The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1726-0531.htm

# Safety climate of UAE petroleum industry: a cross-validation using confirmatory factor analytic approach



Mohmaed Almazrouei, Khalizani Khalid and Ross Davidson
*College of Business, Abu Dhabi University, Abu Dhabi, United Arab Emirates*

Received 21 April 2020
Revised 9 July 2020
25 August 2020
Accepted 15 September 2020

## Abstract

**Purpose** – The purpose of this paper is to develop and validate a safety climate scale for measuring the safety climate in the oil and gas industry.

**Design/methodology/approach** – The scale developed through conducting a literature review about the safety climate and constructing a question pool. The number of items was reduced to 51 after performing a screening process. Explanatory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed to examine the scale's construct validity.

**Findings** – CFA loadings were statistically significant. All Cronbach's alpha (a) and composite reliability values support the construct reliability. The outcomes showed acceptable convergent and discriminant validity: AVEs showed acceptable values, and the square roots of AVE values showed higher values than the construct correlation values. Furthermore, all factor loadings exceeded 0.50, and the *t*-values were statistically significant. CFA loadings were statistically significant.

**Originality/value** – The safety climate measuring scale of 43-instrument items produced in this study is reliable and valid for the oil and gas industry.

**Keywords** Safety climate, Oil and gas, United Arab Emirates, Scale development, Scale validation

**Paper type** Research paper

## 1. Introduction

Safety climate ranks highly as a safety performance indicator for predicting safety-related outcomes, including occupational injuries or accidents and safety behavior (Meliá *et al.*, 2008; Olsen, 2010). Previous studies (Seo *et al.*, 2004; Yeung and Chan, 2012) agree that using a valid scale for safety climate measurement is critical and has the potential to promote accurate data collection. Assessing the reliability of a scale is only useful for describing the magnitude of a scale's measurement errors (Ghahramani and Khalkhali, 2015; Jiang *et al.*, 2018).

Several studies (Chen and Chen, 2012; Ghahramani and Khalkhali, 2015; Glendon and Litherland, 2001; Lu and Shang, 2005; Vinodkumar and Bhasi, 2009) have been carried out to investigate the development of organizational safety climate. Despite such efforts, there is no consensus about the dimensions of safety climate. Generally, past studies (Evans *et al.*, 2007; Flin *et al.*, 2006; Mohamed, 2002; Seo, 2005) have consistently mentioned

The authors thanks Dr Karam for assistance with developing the methodology preparation and Dr Alzarooni for comments that greatly improved the manuscript.

They would also like to show our gratitude to Alain University faculties for sharing their pearls of wisdom with them during the course of this research, and they thank all the participants from downstream and upstream oil and gas companies for being part of this research.



1726-0531
DOI 10.1108/JEDT-04-2020-0138

managements' commitment to safety as a safety climate dimension. Seo *et al.* (2004) came up with five thematic categories of safety climate dimensions. These categories include management commitment to safety, coworker safety support, supervisor safety support, employee safety competence level and employee involvement in safety activities and decision-making. A review of 18 surveys on safety climate by Flin *et al.* (2000) identified a safety system, risk, supervision/management, competence and work procedure as the highest-ranking dimensions by frequency. Other safety climate dimensions reported in the literature (Evans *et al.*, 2007; Mohamed, 2002; Seo, 2005) include safety training, safety rules and procedures, supervisory and supportive environments and safety communication.

Worldwide, several instruments are available for measuring safety climate in multiple industries. However, to the best of our knowledge, this study is a pioneering investigation into the development and validation of a safety climate scale within the oil and gas industry in the United Arab Emirates (UAE). The need to develop a new scale within this industry and cultural context was motivated by the understanding that safety climate is unique, and context culture varies according to the industry, organization and sectors within the organization and country (Høivik *et al.*, 2009; Mearns *et al.*, 2004). Furthermore, calls to develop a standard questionnaire for collecting essential safety climate data and the recognition of the necessity to identify occupation-specific dimensions of safety climate are being made (Kudo *et al.*, 2008). Thus, developing an original safety climate scale for the oil and gas industry in the UAE is important; we developed such a scale in this study, and its reliability and validity were explored.

## 2. Literature review

The following sections present related work to understand the safety climate and its theoretical background and the different methods on developing safety climate scale.

### *2.1 Theoretical background*

This study uses the theory of planned behavior (TPB) as the theoretical framework for developing the instrument. TPB explores the relationships among attitudes, beliefs and self-efficacy, which can affect an individual's decision to follow or reject prescribed safety protocols. Thus, a scale to measure safety climate based on human behavior theory would be a realistic measurement of different aspects (Montano, *et al.*, 1997). In prior studies, TPB has been shown as a suitable predictive model of behavioral intention in a different safety and occupational settings (Arnold, *et al.*, 2006; Elliot, *et al.*, 2003; Evans and Norman, 2002; Petrea, 2001; Quine, *et al.*, 2001; Sheeran and Silverman, 2003). The findings from these studies justify the use of TPB as the basis for the development of a model representing safe behavior.

### *2.2 Developing the construct of safety climate*

Safety climate is described as a unified set cognition that workers of an organization hold in relation to safety aspects in the work environment (Zohar, 1980). Safety climate develops as a result of the daily experiences of workers, which develops into an influential and well-defined form of organizational climate. According to a study conducted by Litwin and Stringer (1968), a divergent point of view exists about the safety climate.

Two distinct features can be used to analyze safety climate perceptions. The first perception relates to viewing perception as a collective property of groups. Sharing across individuals is naturally a unique feature that separates this approach from other safety constructs, for instance, personal attitudes. Unlike psychological climate, which entails individual attitudes toward the work environment, a safety climate exclusively deals with individual perceptions of a particular workgroup. Griffin and Neal (2000) conclude that perceptions originate from a collection of clues and behaviors which employees perceive as safe.

The second type of perception is formed by observable characteristics, which are intrinsic cognition seen and reported by employees in day to day operations (Guldenmund, 2000; Zohar and Luria, 2005). Although issues of safety climate emphasize personal attitudes, skepticism is characteristically based on evaluation and is affective in nature (Mearns *et al.*, 1998).

### *2.3 Multidimensional nature of safety climate*

Researchers have failed to come up with a single acceptable conclusion for designing constituent elements of safety (Christian *et al.*, 2009; Zohar, 2010). Researchers experienced conceptual and practical challenges owing to a wide range of perceptions derived from the formal and informal process such as pieces of training and group related relationships (Christian *et al.*, 2009). It is noteworthy to distinguish between the ingredients of safety climate from other related perceptions, for instance, risk appetite and personal attitudes (Huang *et al.*, 2006). Empirical studies indicate that conceptual complexity exists in safety climate measurement, thus, resulting in several models that conflate cognitive perceptions. Furthermore, elements of climate safety are affected by many variants which include stress at work, risk appetites and personal beliefs (Clarke, 2006). Because of the aggressions across diverse psychological constructs, it has been problematic to establish a direct relationship linking safety climate and safety consequences (Wallace *et al.*, 2006). It has been objectively observed that ongoing methods for developing safety climate tend to raise the prediction and power for consequences such as work-related calamities (Clarke, 2006; Dogru and Peker, 2019).

