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A brief safety climate inventory for petro-maritime organizations

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ABSTRACT

The first aim of this two-study paper was to report psychometric properties of a brief 11-item measure of safety climate adapted to petro-maritime organizations. The second aim was to examine potential indicators of predictive validity. Factor structure, internal consistency, and validity analyses were performed in two independent samples. The first sample consisted of 396 personnel working on offshore oil- and gas installations in the North Sea (response rate: 42%). The second sample comprised 594 crew members working on vessels belonging to two large Norwegian shipping companies (response rate: 73%). Data from both studies supported a three factor solution labelled *Individual intention and motivation*, *Management prioritization*, and *Safety routines*. The subscales had good psychometric properties. The validity indicators revealed correlations between the safety climate scales and transformational and authentic leadership, risk perception, health problems, intentions to leave, and job satisfaction in the expected directions. The present study indicates that this 11-item measure has a psychometrically sound factor structure that represents a theoretically meaningful and empirically anchored expression of safety climate in a petro-maritime organization.

1. Introduction

The International Safety Management (ISM) Code was implemented after a series of severe maritime accidents with the aim to ensure safety at sea, prevent human injury or loss of life and avoid damage to the environment (International Maritime Organization, 2010). Although the ISM Code assumes that an improved safety management practice on board would result in reduced human error and negligence (Anderson, 2003), maritime accidents and near miss incidents are still frequent. For instance, in the period from 2000 to 2005, a worldwide average of 18 ship collisions, groundings, or fires occurred every day (Gregory and Shanahan, 2010). The concept of *safety culture* is often used to describe the many factors related to organizational processes and management practices that have the potential to influence safety performance (Guldenmund, 2000). As a related concept, *safety climate* is defined as the workers impression of safety resources, and based on existing policies and procedures, and how they are enacted, workers will assess whether the organization truly prioritize safety (Zohar, 2010).

Although the distinctions between safety climate and safety culture are debated, the concept of climate is frequently applied in survey research on safety culture (Cox and Flin, 1998). Thus, safety climate is often referred to as an empirically measurable component of safety culture, which has relationships with safety indicators such as near miss reporting, accidents, injuries, and work related illness (Neal et al., 2000; Zohar, 2008, 2010). In line with this perspective, Neal and Griffin (2004) suggests that safety climate provides a motivational antecedent for safe behaviour. In their view safety climate will index *essential determinants of safety* such as safety knowledge and safety motivation. These determinants are often referred to as non-technical skills to indicate that they represent an additional set of competencies that are used integrally with technical shipping skills (Flin et al., 2008). Furthermore, safety climate should be linked to *safe performance*, for instance by worker compliance to safety protocols. When employees from many cultures and nationalities share a confined environment, language and cultural barriers could cause misunderstanding and non-compliance. Finally, safety climate is related to *safe outcomes* in the form of occurrence or non-occurrence of injuries and work related illness. The relationships between safety climate and safety indicators are crucial in this respect. For instance, a growing body of research indicates that employees who perceive the safety climate as strong have a lower chance for workplace accidents (risk perception), safer workplace performance, reduced number of injuries, and most notably fewer reports of rule violations (Mearns et al., 1998, 2001a; Mearns et al., 2001b; Neal et al., 2000; Rundmo, 1996, 2000; Zohar and Luria, 2004).

Maritime accidents share many similarities with accidents in the offshore oil and gas industry, and maritime accidents may also

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cause accidents related to offshore oil and gas production. The Petroleum Safety Authority Norway (PSA) has for instance registered 26 collisions between vessels and structures in the North Sea over the last 10 years. In order to monitor and improve safety management in petro-maritime organizations there is a need for a user-friendly measurement instrument to assess factors related to safety and loss prevention in petro-maritime organizations. In their review of accidents in the shipping industry Hetherington et al., 2006 note several organizational and individual factors that contribute to safety in the maritime industry. Safety critical factors such as fatigue, stress, health, situation awareness, teamwork, decision-making, communication, automation, and safety culture are considered key elements to be included in a safety climate index of petro-maritime organizations (Hetherington et al., 2006). A few comprehensive surveys have been developed to measure different aspects of safety culture in the maritime sector (Håvold, 2003; Oltedal and McArthur, 2011; Oltedal and Wadsworth, 2010). Despite the intentions expressed by the new ISM Code to monitor human factors and safety performance, there is to date no brief measure of maritime safety climate available.

Using a Study 1–Study 2 design, the present study attempts to bridge this gap in the literature by reporting psychometric properties from a brief self-report measure of safety climate adapted to the petro-maritime organizations. To assess the factor structure, reliability, and validity of the inventory, data were collected through two surveys in safety critical organizations, i.e. organizations with high potential for stress, accidents, and injuries (Rundmo, 1994; Sutherland and Cooper, 1989). The first survey was administered to offshore personnel working on oil- and gas installations operating in the North Sea, whereas the second survey was carried out among crew members from two large Norwegian shipping companies.

