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Criterion-related validity of the cultural web when assessing safety culture

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ABSTRACT

The purpose of the safety culture construct is to reduce organisational and occupational accidents. However, researchers have struggled to develop validated 'measures' of safety culture, that unequivocally link cultural traits with actual safety performance.

Johnson's (1992) [Johnson, G., (1992). Managing strategic change—strategy, culture and action. *Long Range Planning, 25*(1), pp.2] qualitative cultural web tool was adapted to simultaneously produce quantitative effectiveness ratings of an organisation's current safety arrangements for impacting personnel's safety-related behaviour. Data was collected at 15 safety culture workshops across North America over three-weeks. The population sample comprised 700 personnel, divided into 110 respondent groups. Data were examined from two perspectives: *Within* the cultural web topics (Routines, Stories, Symbols, Influences, Values, Structures & Measures); and specific safety culture topics (Profit before safety, Culture of Fear, Safety Leadership, Compliance, Competency, Communication, Lessons Learned) derived from thematic content analysis *across* the cultural web topics.

The overall safety culture was shared and stable. Cronbach's Alpha (0.845) indicated reliability. Criterion-related validity between the organisation's Total Recordable Incident Rates (TRIR) for the cultural web topics ($r = 0.488$, $p < 0.01$) and specific safety culture topics ($r = 0.417$, $p < 0.01$) was found. Multiple regressions against specific incident records returned adjusted R^2 criterion-related validity coefficients between 0.06 and 0.45. Both perspectives confirmed the criterion-related validity of the cultural web tool, albeit stronger relationships tended to be obtained from the safety culture topics. The study results reinforce the conclusion that the tool is a reliable and valid method that can help companies reduce organisational and occupational incidents and improve their safety culture.

1. Introduction

The safety culture term is a construct used to explain how internal organisational social environments directly influence organisational risk practices that could lead to personal injuries or catastrophic process safety disasters (Antonsen, 2017). Its purpose is to improve organisational and occupational safety, by preventing low frequency, high severity events such as Chernobyl, Bhopal, Piper Alpha, Texas City, Deepwater Horizon, etc., as well as high frequency, lower impact events (i.e. personal injuries, etc.). First introduced in 1986 by the International Nuclear Safety Advisory Group (INSAG, 1986) and defined in 1991 by the International Atomic Energy Agency (IAEA) as '*that assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, [nuclear power] safety issues receive attention warranted by their significance*', the safety culture construct has become extremely important to regulators e.g. HSE, 2005; CANSO, 2008; EUROCONTROL/FAA, 2008; USDOT, 2011; PSAN, 2011; NRC, 2012; OSHA, 2013; BSEE, 2013). as well as organisations concerned with improving their safety performance to reduce incidents.

1.1. Theoretical models of safety culture

How an organisation approaches the task of improving its safety culture depends in large part on the theoretical safety culture model(s) adopted. Favoured by social scientists, the *interpretative approach* (e.g. Schein, 1983, 1990; Johnson, 1992) states the organisation is the culture, where 'cultural' realities are socially constructed solely by the organisation's membership. The emphasis of the interpretative

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approach is on gaining an in-depth understanding of the prevailing cultural influences (i.e. assumptions & attitudes) affecting people's behaviour. Conversely, the *functionalist approach* is favoured by managers and practitioners (the owners of safety culture) who view culture as a variable to be engineered to suit the prevailing circumstances to affect performance by addressing management system faults, people's safety related behaviour, risk-assessments and decision-making (Cooper, 2018).

During the period 1986–2000 three influential models of safety culture were developed to guide theory, research and practice. Guldenmund's (2000) *interpretative* three-layered organisational culture framework views 'culture' as a pattern of basic assumptions, invented, discovered, or developed by a group as it learns to cope with its problems of external adaptation and internal integration. This pattern of assumptions is considered to be valid and is taught to new members as the correct way to perceive, think, and feel in relation to those problems. From this perspective, organisational culture is not the overt behaviour or visible artefacts one might observe in a company; rather it is the assumptions that underlie the values and determine not only behaviour patterns, but architecture, office layout, dress codes, etc., (Schein, 1983). In accordance with these views, Guldenmund proposes that the safety culture construct has three layers: the bottom layer is comprised of core basic assumptions which are unconscious and unspecified (invisible) where suppositions about safety are not articulated but are taken for granted as the basis for argument or action. The middle layer, predicated on the core basic assumptions, reflects espoused beliefs and values which are operationalised as relatively explicit and conscious attitudes whose target is hardware (safety controls), software (effectiveness of safety arrangements), people (functional groups), and people's safety-related behaviours. Artefacts on the top layer are the manifestation of the previous two layers, which reflect all those visible safety objects (e.g. PPE, inspection reports, safety posters, etc.), from which it is asserted it would be difficult to comprehend an entity's safety culture (Schein, 1992). The basic assumptions are thought to differ for executives, engineers, and operators, which means the overall organisational safety culture is comprised of different sub-cultures. The emphasis of this approach is on understanding these basic assumptions and their meaning to the organisation's membership and changing these to improve performance. There is some indirect anecdotal evidence to support the model in the safety arena (e.g. Nielsen, 2014) and some statistical evidence in marketing (Homburg & Pflesser, 2000).

