the process involved in the event present a much more salient weaknesses that was not detected because it was not involved in the particular event.

A third assumption concern accident theory and the proposal that negative events often are preceded by an incubation phase where latent weaknesses are accumulated until they are released by active failures (Reason, 1997; Turner 1978; Pidgeon and O'Leary 2000). But how should we go about to detect such latent accumulated weaknesses with the help of analysis of specific events? Again, we propose that if the event analysis should take a broader scope, we may increase the probability to find latent weakness. When events happen, there is usually higher motivation to address safety issues in an organisation compared to calm normal operation. This means that events usually support a safety motivation that is not always apparent otherwise.

Together the assumptions above support the conclusion that event investigations and associated remedial actions should take broader view than the common practices to focus on the causes and weaknesses perceived in a specific event. Of course, a well-functioning experience feedback system should have strategies in place to position specific events in a broader context and use different safety management components to support such a view. Previous studies have found that such integrated practices (and other systems) are not utilized to the extent that they could. For, example Rollenhagen et al. (2010) found that a majority of event investigators did not make efficient use of information from other safety management components (risk analysis, indicators, audit reports etc.) when conducting in-depth events analysis. In fact, many safety management systems are not particularly integrated in our view different groups (auditing, risk analysis, event statistics etc.) may run their operations relatively separated from each other. We propose that in depth-event investigations may serve as a suitable context for intergradation of safety management components since specific events usually support an enhanced safety consciousness in organisations.

The arguments above could be taken as a motive to support the analytical (problem finding) phase of event investigation and make this face broader and more integrated. However, we suggest otherwise and argue that focusing on remedial actions is a more suitable strategy given that it is combined with a *second analytical* phase. In the first analytical phase focus should be on the specific event – this is what normally is expected by different stakeholders. Questions like: What happened? Why did it happen? How could similar events be prevented? are all reasonable for this analytical phase. The second analytical phase, we suggest, should broaden the discussion by suggesting remedial actions that can prevent the specific factors that were involved in the event *but also* study the process in which the event occurred and suggest actions that will strengthen the whole process.

Based on the above assumptions and previous empirical work we can formulate the following research questions: How can a process for remedial actions in the context of in-depth event analysis be constructed to meet the demands of; (a) obtaining information about supporting functions (and their quality) during normal operation in the process in which the event occurred; (b) create a suitable context for discussion, learning and informal exchange about the context in which the event occurred? This process should be constructed to support discussion of latent weak factors found in the relevant processes as well as supporting adaptive processes normally used to cope with observed latent weaknesses.

2. Research program

In order to answer the research question above a program was formulated according to the following rationale: The objects for the research were two nuclear power plants in Sweden. Both plants