2. Study 1

Although there are other instruments in existence which assess aspects of safety climate (e.g., Havold and Nesset, 2009; Tharaldsen et al., 2008; Zohar, 2000), there is room for improvement in terms of adapting them to research settings. First of all, as the existing inventories incorporate a high number of items (>30), one may raise the issue of participant response burden. A high number of items are also problematic with regard to confirmatory factor approaches such as structural equation modeling in that larger sample sizes are needed to assure reliable analyzes of data. Finally, some of the existing inventories include a high number of subscales, something which makes it bothersome to conduct analyses, and report findings.

In order to develop a brief, but psychometrically sound, measure of safety climate, our point of departure in this study was the "Norwegian offshore risk and safety climate inventory" (NORSCI), an extensive 35 item measure of safety climate that was adapted to the offshore oil and gas production industry. This inventory has been used by the PSA in bi-annual surveys of safety compliance and risk perception in the offshore oil and gas industry on the Norwegian continental shelf from 2001 and to date. Respondents are asked to rate their agreement to statements describing safe work behaviour (e.g. "My supervisor is committed to the health, safety and environment work on the facility") and safe work environments (e.g. "Lack of maintenance has resulted in reduced safety"). Psychometric properties of the full NORSCI inventory have been reported in several studies. For instance, Tharaldsen et al. (2008) reported a five-dimensional structure using a 35-item version of NORSCI. The five factors were *safety prioritisation*, *safety management and involvement*, *safety* vs. *production*, *individual motivation*, and *system comprehension*. Notably, the first three dimensions primarily reflect situational factors while the remaining factors focus on individual safety precautions and skills. In a follow up study of offshore workers Høivik et al. (2009) identified the five factors mentioned above, with an additional sixth factor of *safety competence*. This same six factor solution was also reported by Hope et al. (2010). From previous research we would expect a brief measure of safety climate to reflect individual and organizational factors related to safety outcomes. More specifically, the measure should assess both management's priority of safety with regard to how safety issues are emphasized over production, as well as individual motivation, competence, and compliance with safety procedures and safety objectives.

Our aim for Study 1 was to examine whether the NORSCI inventory could be reduced to a shorter inventory consisting of fewer items, while still maintaining good psychometric qualities and predictive power with regards to safety outcomes. Following from theoretical models of workplace safety, factors such as leadership and individual health and well-being have been emphasized in the understanding of safety (e.g., Barlow and Iverson, 2005). We will therefore aim to demonstrate relations between the brief safety climate inventory and subjective risk perception, health complaints, and leadership in order to establish the criterion-related validity of the inventory. First of all, it is reasonable to expect safety climate to be associated with other indicators of risks and safety. Indeed, previous research has found that safety climate is related to risk perception, in that perceptions of a strong safety climate is associated with lowered risk perception (Nielsen et al., 2011). Furthermore, perceptions of workplace safety have been shown to be related to health-related variables (Hayes et al., 1998). Finally, leadership has been described as one of the strongest predictors of safety, and various studies substantiate that leadership behaviors that are particularly oriented towards enhancing safety, promoting change, exemplary safety role-modeling, and a positive leader–member exchange are especially important with regard to levels of risks and safety in safety critical organizations (Barling et al., 2002; Hofmann and Morgeson, 1999; Zohar, 2002). Fitting into this description, authentic leadership is a leadership style that has been proposed to be an important predictor of positive employee outcomes, including safety perceptions (Eid et al., 2012). Authentic leaders place a strong emphasis on behaving transparently, and are by followers rated as being high on measures of moral or ethical behavior (Avolio and Gardner, 2005). This could suggest that authentic leadership could be potentially important for fostering more effective risk and safety management practices among workers that serve to prevent harm to employees, the environment and the organization (Nielsen et al., in press). It is therefore sound to assume that a measure of safety climate would be associated with authentic leadership.

2.1. Method

2.1.1. Design, procedure, and sample characteristics

Study 1 is based on a survey of Norwegian offshore personnel employed in a large international petroleum exploration and production company operating on the Norwegian continental shelf. A two-part questionnaire was sent to the company's offshore installations and distributed to all regularly employed offshore personnel in the company during spring 2010. The first part of the questionnaire comprised questions about demographic information, safety climate, risk perception, work environment, health, sleep, accidents, and job demands. The second part of the questionnaire included questions about authentic leadership, psychological capital, and personality. The questionnaires were anonymously returned to the PSA. Altogether 396 of the 934 regularly employed