Safety Science 105 (2018) 192–211

Contents lists available at ScienceDirect

Safety Science

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

Review

Maturity models and safety culture: A critical review

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ARTICLE INFO

Keywords:
Safety culture
Maturity model
Safety culture assessment

ABSTRACT

The available evidence suggests that maturity models are a popular means of assessing safety culture in organisations. The aim of the present study was to review their conceptual underpinnings and roots, as well as provide details of how they have been used to assess safety culture (e.g., types of methods used, coverage of safety domains). A total of 41 publications were reviewed based on a set of selection criteria (e.g., studies which explicitly reported data or a case study which used a maturity model). The findings indicate steady growth in the use of maturity models to assess safety culture particularly within domains such as construction, the oil and gas industries and healthcare. We also found that most studies focus on providing a descriptive account of safety culture using maturity models and make limited attempts to assess the reliability/validity of outcomes from their use. We discuss the strengths and weaknesses of maturity models in the light of our findings, alongside identifying a number of new directions for future work of relevance to safety researchers and practitioners (e.g., the need for more detailed case studies of the use of maturity models to assess safety, as well as more attention to the underlying theory guiding use of maturity models).

1. Introduction

Some of the most compelling arguments that culture and safety might contribute to accidents and disasters were made in the late 1970s by Barry Turner in his pioneering work '*Man-Made Disasters*' (Turner, 1978; Pidgeon, 1988). Following the 1986 Chernobyl nuclear disaster the term 'safety culture' started to be regularly used amongst a broad community of safety scientists, psychologists and other groups (Silbey, 2009). There are a number of different explanations for the rise in interest in the construct of safety culture including increasing recognition of the importance of cultural aspects of health and safety management (Cooper, 2000; Cox and Cheyne, 2000; Flin et al., 2000; Reason, 1998) and the shift in the last few decades towards a focus on organisational factors governing risk and safety (Borys et al., 2009; Waterson et al., 2015; Robertson et al., 2016). As a result, many contemporary organisations strive to understand and improve their safety culture in order to deliver effective health and safety management and enhance their safety performance (Antonsen, 2009a; Reason, 1998, 2016).

At the same time, amongst researchers and academics, there have been a number of criticisms levelled at the construct of safety culture. Henriqson et al. (2014) for example, argue that the study safety culture encourages the view that safety is a widely shared norm, value or set of beliefs within organisations which masks important conflicts and disagreements which may exist amongst employees and managers. Others (e.g., Reiman and Rollenhagen, 2014; Dekker, 2018) suggest that a preoccupation with safety culture has shifted the focus away from more systemic accounts of the causes of accidents and encouraged a rather ore superficial account of how safety is related to system levels and other organisational dynamics (e.g., how safety culture changes over time). Finally, Antonsen (2009b) compared qualitative and quantitative descriptions of the safety culture in the same organisation (a Norwegian oil and gas platform) and found them to be dramatically different, leading him to cast doubt on the predictive validity of safety culture assessments. In the present paper we focus on a review of one popular tool or approach which is used to assess safety culture, namely maturity models. A later section of the paper discusses the findings from our review in the light of contemporary criticisms of the safety culture construct, alongside a consideration of how maturity models fit within debates centred on research-practice gaps within safety science and human factors (Chung and Shorrock, 2011; Waterson, 2016).

2. Safety culture: some current challenges

2.1. Defining 'safety culture'

Despite the considerable literature covering theoretical and empirical aspects of safety culture (Antonsen, 2009a, b; Cox and Flin, 1998; Díaz-Cabrera et al., 2007; Flin et al., 2000; Guldenmund, 2000;

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https://doi.org/10.1016/j.ssci.2018.02.017
Received 23 March 2017; Received in revised form 21 December 2017; Accepted 16 February 2018

Hopkins, 2006; Lee and Harrison, 2000; Mearns et al., 2009) there is still a lack of consensus and agreement about how to define the construct as well as assessment methods and on the overall structure of safety culture assessment (Mkrtchyan and Turcanu, 2012). The difference between safety climate and safety culture, for example, has been debated over decades by a number of safety researchers (Flin et al., 2000; Griffin and Curcuruto, 2016). Safety culture typically refers to the underlying assumptions and values that guide behaviour in organisations rather than the direct perceptions of individuals (Griffin and Curcuruto, 2016). Safety climate, by contrast, is sometimes regarded as the surface features of the safety culture discerned from the workforce's attitudes and perceptions at a given point in time (Flin et al., 2000). Andrew Hale (2000) refers to these and a range of other discussions centred on safety culture (e.g., the relation of culture to other aspects of safety management and behaviour) as examples of 'culture's confusions'. More recently, Hale stated:*"… safety culture is problematic in many of the same ways that 'accident proneness' was in the last century; in terms of its attributional consequences, the difficulties of defining it and the difficulties of deciding what you should measure as the outcome of its presence or absence; either accidents or other intermediate measures of safety"* (Waterson, 2017).