Cooper's (2000) *functionalist* reciprocal model, based on Bandura's (1977) Social Learning Theory, highlights that safety culture is a *product* (Schein, 1992) of multiple goal-directed interactions between internal psychological factors, overt behaviour(s), and situational workplace aspects. In this model, the prevailing organisational safety culture is reflected in the dynamic reciprocal relationships between: members' perceptions about, and attitudes towards, the operationalisation of organisational safety goals; members' day-to-day goal-directed safety behaviour; and the presence and quality of the organisation's safety systems and sub-systems to support the goal-directed behaviour. Formally adopted by the American Petroleum Institute (2015) and the American National Standards Institute (ANSI), the reciprocal safety culture model is supported by large-scale studies on accident prevention (e.g. Lund & Aarø, 2004) and safety culture (e.g. Fernández-Muñiz et al., 2009; Cooper, 2008; Lefranc et al., 2012).

Reason's (1998) *functionalist* approach equates safety culture with an 'informed culture', where members of the organisation understand and respect the hazards facing their operations and are alert to the many ways in which the system's defences can be breached or bypassed. In short, an informed culture is one in which people, at all levels do not forget to be afraid; they know where the 'edge' is without having to fall over it. To be informed requires that there is a reporting culture, which in turn relies on the presence of a centralised safety information system that collates and analyses data from incidents, near-miss reports, and other sources (behavioural observations, workplace inspections, etc.), and translates that information into knowledge, so that it can be widely disseminated (e.g. Carthey et al., 2001). This requires a learning culture where there is willingness and competence to draw the right conclusions from the safety information system. Based on this, a flexible culture is required where there is the will to implement major reforms when the need is indicated. However, the reporting culture is itself dependent on a just culture (how an organisation handles blame and punishment for actual or perceived transgressions). Reason asserts that trust lies at the heart of any safety culture. Reason's model is also supported by evidence (e.g. Collinson, 1999; Saji, 2003; Pluye & Hong, 2014).

Regardless of philosophical approach (i.e. interpretative or functionalist), each of the safety culture models have attempted to provide an actionable framework, and each has been influential in the sense that researchers, regulators and industry have made use of them in some empirical and/or practical capacity.

1.2. Assessing safety culture

Although scholars recommend using a triangulation of assessment methods such as audits (Grote and Künzler, 2000), qualitative focus group exercises (Buchan, 1999), and behavioural observations (Cox & Cheyne, 2000), the most common method for assessing organisational safety culture is via cross-sectional perceptual surveys (e.g. Clarke, 2006; Goodheart & Smith, 2014; Leitão & Greiner, 2015). Through a series of pre-determined questions targeting various safety-related topics, surveys typically measure staff perceptions about how safety is being managed at a particular moment in time (Byrom & Corbridge, 1997).

In occupational safety there are an almost infinite number of characteristics that can influence safety performance, and hence the prevailing safety culture. Previous work from both academe (Flin et al., 2000) and examinations of the results of public enquiries (Cooper & Finley, 2013) into process safety disasters (e.g. Deepwater Horizon, Texas City), identified six main topics reflecting important contributors to a safety culture. These were: [1] management/supervision, [2] safety systems, [3] risk, [4] work pressure, [5] competence, and [6] procedures and rules. Typically, these characteristics are contained in modern safety management systems (e.g. OSHA (S) 18001:2007; ANSI-Z10: 2012; ISO45001: 2018) implemented in many countries. Although these topics are found in many perceptual safety surveys, Cooper's (2016) safety culture review found such surveys typically exhibit non-existent to weak relationships to *actual* safety outcomes (e.g. safety behaviour, adverse safety incident records). After almost three decades of research, it seems sensible, therefore, to seek valid alternative methods for assessing safety culture.

A precursor to Guldenmund's (2000) model of safety culture, Johnson (1992) developed a qualitative practical 'cultural web' tool based on an amalgamation of both Schein's (1990) and Hofstede's (1990) culture models to assess an organisation's culture. 'In three layers, this examines: first, any unshared underlying unstated assumptions – this is 'the what' (bottom layer); next, espoused beliefs and values reflected in justifications for behaviour – this is 'the why' (middle layer); and lastly, behaviours and artefacts – this is 'the how' (top layer). These are reflected in visible organisational behavioural patterns. Johnson divided the latter into rituals and routine practices, stories told, symbols used, power relationships, organisation structures, and controls. As such, Johnson's cultural web topics are linked to the organisation's political, symbolic and structural aspects that reveal the mechanisms for change. Buchan (1999) used the cultural web extensively, with different groups in many countries, to assess safety culture in the offshore petrochemical industry. Seemingly well received by company personnel, no criterion-related validation against actual safety performance, such as lost-time incidents or other safety indicators, was reported. Biggs et al., (2010) argue that adverse incident