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Review

Failure to learn from safety incidents: Status, challenges and opportunities

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ABSTRACT

For effective and efficient learning to occur from safety incidents, certain factors and conditions related to the organisation, the actors or agents of learning, the learning process and the incidents themselves must be considered. Learning from incidents is not automatic and requires conscious and systematic steps to ensure it happens. Retaining the lessons learnt in the organisational memory to ensure continuous usage during the lifetime of the organisation is critical because personnel and learning agents change. To understand where breakdowns in learning from incidents are occurring, a bowtie analysis was used to organise the literature on failure to learn from safety incidents in a way that informs researchers and practitioners of priority areas. Additionally, the analysis aimed to test the validity of the bowtie method to filter failure to learn literature to identify key areas that could maximise learning. Using the bowtie analysis method led to the grouping of the issues identified in the literature on learning from safety incidents into three themes, namely, ***threats*** to failure to learn, ***consequences*** of failure to learn, and ***controls*** for overcoming failure to learn. This approach allows a summary representation of how and why failure to learn continues to occur together with potential practical strategies on how to overcome failure.

1. Introduction

All over the world safety incidents with diverse consequences continue to occur despite the investments organisations make into safety management (Drupsteen and Guldenmund, 2014; Drupsteen and Wybo, 2015). The recurrences of the same or similar incidents suggest a failure to learn from previous events. Learning from incidents (LFI) refers to the ability of a business to obtain useful experiences and understanding from past incidents and transfer them into practices and behaviours that prevent future events, contributing to the overall improvement in safety (Jacobsson et al., 2011). A failure to learn from incidents refers to the inability to obtain, retain and utilise the right lessons from past incidents to prevent future recurrences of same or similar events. A failure to learn suggests one of two things. Either lessons were not learned from previous incidents or the lessons learned were not effectively implemented, monitored and maintained over time.

Much has been written about the failure to learn from safety incidents. Early research in this field was conducted by cognitive systems engineers Rasmussen and Vicente (1989), Woods and Cook (2002), Hollnagel et al. (2007) and others. Pioneering work was also conducted by high reliability organisation researchers including Rochlin et al. (1998). In addition, Donald Schön and Chris Argyris developed the concept of single-loop and double-loop learning and offered explanations on how these translate into different models of organisational learning systems (Argyris and Schön, 1978). Trevor Kletz also impacted the field of process safety significantly, particularly with his emphasis on the need to undertake root cause analysis to identify key lessons that normally might have been overlooked (Kletz, 2001). All these researchers reached a consensus that for organisations to achieve high levels of safety, they must improve their ability to learn from incidents and accidents.

In addition, reviews on the subject of learning from incidents have been carried out with different aims, objectives and emphases including work by Drupsteen and Guldenmund (2014), Le Coze (2013), Lindberg et al. (2010) and Lukic et al. (2010). These reviews, together with other works, have contributed to the advancement of the still developing LFI subject. However, a systematic review that considers the threats to learning or why organisations fail to learn, the outcomes of failure to learn and how failure to learn from incidents can be avoided has not been completed. A systematic review is needed to further develop understanding of the LFI subject and to assist organisations in identifying the critical decisions they need to take to maximise learning from incidents and ensure that an organisational memory of lessons learnt is retained and used.

Causes and conditions contributing to the failure to learn from incidents need to be identified and understood. It is only when these

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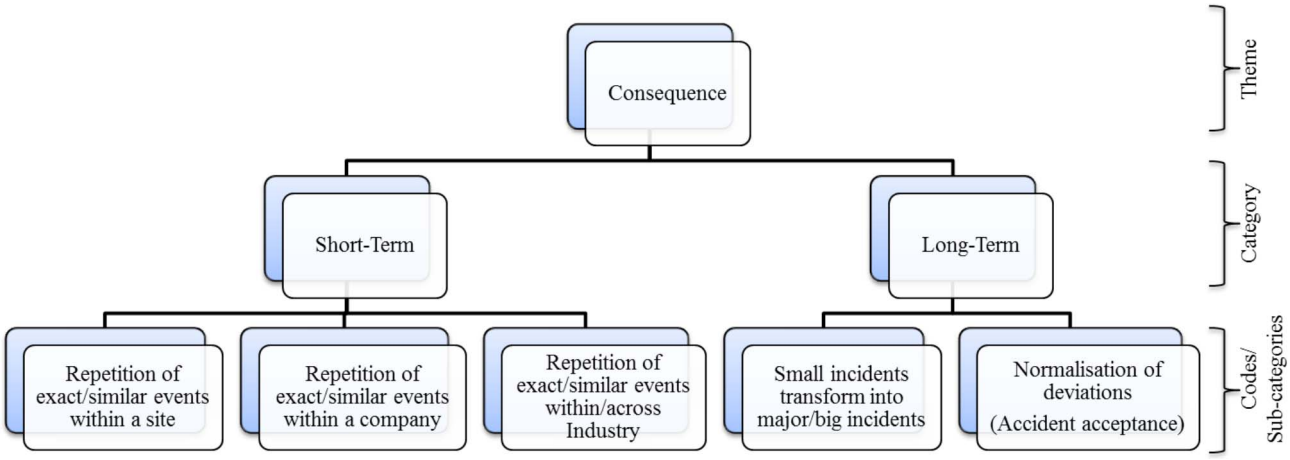

Fig. 1. Final coding structure for the consequence theme.

causes and conditions are systematically determined that specific sustainable solutions can be offered not just to overcome failure to learn but most importantly to maximise learning from incidents. One possible method for conducting such a systematic analysis of failure to learn in order to identify causes, consequences and solutions is bowtie analysis.