2.2. The theoretical status of safety culture

A number of authors have attempted to characterise the various theoretical approaches and methods which have been used to assess safety culture. Silbey (2009) for example, describes three dominant 'lenses' which characterise what she terms as 'talk about safety and culture'. The first 'lens', *'culture as causal attitude'*, view safety culture as something that is measureable and comprises the values, competencies, attitudes and behaviours about safety which exist within organisations. From this point of view culture "determine[s] the commitment to, and the style and proficiency of, an organisations' health and safety programs" (Silbey, 2009, p. 350 quoting Reason, 1997, p. 194). By contrast, the second 'lens', *'culture as engineered organisation'* whilst similarly focusing on the importance of cultural factors on safety outcomes, places more emphasis on how an organisation configures its processes and practices in order to improve safety, reliability and resilience. Proponents of the High Reliability Organisations (HROs) approach towards safety are viewed by Silbey (2009) as examples of the 'culture as engineered organisation' approach to safety culture (e.g., Eisenhardt, 1993; La Porte and Rochlin, 1994; Weick, 1987). A third 'lens' refers to *'culture as emergent and indeterminate'*. From this point of view, safety culture is understood to be socially constructed and mediated by artefacts and material, both mental and representational (Gherardi and Nicolini, 2000).

An alternative characterisation of safety culture and ways in which it is conceptualised and assessed which draws partly on Burrell and Morgan's (1979) analysis of sociological paradigms is provided by Guldenmund (2010, 2016). Guldenmund describes three approaches: (1) *interpretative or anthropological approaches* – these often treat culture as a system of meanings and symbols shared between groups of individuals who participate in this social process. Culture cannot be changed easily and cannot be assessed easily using scientific methods (Geertz, 1973; Alvesson, 2007; Martins, 1992). Qualitative methods, such as a narrative study, phenomenology, grounded theory, ethnography or case studies (Antonsen, 2009a, b), or various combinations of these approaches, are methods used by an interpretative approach. Data collection such interviews, observational studies, document analysis are typically used to provide clues to underlying cultural assumptions (e.g., Scott et al., 2003); (2) *analytical or psychological approaches* – this is similar to Silbey's notion of *'culture as causal attitude'*, however, specifically relates to the use of questionnaires and to assess safety culture and the analysis of dimensions, factors and other statistical and psychometric properties of the survey instrument being used; (3) *pragmatic or experience-based approaches* – this approach focuses on the structure and interactions within an organisation and the dynamic interplay between these which shapes and influences culture. The pragmatic approach also places emphasis on the types of processes that an organisation should have in order to achieve a mature or advanced status with regard to safety culture. These processes are reflected in Geller's approach towards Total Safety Culture (Geller, 1994) and safety culture maturity models such as the Shell Hearts and Minds programme (Hudson and Willekes, 2000; Hudson, 2007).

2.3. Aims, objectives and organisation of the current study

The focus of the current study is to outline the results of carrying a literature review on one particular approach towards safety culture, namely the use of maturity models for safety culture assessment. There is some evidence to suggest that maturity models are increasing in popularity (e.g., Fleming, 2001, 2017; Goncalves Filho et al., 2010; Parker et al., 2006; Health and Safety Technology and Management, 2017; Office of Rail and Road, 2017). Previous reviews have been carried out on the subject of maturity models and their use within domains such as software, management, business process management, information management and information technology management (Becker et al., 2009; Maier et al., 2012; Wendler, 2012). Little work however, has assessed the extent to which maturity models have been used to assess safety culture, as well as their scope and coverage. With this in mind, the specific aims of the review are:

1. To provide a better understanding of how maturity models to assess safety culture have been developed; their conceptual underpinnings and roots; the range of safety domains in which they have been applied; and, characteristics of their use;
2. To examine the methodological properties of maturity models to assess safety culture and the extent to which the outputs from using maturity models are evaluated (e.g., assessment of validity and reliability);
3. To use the outcomes from the review to offer some reflections on the theoretical status of the use of maturity models to assess safety culture and suggest new directions for future research and practice.

3. Maturity models and safety culture

3.1. Definition and scope

Maturity models involve defining maturity stages or levels which assess the completeness of the analysed objects, usually organisations or processes, via different sets of multi-dimensional criteria (Wendler, 2012; Becker et al., 2009). Hudson (2007) defines the use of maturity models in safety culture in terms of a continuum ranging from organisations that have unsafe cultures ('pathological' organisations) through to those who manage safety proactively ('generative' organisations) and those who are an intermediate stage of development ('bureaucratic' organisations). Organisations are seen as progress sequentially through the stages, by building on the strengths and removing the weaknesses of the previous levels (Fleming, 2001). A maturity model is a descriptive model in the sense that it describes essential, or key, attributes that would be expected to characterise an organisation at a particular level.

The application of this concept is not limited to any particular domain (Wendler, 2012) and maturity models can be used both as an assessment tool and as an improvement tool (Maier et al., 2012). Focus groups, interviews, audits and checklists support maturity models in safety culture as well as questionnaires. Assessment can be also structured around a matrix or grid, where levels of maturity are allocated against key aspects of performance or key activities, thereby creating a series of cells. An important feature of this maturity matrix approach is that the cells contain descriptive text for the characteristic traits of performance at each level. One stated advantage of the use of a