### *2.4 Multilevel nature of safety climate*

Klein and Kozlowski (2000) findings reveal several varieties of aggregate entities that collectively make up safety climate. As such multi-level nature analysis in different levels of operations in safety climates is required. Initially, the safety climate was viewed as a conceptual framework which operates mainly at the organization level. However, studies reveal an emerging trend where a safety climate is conceptualized in informative and predictive levels of climate safety aggregation (Zohar, 1980).

### *2.5 Organization level safety and variation within the organizations*

Major theories tend to view safety climate as an organization-level construct. However, empirical studies suggest that most of these theories come from biased researchers. Studies conducted in 1980 by Scopus, as database research of safety climate, reveal that more than half of the findings organizations acted as autonomous entities with well-structured borders (Zohar, 2010).

Organizational levels are characterized by clear policies, well-defined procedures and good practices. These primary conceptual features when applied consistently form a strong safety climate, hence portraying the organization level as a prominent initiative when dealing with safety climate issues. The organization-level contains various variables, which include safety actions observed by management, the competence of safety systems, management systems quality and safety training adequacy (Flin *et al.*, 2000; Zohar and Luria, 2005).

### 2.6 Team- and unit-level safety climate

Because of the autonomy allowed to supervisors, they have freedom in exercising their authority, and this means that different departments may have a different understanding of policies relating to safety, procedures applied and practices (Zohar, 2010). This stems from several variable causes. For instance, the steps do not cover all scenarios, and at a local level, substantial discretion can be implemented depending on how wide the plans are. Interpersonal dynamics are involved in leader-member exchange governed partially by formal procedures. Formal procedures greatly influence how supervisors interpret and implement instructions to subordinates.

### 2.7 Industry level

Because of turbulences in dynamic and high-risk business environments that occasionally experience catastrophes, researchers have tried to find solutions that will enable the business to mitigate these risks by developing concepts, new tools and sophisticated methods (Grote, 2009). Risk management is essential for business survival. Some companies manage risk within the organization as per their requirements while other companies adapt and improvise existing best practices (Mearns and Yule, 2009).

Across the board, industries view safety climate models and relevant approaches as an important field of study. Safety climate is not universal in all industries. For this reason, safety climate is influenced by several factors, for instance, the presence of cultural diversity in professional relationships, interactions across departments, investigations setups, social and technical risk and regulatory frameworks (Grote, 2009).

### 2.8 National culture and safety climate

National culture and safety climate is a combination of inter-play between differences in cultural practices, risk perceptions and wide socio-economic situation interactions. Because of social interactions among diverse cultures, the management of safety climates in such organizations is of the essence. Accommodating diverse cultures in these organizations is an emerging issue that should be taken into consideration (Reader *et al.*, 2015).

Studies demonstrate that safety climate is often applicable across many organizations, However, in some industries, it is not given the much-deserved attention given to mainstream aspects of national culture (Hahn and Murphy, 2008). Western studies have outlined the low attention given to safety climate (Bahrami *et al.*, 2014). There is a need for comparative studies to comprehend the meaning of safety climate and the possibility of transferring understanding to other nationalities across cultural contexts (Zohar, 2014).

### 2.9 Developing climate through sense-making processes

Safety climates develop gradually as people interact by sharing their perception in the work environment. Sense making in the organizational perspective occurs when employees face complicated challenges together in a social set up and discuss and gain insights on their environment to eliminate uncertainties that impact the goals, workplace norms and other organizational decisions. Sense making helps develop perceptions as individuals share ideas collectively (Gonzalez-Roma *et al.*, 2002). These interactions are either rewarded or sanctioned (Weick, 1995). Through sense making, a safety climate is developed by using experience availed by social events (Ostroff *et al.*, 2003).

## 3. Materials and methods

This study sought to test the reliability and validity of a new scale for measuring the safety climate in the UAE oil and gas industry. For the face and content validity analysis, 50 participants were divided into three groups. The first group comprised the faculty members ($n$ = 14) from Alain University and Zayed University in UAE; they were involved in occupational health and safety (OHS) research. The second group consisted of OHS officers who held managerial positions ($n$ = 10) in different subsidiary companies under the Abu Dhabi Oil Refining Company. The third group consisted of employees from the upstream and downstream companies ($n$ = 26). An additional group of employees ($n$ = 26) from the oil and gas also participated in a test–retest reliability study by completing questionnaires after three weeks. The employees were selected via random selection for reliability and validity analyses. Eventually, 269 employees working at six different oil and gas companies provided the data for the exploratory factor analysis (EFA), CFA and reliability analysis.

Content validity was measured on different criteria, which included three scales labels based on Lawshe (1975): not necessary, useful but not essential and essential. For evaluating face validity, OHS experts were requested to include their comments concerning the clarity and ambiguity of the items. For the employee sample, the criterion was deduced from Polit and Beck (2006). The employee sampling involved ranking each safety climate item for simplicity, relevance and clarity based on a four-point Likert scale. In the scale, 1 = clear or simple (not relevant), 2 = item requires revision, 3 = clear or simple (relevant) with need for minor revisions and 4 = clear or simple (very relevant).

Descriptive statistics were used to describe the individual traits of the respondents and to analyze the scale's content validity. The data obtained from the OHS experts was used for computing the content validity ratio (CVR) based on the formula below:

$$CVR = (n_e - N/2)/(N/2)$$

The mean of the item CVRs aided in the calculation of the content validity index (CVI) (cf. Lawshe, 1975). For each questionnaire item that was completed by the employees, an item-CVI (I-CVI) was computed as the count of "3" and "4" scores divided by the experts' count and multiplied by 100 (cf. Polit and Beck, 2006). Subsequently, the scale-CVI (S-CVI) was calculated for the entire questionnaire by calculating the mean of all I-CVIs. EFA was performed for identifying the underlying dimensions of safety climate as Cronbach's alpha and interclass correlation coefficient. The scale's dimensional structure was investigated using CFA. All statistical analyses were carried out using IBM's Statistical Package for the Social Sciences v.21; AMOS v.21 was used for performing CFA.

## 4. Design and approach

This study was undertaken in three major phases (Figure 1), starting with the collection of relevant data through a questionnaire. For the questionnaire, 662 safety climate items were identified from previously published articles through a literature review. After narrowing down the main objectives and aims of the current study, the number was reduced to 51 through screening for repetition and relevance by interviewing experts in the health safety environment field and researchers working in the UAE university. The screening process used the inclusion and exclusion criteria. Inclusion criteria are attributes that an individual believes should be included in the study whereas exclusion criteria are attributes that individuals eliminate from the study (Meline, 2006). As shown in Figure 1, the second research phase implements quantitative research methods to generate a pool of items that were included in a scale for measuring the constructs of the safety climate dimensions. This was a critical phase because of the fragmented ideas in the existing literature on safety climate dimensions. The outcomes were to ascertain the initial validity and reliability