The bowtie analysis (BTA) was developed by coupling a fault tree and an event tree connected to an unwanted (initiating) event in the early 1970s (Nielsen, 1971). While some authors describe how the method can be implemented (Cardwell, 2008; de Dianous and Fiévez, 2006; Duijm, 2009; Ferdous et al., 2013; Jacinto and Silva, 2010; Lewis and Smith, 2010; Pitblado and Nelsone, 2013), others focus on specific aspects such as evaluating the characteristics of controls (Guldenmund et al., 2006; Hollnagel, 2008; Rowe and Taylor; Sklet, 2006). As identified by Pitblado and Weijand (2014) there exist several descriptions of the method including the EU ARIMIS project (Salvi and Debray, 2006), a risk management project by Shell to the European Union (Zuijderduijn, 2000) and the Norway BORA project (Aven et al., 2006). Most descriptions highlight that the BTA method consists of elements such as, a hazard, an unwanted event, threats, consequence and controls (mitigating and preventing), all arranged to form the shape of a bowtie. The technique has been extensively used in safety critical domains such as the petrochemical and chemical industry (Chevreau et al., 2006; Pitblado et al., 2015; Pitblado and Weijand, 2014) and mining industry (Burgess-Limerick et al., 2014; Dodshon and Burgess-Limerick, 2015; Hassall and Burgess-Limerick, 2016). Chevreau et al. (2006) have demonstrated that the technique does not only assist in effective analysis of incidents and risks but can also be utilised as an effective tool for communicating safety issues.

This review used the BTA approach to organise LFI related literatures into three broad themes or topics namely;

- threats to learning,
- consequences of failure to learn and
- the interventions required to prevent or mitigate the failure to learn from incidents.

By adopting the bowtie analysis method, the review aimed at answering the question "***Can bowtie analysis help in distilling failure to learn from safety incidents literature in a way that informs decision makers on how to maximise learning?***"

2. Methodology

2.1. Collection and analysis of literature

The search methodology used in this review is consistent with that of Drupsteen and Guldenmund (2014) and Lukic et al. (2010). Four major databases namely, Scopus, Science Direct, ProQuest and Ingenta Connect were searched using various search strings related to various stages of the LFI process. The search string used was *learning* and (*failure to learn)* and *incidents or accidents*. Additional search strings specific to some aspect of the learning process were also used such as *incidents or accident investigation or analysis* and *planning and implementation of investigation recommendations*. The search was restricted to titles, keywords and abstracts of peer-reviewed papers that were published from 2000 to 2016. Apart from the selected peer-reviewed articles, some selected books were also included in the review. Two of such books are, *Prevention of Accident through Experience Feedback* by Kjellén (2000) and *Organizational Learning: A Theory of Action Perspective*, by Argyris and Schön (1978). These two books were considered particularly important for the review due to their significance and influence on the LFI subject.

A total of 45 of the identified papers were selected for detailed analysis. The selected articles were those that were very specific to workplace safety related learning such as learning from disasters, accident and incidents. Each article was analysed thematically and coded using an integration of deductive and inductive approach. Through the deductive approach, the articles were categorised into three predefined themes derived from the BTA method of risk assessment. The three themes are ***threats*** to failure, ***consequences*** of failure, and ***controls measures*** for overcoming failure. The collected articles were sorted into these three broad topics after each article was read through as a whole. After the broad categorisation, the articles were reread and coded through an inductive approach. The inductive process of coding involve dividing text of an article into "chunks" of words, paragraphs and sentences and assigning each chunk with summary words or phrases that described the meaning of the text. This was an iterative process and involved going back to originally coded articles to check and compare codes. The process was repeated for all the articles and codes were constantly compared and refined until a final coding structure applicable to all the articles under a particle major theme was developed. As a result the inductive coding process produced for each theme, overarching categories and subthemes that comprised group similar codes. An example of the coding structure is shown in Fig. 1, which is the final coding structure for the consequence theme. The final coding structure was then arranged to form a bowtie using the BTA method as explained in the next subsection.

2.2. Development of bowtie

The basic structure of the bowtie is shown in Fig. 2. The centre (knot) of the bowtie describes the unwanted event, which for this analysis is the ***failure to learn*** from incidents. The hazard refers to