Safety Science 94 (2017) 208–218

Contents lists available at ScienceDirect

Safety Science

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

Assessing the statistical properties and underlying model structure of fifteen safety constructs

Jakko van Kampen [a], Dolf van der Beek [a], Wouter Steijn [a,*], Jop Groeneweg [a,b], Frank Guldenmund [c]

[a] Department Sustainable Urban Mobility & Safety, TNO, Leiden, Schipholweg 77-89, 2316 ZL Leiden, Netherlands
[b] Leiden University, Wassenaarseweg 52, 2333 AK Leiden, Netherlands
[c] Delft University of Technology, Safety Science & Security Group, Jaffalaan 5, 2628 BX Delft, Netherlands

ARTICLE INFO

Article history:
Received 19 July 2016
Received in revised form 28 October 2016
Accepted 31 October 2016
Available online 10 November 2016

Keywords:
Safety survey
Safety climate
Workplace conditions
Instrument development
Factor analysis
Statistical modelling

ABSTRACT

Background: Organisations spend a considerable amount of time and effort on diagnosing and analysing risks within their organisation. In the area of occupational and process safety, a myriad of employee survey instruments is available. Many studies show that operational processes play an important role in an organisations overall safety. Yet, so far safety surveys mainly focus on safety measures or operational *safety* processes. A flexible instrument was developed with which a wide variety of constructs, from different disciplines, can be measured in a consistent and practical way. The resulting survey distinguishes itself from existing safety surveys by extending the scope with the operational processes which are also referred to as the 'Core Business'.
Study: This study reports on the development of a catalogue of constructs which were derived from scientific literature and practice. Each of these constructs has been developed with a view towards measurability in an employee survey. The reliability and validity for fifteen of these constructs was assessed. Five separate projects have been conducted within a range of organisations operating as high risk industries.
Results: Construct validity and the dimensional structure of the instrument have been established through exploratory factor analysis and confirmed through confirmatory factor analysis. Diverse aspects derived from motivational and ergonomic approaches to safety proved to be distinguishable in this analysis.
Conclusion: The described instrument allows the mapping and quantification of various aspects of the operational process that are, based on existing knowledge, related to the occurrence of incidents.
© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Over the past decades front-running organisations and industries have been successful in reducing the frequency of occupational accidents within their organisation. The combined oil and gas producing organisations for example have managed to reduce the frequency of personal harm year on year since 2004 (OGP, 2013). Although on a broader societal scale accidents and incidents still cause considerable personal harm (Takala et al., 2014) or, in the case of major high impact events, have consequences for business, people and environment (Baker et al., 2007; Onderzoeksraad voor Veiligheid, 2013; GPO, 2011; Powell, 2006a, 2006b, 2006c). The ability to map factors that may contribute to accident causation is therefore of great importance. Safety surveys are a common tool for this purpose. Here we will first provide a short review of existing safety surveys where we focus on two dominant approaches related to 'motivational aspects of safety' (e.g. Zohar, 2010) and 'workplace conditions and systems' (e.g. Reason, 1990). First, we focus on safety climate research, thereafter we describe surveys related to workplace conditions. Subsequently, we will present a new approach which intends to span domains and enable a more flexible approach to safety surveys. The overall goal of this paper is to introduce a newly developed catalogue of constructs. The resulting survey distinguishes itself from existing safety surveys by extending the scope with the operational processes which are also referred to as the 'Core Business'. Since safety is an integral part of successful business operations (Zwetsloot et al., 2017), this instrument can be starting point for organisations to enhance their operational safety through integral system management. The first findings concerning the reliability and validity of these constructs are provided.

* Corresponding author.
E-mail address: wouter.steijn@tno.nl (W. Steijn).

http://dx.doi.org/10.1016/j.ssci.2016.10.018
0925-7535/© 2016 The Authors. Published by Elsevier Ltd.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1.1. Safety climate

Understanding the complex array of factors that may contribute to accident causation is no easy task. One way to gain proactive insight is the study of organisational (safety) culture and safety climate (Guldenmund, 2007; Parker et al., 2006; Zohar, 2010). The concepts of safety culture and safety climate are closely related (see Guldenmund, 2007 for a discussion), generally organisational safety culture is seen as a more generic, overarching concept whereas safety climate refers to attitudinal and more overt manifestations of culture within an organisation. For recent literature reviews concerning safety climate we refer to Griffin and Curcuruto (2016) and Schwatka et al. (2016). In this area the use of questionnaires has been the most popular approach as a 'quick and dirty' method to gain insight into momentary safety attitudes, more accurately referred to as the organisation's safety climate (Guldenmund, 2007). Measuring safety perceptions or safety culture is not only popular in academia but is also used extensively within the wider industry, over 60% of organisations measured safety perceptions or safety culture within their organisation in one survey of Dutch safety professionals (van Kampen et al., 2014).