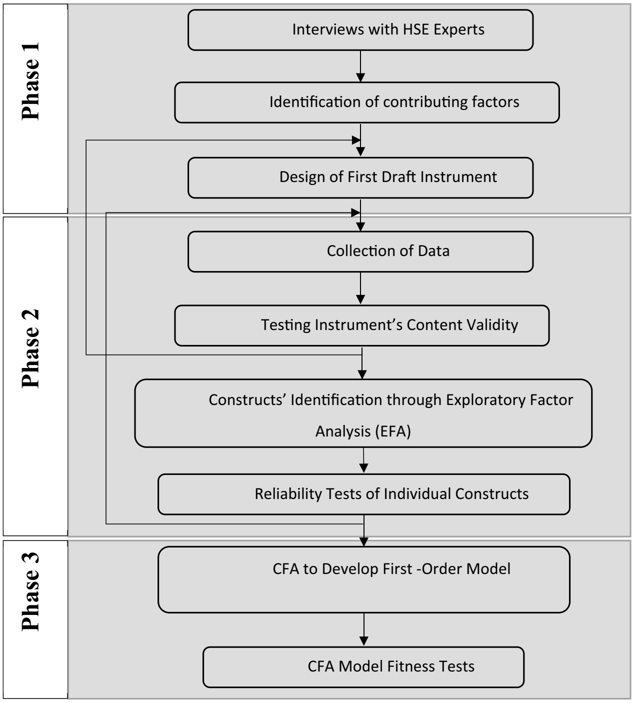



**Figure 1.**
Research methodology

information about each measurement scale. The safety experts communicated with the researchers four times via video conferencing to assess the original 662 items collected from previously published literature and eliminate all theoretically or practically insignificant items, unclear items and items that repeated the imperative of other items. Also, the researchers asked the experts to report different dimensions that underlie their commitment and desire to adopt, adhere to and maintain a safety climate that affects the process safety performance, especially in the UAE. According to (Lynn, 1986), content validity relies on the intuitive or experienced judgment. Following this, the investigators deleted items with CVI lower than 0.83, which reduced the original items in the questionnaire from 662 to 51. To further evaluate the 51-item questionnaire, the researcher conducted semi-structured interviews with the safety experts, through which four core themes were identified on how safety climate influences employee's approach to safety (Appendix 1).

After this phase, the SurveyMonkey platform was used to administer the final data-collection instrument, and this led to 269 responses from various employees in different oil and gas companies. During the third phase, the 269 responses obtained from the survey were tested. Principle component analysis (PCA) was conducted to explain the highest possible common variance with the fewest explanatory constructs (latent variables or factors). A Cronbach's alpha coefficient (Cronbach, 1951) of 0.962 affirmed the reliability of the responses for further analysis. Subsequently, model fit was assessed using the comparative fit index (CFI), Tucker–Lewis index (TLI) and confidence interval of root mean square error of approximation (RAMSEA) and found all the indices to be within the threshold limit. Furthermore, the overall model fit was assessed using CMIN/DOF and found to be fit. The assessment is described thoroughly in Section 5. After this, the constructs describing the safety climate dimension of the UAE's oil and gas industry were assessed and validated using CFA. The final 43-item questionnaire is tabulated in Appendix 2.

## 5. Data analysis

Fifty individuals took part in the safety climate scale's face and content validity analyses. As displayed in Table 1, most of the employees and faculty members were male, accounting for 84.2% and 92.9%, respectively. The descriptive statistics show that respondents aged between 30 and 39 years old dominated all three groups (Table 1). The working experience of most of the OHS experts ranged between one and five years (40 %), while that of most employees was between six and ten years (36.4%). Male employees constituted the majority of the employee participants in the test–retest reliability analysis (96.2%). Employees aged between 40 and 49 years old were the majority, and 34.6% had more than 20 years' work experience.

### *5.1 Exploratory factor analysis*

EFA was performed during the pilot study phase involving different safety actors, workers, supervisors and managers in various units and departments. Before proceeding with EFA on the items, some conditions must be satisfied, and this can be assessed through various tests. The Kaiser–Meyer–Olkin (KMO) test (Kaiser, 1970) and Bartlett's test of sphericity (Bentler, 1992) were among the tests that were performed. As shown in Table 1, the considerably high KMO value (0.955) indicates that the items are appropriate for undertaking factor analysis because no serious multicollinearity issues are indicated within the dataset. Bartlett's test of sphericity (Sig. $< 0.01$) showed that the interitem correlations were adequate for running factor analysis (Table 2).

| | Validity analysis | | | |
|---|---|---|---|---|
| Variables | Employees ($n$ = 26) | OHS experts ($n$ = 10) | Faculty members ($n$ = 14) | Reliability analysis ($n$ = 26) |
| *Gender* | | | | |
| Female | 4 (18.2%) | 5 (50%) | 1 (7.1%) | 1 (3.8%) |
| Male | 18 (81.8%) | 5 (50%) | 13 (92.9%) | 25 (96.2%) |
| Age (years) | 35.5 (10)* | 32.7 (7.00)* | 40.7 (10.7)* | 41.85 (8.05)* |
| ≥ 60 | – | – | 1 (7.1%) | – |
| 50–59 | 2(4.5%) | – | 2 (14.3) | 4 (15.4%) |
| 40–49 | – | 2 (20%) | 3 (21.4%) | 14 (53.8%) |
| 30–39 | 16 (72.7%) | 4 (40%) | 6 (42.9%) | 5 (19.2%) |
| <30 | 5 (22.7%) | 4 (40%) | 2 (14.3%) | 3 (11.5%) |
| Working experience (years) | 11.6 (7.70)* | 8 (6.05)* | 10.6 (9.5)* | 15.73 (7.65)* |
| >20 | – | 2 (9.1%) | 4 (28.6%) | 9 (34.6%) |
| 15–20 | 6 (27.3% | 1 (10%) | 1 (7.1%) | 7 (26.9%) |
| 11–15 | 1 (4.5%) | 2 (20%) | – | 2 (7.7%) |
| 6–10 | 8 (36.4%) | 2 (20%) | 2 (14.3%) | 3 (11.5%) |
| 1–5 | 5 (22.7%) | 4 (40%) | 6 (42.9%) | 4 (15.4%) |
| <1 | – | 1(10%) | 1 (7.1%) | 1 (3.8%) |

**Notes:** All data are presented as $n$ (%) unless specified otherwise. *Standard deviation and mean in years given for working experience and age of participants

**Table 1.** Demographic statistics of reliability and content validity participants

After these two suitability tests, the 51-item instrument was subjected to EFA using PCA as the factor extraction method while varimax rotation was invoked. The factor retention approach was based on the robust combination of theoretical salience, scree plots and eigenvalues greater than 1.0 for the rotated factors. According to Stevens (2009), the ideal situation is for an item to load above 0.40 on its respective factor and below that threshold on any other factor. The resulting 43-instrument items accounted for 68.27% of the variance in all responses.

Table 3 shows the rotated component matrix presenting the item loadings and respective factor pattern. The first factor (F1) accounted for a maximum of 51.44% of the variance in all responses. The 16 questionnaire items that loaded into F1 seemingly relate to various aspects of organizational commitment to safety (OCS) and safety practices. Thus, F1 was labeled as OCS. The 10 items that are loaded into the second factor (F2) relate to the commitment of the supervisor to the safety of subordinates. Thus, F2, which accounted for 5.25% of the variance in all responses, was labeled as supervisor–subordinate commitment to safety (SSCS). The eight factors that loaded into the third factor (F3) accounted for 4.83% of the variance in all responses. They were mainly about training on safety (TOS), so F3 was labeled as TOS. Six factors loaded into the fourth factor (F4), which explained 3.51% of the variance in all responses. They all appeared to be about the extent to which the employees were engaged in safety, so F4 was labeled as employee engagement with safety (EES). Finally, the fifth factor (F5) accounted for 3.24% of the variance and contained three items regarding compliance with HSE standards, practices and procedures. Therefore, F5 was labeled as HSE compliance.

### *5.2 Content validity and internal consistency*

Reliability speaks to the magnitude of consistency in the responses pertaining to a respective construct. Normally, Cronbach's alpha is the common measure for these tests. As illustrated in the bottom row of Table 2, the five latent constructs constituted from the contributing factors of safety climate were between 0.778 and 0.963. The results indicate that the five proposed constructs have good psychometric properties.

*5.2.1 Convergent validity.* The Bentler–Bonett's normed fit index (NFI) is commonly used for evaluating convergent validity (Bentler, 1995). This index shows the extent to which the various approaches used in measuring a given construct are likely to yield consistent results (Ahire *et al.*, 1996). Bentler (1995) asserted that the rule of thumb is that NFI values of at least 0.90 imply an acceptable fit index. The five constructs had acceptable NFI values, which meant that their constituent items converge well enough to warrant further analysis, as shown in Table 3 (Table 4).

*5.2.2 Discriminant validity.* Bagozzi *et al.* (1991) explained that this type of validity refers to the degree of distinction of latent constructs and their respective indicators from other constructs and indicators. The computation of discriminant validity involves comparing a latent construct's Cronbach's alpha with its average correlations with the other latent constructs. When the comparison yields a significant difference in the two measures,

**Table 2.** Results of KMO test and bartlett's test of sphericity

| | | |
|---|---|---|
| KMO measure of sampling adequacy | | 0.955 |
| Bartlett's test of sphericity | Approx. Chi square | 8,125.709 |
| | df | 1,081 |
| | Sig | 0.000 |

**Table 3.** Rotated component matrix

| Items | Questions | F1 | F2 | F3 | F4 | F5 |
|---|---|---|---|---|---|---|
| Q14 | The management ensures reliable and safe equipment | 0.737 | – | – | – | – |
| Q15 | The management eliminates potential safety issues | 0.736 | – | – | – | – |
| Q19 | My company engages an HSE third-party audit to ensure that safety rules and regulations are followed | 0.726 | – | – | – | – |
| Q2 | The company maintains records of all first-aid treatments, inspections, incident investigations and training activities | 0.726 | – | – | – | – |
| Q11 | The management conducts regular hazard inspections in your work area | 0.725 | – | – | – | – |
| Q18 | My organization enforces a PTW system in all types of work | 0.712 | – | – | – | – |
| Q16 | The management provides and participates in safety campaigns | 0.708 | – | – | – | – |
| Q9 | My company provides sufficient personal protective equipment and gas detectors for the workers | 0.682 | – | – | – | – |
| Q8 | My management encourages raising near misses, unsafe acts and unsafe conditions | 0.680 | – | – | – | – |
| Q1 | The management considers safety as a core organizational value | 0.639 | – | – | – | – |
| Q12 | The management investigates near misses, unsafe acts and unsafe conditions in a timely manner | 0.634 | – | – | – | – |
| Q5 | The management considers production to be more important than safety | 0.631 | – | – | – | – |
| Q17 | My company has clear hydrocarbon and chemical spill response procedures | 0.625 | – | – | – | – |
| Q10 | My company provides enough safety training programs | 0.612 | – | – | – | – |
| Q13 | The management considers production to be more important than environmental pollution | 0.578 | – | – | – | – |
| Q41 | The management exercises safety consequences management standards in case of violation of safety measures | 0.491 | – | – | – | – |
| Avg. factor loading is 0.80; average variance extracted (AVE) is 0.84; composite reliability is 0.965 | | | | | | |
| Reliability is 0.794 and SQRT of AVE is 0.92 | | | | | | |
| Q26 | My immediate supervisor conducts sufficient toolbox talks | – | 0.817 | – | – | – |
| Q25 | My immediate supervisor discusses safety issues with others before performing tasks | – | 0.808 | – | – | – |
| Q28 | My immediate supervisor ensures that the workload and work patterns are adequate | – | 0.760 | – | – | – |
| Q20 | My immediate supervisor enforces safe work behaviors | – | 0.756 | – | – | – |
| Q24 | My immediate supervisor corrects near misses, unsafe acts and unsafe conditions | – | 0.707 | – | – | – |
| Q29 | My immediate supervisor considers human error as part of the risk assessment | – | 0.702 | – | – | – |
| Q27 | My immediate supervisor investigates workplace accidents | – | 0.697 | – | – | – |
| Q21 | My immediate supervisor cascades the corporate HSE KPIs to the employees | – | 0.677 | – | – | – |
| Q22 | My immediate supervisor ensures work permits are obtained and signed | – | 0.677 | – | – | – |
| Q23 | My immediate supervisor ensures that the employees' skills and abilities match the job tasks | – | 0.609 | – | – | – |
| Avg. factor loading is 0.84; AVE is 0.70; composite reliability is 0.96. | | | | | | |
| Reliability is 0.84 and SQRT of AVE is 0.84 | | | | | | |
| Q43 | New recruits are trained adequately to learn the safety rules and procedures | – | – | 0.634 | – | – |
| Q42 | My company ensures that contractors are trained to perform their tasks safely | – | – | 0.598 | – | – |

(*continued*)

Table 3.

| Items | Questions | F1 | F2 | F3 | F4 | F5 |
|---|---|---|---|---|---|---|
| Q47 | The safety training given to me is adequate to enable me to assess hazards in the workplace | – | – | 0.589 | – | – |
| Q44 | The safety training is specific to the job, including hazardous materials, equipment, noise, fire and other physical hazards | – | – | 0.564 | – | – |
| Q32 | The safety training includes hazard control measures, such as department-specific safe operating procedures, acceptable practices, lock-out/tag-out and working after hours or alone | – | – | 0.547 | – | – |
| Q46 | The employees' training hours are linked to the overall performance of my department | – | – | 0.523 | – | – |
| Q36 | The safety training provided is adequate for responses to emergency seniors and to control safety incidents | – | – | 0.500 | – | – |
| Q33 | Employees changing jobs or taking extra responsibilities are trained on the new safety regulations | – | – | 0.490 | – | – |
| Avg. factor loading is 0.80; AVE is 0.65; composite reliability is 0.94. Reliability is 0.80 and SQRT of AVE is 0.80 | | | | | | |
| | | – | – | – | | – |
| Q38 | I feel that my organization is keen on eliminating process safety incidents | – | – | – | 0.684 | – |
| Q37 | I believe that it is possible to achieve zero process safety events/incidents in my organization | – | – | – | 0.680 | – |
| Q40 | Employees regularly break the safety rules if they think they will not get caught | – | – | – | 0.652 | – |
| Q39 | Safety professionals are viewed as law enforcement officers | – | – | – | 0.633 | – |
| Q35 | Safety performance does not improve despite adequate OSHA compliance, leadership commitment and training | – | – | – | 0.531 | – |
| Q34 | Employees' participation in safety committees, training and other safety-related meetings is low | – | – | – | 0.452 | – |
| Avg. factor loading is 0.76; AVE is 0.58; composite reliability is 0.89. Reliability is 0.76 and SQRT of AVE is 0.77 | | | | | | |
| Q31 | My organization performs an assessment and audit of compliance with applicable HSE laws | – | – | – | – | 0.843 |
| Q30 | My organization conducts mock drills to evaluate the emergency response plan | – | – | – | – | 0.816 |
| Q3 | My organization has HSE measurable performance metrics | – | – | – | – | 0.442 |
| Avg. factor loading is 0.76; AVE is 0.61; composite reliability is 0.82. Reliability is 0.76 and SQRT of AVE is 0.782 | | | | | | |

discriminant validity is confirmed (Ghiselli *et al.*, 1981). The values shown in Table 3 demonstrate a conceptual distinction between the five latent constructs.