Extensive research has been conducted on the measurement of safety climate through questionnaires (see for example: Christian et al., 2009; Clarke, 2006; Guldenmund, 2000, 2007; Kines et al., 2011; Zohar, 2010). As a result, a large number of different questionnaires has been designed to measure safety climate, with each questionnaire using (slightly) different operationalisations of the concept, although with a similar goal. In order to use safety climate scores as a valid indicator for safety within organisations it is important to know the extent to which these scores are predictive of safety outcomes. Only a subset of safety climate studies takes the step to correlate the concept with safety outcomes, these have been summarised in several literature reviews and meta-analyses. Clarke (2006) analysed 28 studies which contained measures of safety climate combined with a measure of actual incidents or injuries (occupational accidents). She found that the relationship between safety climate and accident involvement was small and moderated by research design. Nahrgang et al. (2007) also found a small yet significant correlation between safety climate and accidents or injuries based on their meta-analysis of 24 studies. Christian et al. (2009) most recently conducted a systematic review looking not only at relationships between safety climate constructs and outcomes but more broadly at safety knowledge, motivation, performance (compliance and participation), personality and safety climate. Again, they found a modest relationship between safety climate and safety outcomes and identified a broad variety of concepts which were included in safety climate studies and were correlated with some proxy-outcome measure of safety (e.g. safety compliance and participation).

On the basis of these and other studies Zohar concluded in 2010 that recent meta-analytic studies revealed that safety climate offers robust prediction of objective and subjective safety criteria across industries and countries. Zohar, however, also concludes that much work is needed in exploring the relationship between safety climate and its antecedents and mediators. This is also apparent from the meta-analysis from Christian et al. (2009). They show the primary focus of current safety climate literature through a meta-analytic path analysis (Fig. 1) which was by necessity limited to only the factors which were found most consistently in the literature.

As can be seen from Fig. 1 the safety climate literature is currently focused on Safety compliance – the extent to which employees report adherence to obligatory safety behaviours – and Safety participation – the extent to which employees self-report additional positive safety behaviours which are not 'obligatory'. These behaviours are the main hypothetical mediators used in some form within most of the studies and they are grouped by Christian et al. (2009) as 'safety performance'. These factors are observed to relate negatively to (self-reported) accident and injury involvement and seen to be positively shaped by 'safety knowledge' and 'safety motivation' and in turn by 'safety climate'. The model shows the person-oriented (behavioural) focus of safety climate research in current practice with main pathways through individual motivation, individual knowledge and rule following behaviour.

1.2. Workplace conditions and systems orientation

Whilst intentional behaviour is evidently relevant for safety, other studies suggest that behaviours which can be influenced by knowledge and motivation are only a subset of those which are relevant. Aspects of the situation in which the work is conducted are seen to be at least, as if not more, relevant (Wagenaar and Groeneweg, 1987). Winsemius for example in 1965 writes that: *It is too easily forgotten that a 'human factor' as a direct causal element in the genesis of an accident can only mean some form of human behaviour which is not only determined by the individual's personal traits, but also by the situation the individual has to cope with (p. 151).* It therefore seems to be especially useful to expand on the role of human error probability and latent conditions in relation to safety climate (Dekker, 2014, 2015). In his influential book 'Human Error' Reason (1990) identified particular types of cognitive error and combined it with earlier work on levels of cognitive processing (Rasmussen, 1980). Groeneweg (2002) reported on the development of basic risk factors or 'general failure types' and their assessment using a questionnaire instrument called TRIPOD Delta. The importance of systemic and organisational performance shaping conditions has been clearly established (e.g., Groeneweg, 2002; Hollnagel, 1998; Reason, 1990, 1997).

The findings of the investigation into the explosion of Piper Alpha (Cullen, 1990) lead to increased attention for organisational factors and the development of safety management systems. Organisational factors which are thought to influence worker conditions have been classified in many ways. The concept of basic risk factors (Groeneweg, 2002; Wagenaar et al., 1994) was developed by starting from the latent failure 'Swiss cheese' model of accident causation (Reason, 1990). At a similar point in time Hollnagel (1998) identified nine 'common performance conditions'. Guldenmund et al. (2006) identified nine elements of so-called management delivery systems which are primary safety management processes. Zacharatos et al. (2005) looked at High-Performance work systems and management practices in relation to occupational safety outcomes. Ale et al. (2008) used seven delivery systems or 'components of working safely'. Finally, Sklet et al. (2010) identified seven risk influencing factors. An overview of the themes these authors identified is included in Table 1.

As can be seen from Table 1 some similar concepts are included in most of these approaches though with different labels and level of detail. A questionnaire was central to the development of the 'basic risk factors'. The TRIPOD Delta checklist which was developed in the nineties uses a questionnaire-based approach to measure performance on these aspects (Hudson et al., 1991, 1998; Groeneweg, 2002). The instrument consists of a broad database of binary questions on observable characteristics of latent failures grouped into the factors. The instrument was used extensively in practice and was shown to provide additional insight into the performance of safety management systems over a purely audit based approach (Cambon et al., 2006) and was adapted to a healthcare setting (van Schoten et al., 2014). For the other taxonomies, quantification of organisational contributions to 'human error' has instead been focused on methods such as systematic interviews (Vinnem et al., 2012) and expert judgement (Ale et al., 2008;

Download English Version:

https://daneshyari.com/en/article/4981228

Download Persian Version:

https://daneshyari.com/article/4981228

Daneshyari.com