*5.3 Confirmatory factor analysis*

The EFA led to the identification of OCS, SSCS, TOS, EES and HSEC as the initial safety climate dimensions in the oil and gas industries in the UAE. The first-order model contains OCS, SSCS, TOS, EES and HSEC as the correlated safety climate factors in the oil and gas industry in the UAE. To assess the model fit, extensively approved fit indices were used, such as CFI (0.881), TLI (0.871) and at or below 0.06 RMSEA (0.078), indicating a good model fit for the 43-items as suggested from Ghahramani and Khalkhali (2015). The results of CFA model show a good fit ($X^2$ = 1,748.356, DOF = 833, CMIN/DOF = 2.099, CFI = 0.881, TLI = 0.871 and RMSEA = 0.078). The confirmatory factor analysis (CFA) loadings were statistically significant (i.e. average factors loading were between 0.75 and 0.83). All Cronbach's alpha ($\alpha$) and composite reliability values were greater than 0.70 which supports the construct reliability. The AVEs showed acceptable values of more than 0.50 (Kline, 2010), and the square roots of AVE values showed higher values than the construct correlation values (Fornell and Larcker, 1981). Furthermore, all factor loadings exceeded 0.50, and the *t*-vlaues were statistically significant ($p$ < 0.01) (Hair *et al.*, 2010). Figure 2 below shows the first-order model.

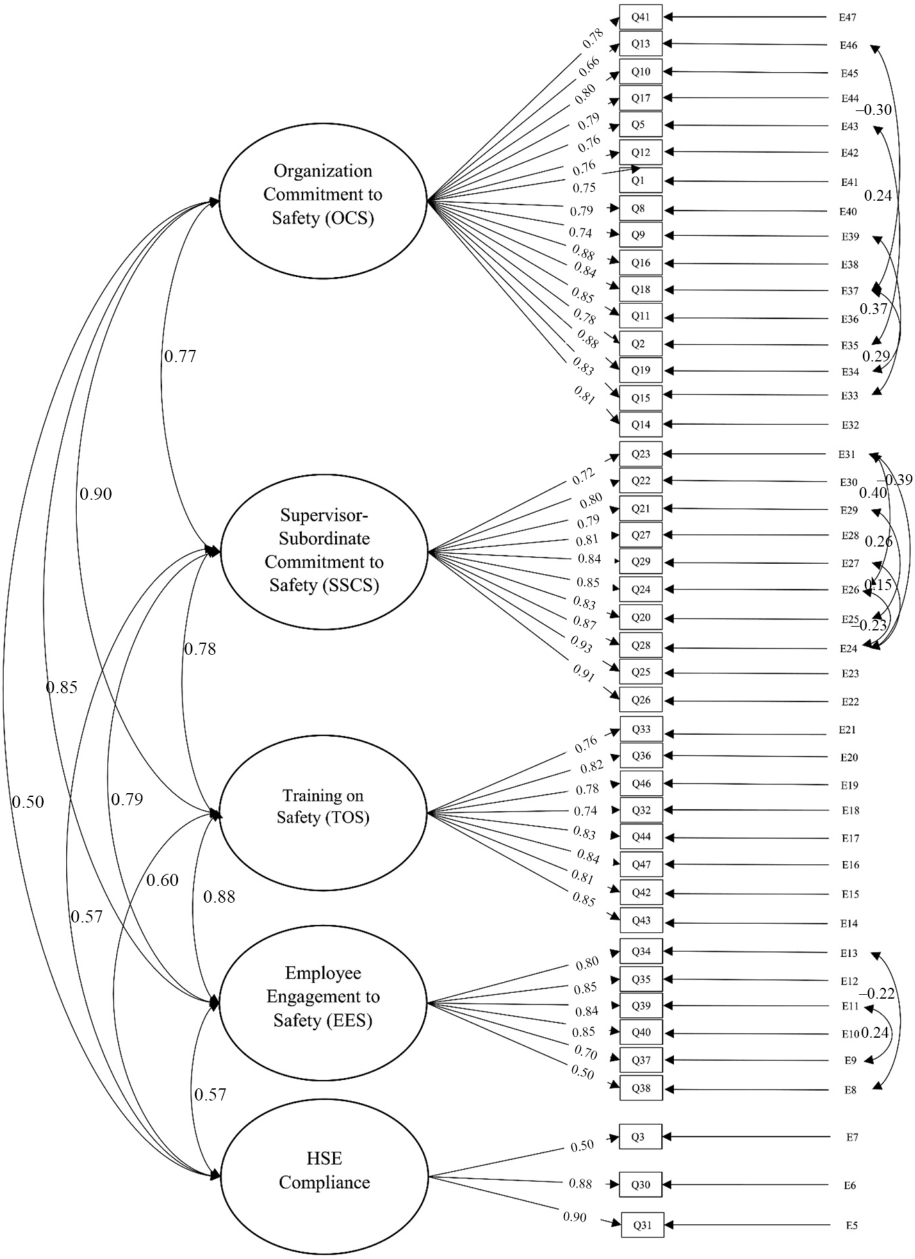
## 6. Discussion

This study develops and validates a safety climate scale for the oil and gas industry in the UAE. The reliability and validity analyses of the initial scale developed in this study contained 51 items. These items were further reduced to 43-items following EFA, PCA and reliability analysis. Quantitative methods were used in this study to investigate the content validity and EFA and CFA to examine the scale's construct validity. In addition, the scale's internal consistency was satisfactory. Therefore, the scale developed in this study was proven to be a reliable and valid tool for measuring safety climate. Concurrent validity assessment of the safety climate and the experience of accidents by the participants presented insignificant results may be because the respondents were prompted to consider their related experiences within the past three years.

A factor reduction using EFA led to the identification of OCS, supervisory commitment to safety, TOS, employee engagement to safety and HSE compliance as the dimensions of safety climate. These findings complement the results of previous studies that identified safety climate and perception of process safety as employee engagement to safety, employee safety performance and safe working environment (Mazrouei *et al.*, 2019; Probst, 2015; Roughton *et al.*, 2019; Tawfik *et al.*, 2019). Our findings are in line with Griffin and Curcuruto (2016) and Naik (2019), who found that safety climate is a shared concept which results from individuals' shared insights and observations of different ways that safety is valued in the organization. The OCS accounted for

| Factors/construct | Convergent validity Bentler–Bonett NFI | Discriminant validity Factor Cronbach's $\alpha$ – average correlation between factors |
|---|---|---|
| F1 | 0.923 | 0.243 |
| F2 | 0.977 | 0.238 |
| F3 | 0.962 | 0.215 |
| F4 | 0.990 | 0.174 |
| F5 | 1.00 | 0.058 |

**Table 4.** Construct validity analysis




X² = 1748.356, DOF = 833, CMIN/DOF = 2.099, CFI = 0.881, TLI = 0.871, RMSEA = 0.078

**Figure 2.**
First-order measurement model for safety climate dimension

37% of the variance in all responses, followed by supervisor–subordinate commitment to safety at 23%, TOS at 19%, employee engagement on safety at 14% and HSE compliance at 7%. This indicates that these values are valued by individuals according to their shared perceptions and understanding of the safety climate (Griffin and Curcuruto, 2016).

The safety climate scale's dimensional structure was found to be satisfactory based on the significant fit indices. The Chi-square test results – one model fit indicator – of the CFA model was also statistically significant. The Chi-square test is faulted for its sensitivity to sample size (Cheung and Rensvold, 2002; Silva *et al.*, 2004; Furr, 2011) and insignificant misspecifications within the structure of the model (Sexton *et al.*, 2006). Some authors (Sexton *et al.*, 2006; Leach *et al.*, 2008; Fernández-Muñiz *et al.*, 2012) relied on other indices for model fit proof when the result of the Chi-square test was significant. There have also been cases where the authors did not report the result of the Chi-square test (Tharaldsen *et al.*, 2008). Therefore, the RMSEA, goodness-of-fit, IFI and CFI were used to assess the model fit of the CFA in this study, similar to Ghahramani and Khalkhali (2015).

Relying on a large sample in a factor analysis has been described as more desirable (Ghahramani and Khalkhali, 2015). Furr (2011) decried the complexity of identifying an appropriate CFA sample with "recommendations for absolute sample sizes [varying] from a minimum of 50 participants (with simple models under ideal conditions) to 400 or more, while other recommendations are framed as 'participants-to-variables' ratios with suggestions ranging from 5:1 to 20:1 or more" (p. 94). Suggestions for sample sizes ranging from 200 to 300 for factor analysis have been offered Comrey and Lee (1992). Based on these varying arguments in the literature, the sample size used in this study was within the satisfactory range for performing CFA.

Qualitative expert evaluation for analyzing the scale content validity is a common practice (Seo *et al.*, 2004). Applying quantitative methods to conduct such an analysis enhances the decision-making processes regarding the scale items that should be retained or dropped. In this study, several experts were involved, and this was further buttressed using a Likert-type scale to rate the various scale items during the validation process. This approach was based on the recommendations of Wynd *et al.* (2003) for overcoming CVI limitations.

## 7. Conclusion

The findings of this study demonstrate the adequacy of reliability and validity of the scale developed to measure safety climate in the UAE oil and gas industry. The development of the scale was motivated by the need to have a safety climate scale that is specific to the UAE oil and gas industry. The scale is applicable in the investigation of safety perceptions of employees in the oil and gas industry.

Further investigations are required to reexamine the reliability and validity using a more diverse and larger sample of oil and gas employees. Such studies will be necessary to determine the reliability and validity of the dimensions of safety climate structure in oil and gas companies not within the petroleum industry in the UAE. In addition, there is a need for future research to examine the scale's discriminant validity using correlation analysis between the dimensions of safety climate and other contributing organizational or occupational factors.

Moreover, it is suggested to have contractors participate in future studies, as they are frequently exposed to new organizations and different cultures and are considered strangers, unfamiliar with the organization's rules, risks and hazards.

Finally, it suggested that second-order CFA be conducted to confirm that the model is a fit for dependent and independent variables.

Mohamed Ali Almazrouei holds a master's degree in Business Administration and is currently a DBA student at College of Business, Abu Dhabi University, United Arab Emirates. His research interests are in the areas of understanding process safety in the modern process industry: psychometric properties and relationship with safety culture.

Khalizani Khalid holds a PhD in Business Administration, and she is presently an Assistant Professor at College of Business, Abu Dhabi University UAE. Her research interest includes human resource management, behavioral decision-making, sustainability, technology management and vocational education.

Ross Davidson received his PhD in international HR management, and he is presently an Assistant Professor at College of Business, Abu Dhabi University, UAE. His research interests focus on the co-creation of safety, international human resource management and organizational learning in the international setting and leadership.

## References

Ahire, S.L., Waller, M.A. and Golhar, D.Y. (1996), "Quality management in TQM versus non-TQM firms: an empirical investigation", *International Journal of Quality and Reliability Management*, Vol. 13 No. 8, pp. 8-27. available at: https://doi.org/10.1108/02656719610128466

Alexander, M., Cox, S. and Cheyne, A. (1995), "The concept of safety culture within a UK offshore organisation", Paper presented at the Understanding Risk Perception Conference, Aberdeen.

Arnold, J., Loan-Clarke, J., Coombs, C., Wilkinson, A., Park, J. and Preston, D. (2006), "How well can the theory of planned behavior account for occupational intentions?", *Journal of Vocational Behavior*, Vol. 69 No. 3, pp. 374-390.

Bagozzi, R.P., Yi, Y. and Phillips, L.W. (1991), "Assessing construct validity in organizational research", *Administrative Science Quarterly*, Vol. 36 No. 3, p. 421, available at: https://doi.org/10.2307/2393203

Bahrami, M.A., Chalak, M., Montazeralfaraj, R. and Dehghani Tafti, A. (2014), "Iranian nurse association perception of patient safety culture", *Iranian Red Crescent Medical Journal*, Vol. 16 No. 4, pp. 1-9, available at: https://doi.org/10.5812/ircmj.11894

Bentler, P.M. (1992), *EQS Structural Equations Program Manual*, BMDP Statistical Software. Los Angeles.

Bentler, P.M. (1995), *Bentler EQS Structural Equations Program Manual Multivariate Software*, Encino, CA.

Brown, R.L. and Holmes, H. (1986), "The use of a factor analytic procedure for assessing the validity of an employee safety climate model", *Accident Analysis and Prevention*, Vol. 18 No. 6, pp. 445-470.

Brown, K.A., Willis, P.G. and Prussia, G.E. (2000), "Predicting safe employee behavior in the steel industry: Development and test of a socio-technical model", *Journal of Operations Management*, Vol. 18 No. 4, pp. 445-465.

Chen, C.F. and Chen, S.C. (2012), "Scale development of safety management system evaluation for the airline industry", *Accident; Analysis and Prevention*, Vol. 47, pp. 177-181.

Cheung, G.W. and Rensvold, R.B. (2002), "Evaluating goodness-of-fit indexes for testing measurement invariance", *Structural Equation Modeling: A Multidisciplinary Journal*, Vol. 9 No. 2, pp. 233-255.

Christian, M.S., Bradley, J.C., Wallace, J.C. and Burke, M.J. (2009), "Workplace safety: a Meta-analysis of the roles of person and situation factors", *Journal of Applied Psychology*, Vol. 94 No. 5, pp. 1103-1127.

Clarke, S. (2006), "The relationship between safety climate and safety performance: a Meta-analytic review", *Journal of Occupational Health Psychology*, Vol. 11 No. 4, pp. 315-327.

Comrey, A.L. and Lee, H.B. (1992), *A First Course in Factor Analysis*, Erlbaum, Hillsdale, NJ.

Cox, S.J. and Cheyne, A.J.T. (2000), "Assessing safety culture in offshore environments", *Safety Science*, Vol. 34 Nos 1/3, pp. 111-129.

Cronbach, L.J. (1951), "Coefficient alpha and the internal structure of tests", *Psychometrika*, Vol. 16 No. 3, pp. 297-334, available at: https://doi.org/10.1007/bf02310555

Dogru, O.C. and Peker, M. (2019), "Understanding safety behaviour: role of safety climate, supervisory behaviour, and individual motivation", doi: 10.26226/morressier.5cf632c2af72dec2b05549ac

Elliot, M.A., Armitage, C.J. and Baughan, C.J. (2003), "Drivers' compliance with speed limits: an application of the theory of planned behavior", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 964-972.

Evans, A., Wilson, G., Fortelius, M. and Jernvall, J. (2007), "High-level similarity of dentition in carnivorans and rodents", *Nature*, Vol. 445 No. 7123, pp. 78-81, doi: 10.1038/nature05433.

Evans, D. and Norman, P. (2002), "Predicting adolescent pedestrians' road-crossing intentions: an application and extension of the theory of planned behavior", *Health Education Research*, Vol. 18 No. 3, pp. 267-277.

Fernández-Muñiz, B., Montes-Peón, J.M. and Vázquez-Ordás, C.J. (2012), "Safety climate in OHSAS 18001-certified organisations: antecedents and consequences of safety behaviour", *Accident Analysis and Prevention*, Vol. 45, pp. 745-758.

Flin, R., Mearns, K., O'Connor, P. and Bryden, R. (2000), "Measuring safety climate: identifying the common features", *Safety Science*, Vol. 34 Nos 1/3, pp. 177-192.

Flin, R., Burns, C., Mearns, K., Yule, S. and Robertson, E. (2006), "Measuring safety climate in health care", *Quality and Safety in Health Care*, Vol. 15 No. 2, pp. 109-115.

Fornell, C.G. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50. doi:10.1177/002224378101800104

Furr, M. (2011), *Scale Construction and Psychometrics for Social and Personality Psychology*, SAGE Publications Ltd, Thousand Oaks, CA.

Gershon, R.R., Karkashian, C.D., Grosch, J.W., Murphy, L.R., Escamilla-Cejudo, A., Flanagan, P.A., Bernacki, E., Kasting, C. and Martin, L. (2000), "Hospital safety climate and its relationship with safe work practices and workplace exposure incidents", *American Journal of Infection Control*, Vol. 28 No. 3, pp. 211-221.

Ghahramani, A. and Khalkhali, H. (2015), "Development and validation of a safety climate scale for manufacturing industry", *Safety and Health at Work*, Vol. 6 No. 2.

Ghiselli, E.E., Campbell, J.P., (1981), and S. and Zedeck, *Measurement Theory for the Behavioral Sciences*, W.H. Freeman. San Francisco.

Glendon, A.I. and Litherland, D.K. (2001), "Safety climate factors, group differences and safety behaviour in road construction", *Safety Science*, Vol. 39 No. 3, pp. 157-188.

Glennon, D.E. (1982), "Safety climate in organizations. Ergonomics and occupational health", Paper presented at the 19th Annual Conference of the Ergonomics society of Australia and New Zealand.

Gonzalez-Roma, V., Peiro, J.M. and Tordera, N. (2002), "An examination of the antecedents and moderator influences of climate strength", *Journal of Applied Psychology*, Vol. 87 No. 3, pp. 465-473.

Griffin, M. and Neal, A. (2000), "Perceptions of safety at work: a framework for linking safety climate to safety performance, knowledge, and motivation", *Journal of Occupational Health Psychology*, Vol. 5 No. 3, doi: 10.1037//1076-8998.5.3.347.

Griffin, M.A. and Curcuruto, M. (2016), "Safety climate in organizations", *Annual Review of Organizational Psychology and Organizational Behavior*, Vol. 3 No. 1, pp. 191-212, available at: https://doi.org/10.1146/annurev-orgpsych-041015-062414

Grote, G. (2009), *Management of Uncertainty – Theory and Application in the Design of Systems and Organizations*, Springer, London.

Guldenmund, F.W. (2000), "The nature of safety culture: a review of theory and research", *Safety Science*, Vol. 34 Nos 1/3, pp. 215-257.

Hahn, S.E. and Murphy, L.R. (2008), "A short scale for measuring safety climate", Journal.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010), *Multivariate Data Analysis*, 7th ed.: Pearson Hall. Upper Saddle River, NJ.

Høivik, D., Tharaldsen, J.E., Baste, V. and Moen, B.E. (2009), "What is most important for safety climate: the company belonging or the local working environment? A study from the Norwegian offshore industry", *Safety Science*, Vol. 47 No. 10, pp. 1324-1331.

Huang, Y.H., Ho, M., Smith, G.S. and Chen, P.Y. (2006), "Safety climate and self-reported injury: assessing the mediating role of employee safety control", *Accident; Analysis and Prevention*, Vol. 38 No. 3, pp. 425-433.

Jiang, L., Lavaysse, L.M. and Probst, T.M. (2018), "Safety climate and safety outcomes: a Meta-analytic comparison of universal vs. industry-specific safety climate predictive validity", *Work and Stress*, Vol. 33 No. 1, pp. 41-57, doi: 10.1080/02678373.2018.1457737.

Kaiser, H.F. (1970), "A second generation little jiffy", *Psychometrika*, Vol. 35 No. 4, pp. 401-415.

Kline, R.B. (2010), *Principles and Practices of Structural Equation Modeling*, 3rd ed.: Guildford, New York, NY.

Klein, K. and Kozlowski, S. (2000), "From micro to meso: critical steps in conceptualizing and conducting multilevel research", *Organizational Research Methods*, Vol. 3 No. 3, pp. 211-236.

Kudo, Y., Satoh, T., Kido, S., Watanabe, M., Miki, T., Miyajima, E., Saegusa, Y., Tsunoda, M. and Aizawa, Y. (2008), "A pilot study testing the dimensions of safety climate among Japanese nurses", *Industrial Health*, Vol. 46 No. 2, pp. 158-165.

Lawshe, C.H. (1975), "A quantitative approach to content validity", *Personnel Psychology*, Vol. 28 No. 4, pp. 563-575.

Leach, C.W., van Zomeren, M., Zebel, S., Vliek, M.L., Pennekamp, S.F., Doosje, B., Ouwerkerk, J.W. and Spears, R. (2008), "Group-level self-definition and self-investment: a hierarchical (multicomponent) model of in-group identification", *Journal of Personality and Social Psychology*, Vol. 95 No. 1, pp. 144-165.

Lin, S.H., Tang, W.J., Miao, J.Y., Wang, Z.M. and Wang, P.X. (2008), "Safety climate measurement at workplace in China: a validity and reliability assessment", *Safety Science*, Vol. 46 No. 7, pp. 1037-1046.

Litwin, G.H. and Stringer, R.A. Jr (1968), *Motivation and organisational climate*. Division of Research, Harvard Business School, Boston.

Lu, C.S. and Shang, K.C. (2005), "An empirical investigation of safety climate in container terminal operators", *Journal of Safety Research*, Vol. 36 No. 3, pp. 297-308.

Lynn, M.R. (1986), "Determination and quantification of content validity", *Nursing Research*, Vol. 35, pp. 382-386.

Mazrouei, M.A., Khalid, K. and Davidson, R. (2019), "Modeling the impact of safety climate on process safety in a modern process industry: the case of the UAE's oil-refining industry", *Cogent Business and Management*, Vol. 6 No. 1, doi: 10.1080/23311975.2019.1647591.

Mearns, K. and Yule, S. (2009), "The role of national culture in determining safety performance: challenges for the global oil and gas industry", *Safety Science*, Vol. 47 No. 6, pp. 777-785, doi: 10.1016/j.ssci.2008.01.009.

Mearns, K., Flin, R., Gordon, R. and Fleming, M. (1998), "Measuring safety climate on offshore installations", *Work and Stress*, Vol. 12 No. 3, pp. 238-254.

Mearns, K., Rundmo, T., Flin, R., Gordon, R. and Fleming, M. (2004), "Evaluation of psychosocial and organizational factors in offshore safety: a comparative study", *Journal of Risk Research*, Vol. 7 No. 5, pp. 545-561.

Meliá, J.L., Mearns, K., Silva, S.A. and Lima, M.L. (2008), "Safety climate responses and the perceived risk of accidents in the construction industry", *Safety Science*, Vol. 46 No. 6, pp. 949-958.

Meline, T. (2006), "Selecting studies for systemic review: Inclusion and exclusion criteria", *Contemporary Issues in Communication Science and Disorders*, Vol. 33 No. Spring, pp. 21-27. doi:10.1044/cicsd_33_s_21

Mohamed, S. (2002), "Safety climate in construction site environments", *Journal of Construction Engineering and Management*, Vol. 128 No. 5, pp. 375-384.

Montano, D., Kasprzy, K.D. and Taplin, S. (1997), "The theory of reasoned action and the theory of planned behavior", 2nd ed. *Health Behavior and Health Education*, Jossey-Bass, San Francisco, CA.

Naik, H.R. (2019), "Impact of climate change on food safety", *Agricultural Impacts of Climate Change*, Vol. 46, pp. 173-189, doi: 10.1201/9780429326349-10.

Olsen, E. (2010), "Exploring the possibility of a common structural model measuring associations between safety climate factors and safety behaviour in health care and the petroleum sectors", *Accident; Analysis and Prevention*, Vol. 42 No. 5, pp. 1507-1516.

Ostroff, C., Kinicki, A.J. and Tamkins Mm, (2003), "Organizational culture and climate: Part three", *The Work Environment*, Wiley. Hoboken, NJ.

Petrea, R.E. (2001), "The theory of planned behavior: use and application in targeting agricultural safety and health interventions", *Journal of Agricultural Safety and Health*, Vol. 7 No. 1, pp. 7-19.

Polit, D.F. and Beck, C.T. (2006), "The content validity index: are you sure you know what's being reported? Critique and recommendations", *Research in Nursing and Health*, Vol. 29 No. 5, pp. 489-497.

Probst, T.M. (2015), "Organizational safety climate and supervisor safety enforcement: multilevel explorations of the causes of accident underreporting", *Journal of Applied Psychology*, Vol. 100 No. 6, pp. 1899-1907. available at: https://doi.org/10.1037/a0039195

Quine, L., Rutter, D.R. and Arnold, L. (2001), "Persuading school-age cyclists to use safety helmets: Effectiveness of an intervention based on the theory of planned behavior", *British Journal of Health Psychology*, Vol. 6 No. 4, pp. 327-345.

Reader, T.W., Noort, M.C., Shorrock, S. and Kirwan, B. (2015), "Safety sans frontières: an international safety culture model", *Risk Analysis*, Vol. 35 No. 5, pp. 770-789.

Roughton, J., Crutchfield, N. and Waite, M. (2019), "Evaluating leadership and the safety culture", *Safety Culture*, Vol. 1, pp. 149-168, doi: 10.1016/b978-0-12-814663-7.00007-8.

Seo, D.C. (2005), "An explicative model of unsafe work behavior", *Safety Science*, Vol. 43 No. 3, pp. 187-211.

Seo, D.C., Torabi, M.R., Blair, E.H. and Ellis, N.T. (2004), "A cross-validation of safety climate scale using confirmatory factor analytic approach", *Journal of Safety Research*, Vol. 35 No. 4, pp. 427-445.

Sexton, J.B., Helmreich, R.L., Neilands, T.B., Rowan, K., Vella, K., Boyden, J., Roberts, P.R. and Thomas, E.J. (2006), "The safety attitudes questionnaire: psychometric properties, benchmarking data, and emerging research", *BMC Health Services Research*, Vol. 6 No. 1.

Sheeran, P. and Silverman, M. (2003), "Evaluation of three interventions to promote workplace health and safety: evidence for the utility of implementation intentions", *Social Science and Medicine*, Vol. 56 No. 10, pp. 2153-2163, available at: https://doi.org/10.1016/s0277-9536(02)00220-4

Silva, S., Lima, M.L. and Baptista, C. (2004), "OSCI: an organisational and safety climate inventory", *Safety Science*, Vol. 42 No. 3, pp. 205-220.

Tawfik, D.S., Thomas, E.J. and Vogus, T.J. (2019), "Safety climate, safety climate strength, and length of stay in the NICU", *BMC Health Services Research*, Vol. 19 No. 1, p. 738, available at: https://doi.org/10.1186/s12913-019-4592-1

Tharaldsen, J., Olsen, E. and Rundmo, T. (2008), "A longitudinal study of safety climate on the norwegian continental shelf", *Safety Science*, Vol. 46 No. 3, pp. 427-439.

Vinodkumar, M. and Bhasi, M. (2009), "Safety climate factors and its relationship with accidents and personal attributes in the chemical industry", *Safety Science*, Vol. 47 No. 5, pp. 659-667.

Wallace, K., Bilham, R., Blume, F., Gaur, V.K. and Gahalaut, V. (2006), "Geodetic constraints on the bhuj 2001 earthquake and surface deformation in the kachchh rift basin", *Geophysical Research Letters*, Vol. 33 No. 10, available at: https://doi.org/10.1029/2006gl025775

Weick, K.E. (1995), *Sensemaking in Organizations*, Sage. Thousand Oaks, CA.

Wills, A.R., Biggs, H.C. and Watson, B.C. (2005), "Analysis of a safety climate measure for occupational vehicle drivers and implications for safer workplaces", *The Australian Journal of Rehabilitation Counselling*, Vol. 11 No. 1, pp. 8-21.

Wynd, C.A., Schmidt, B. and Schaefer, M.A. (2003), "Two quantitative approaches for estimating content validity", *Western Journal of Nursing Research*, Vol. 25 No. 5, pp. 508-518.

Yeung, K.C. and Chan, C.C. (2012), "Measuring safety climate in elderly homes", *Journal of Safety Research*, Vol. 43 No. 1, pp. 9-20.

Zohar, D. (1980), "Safety climate in industrial organizations: theoretical and applied implications", *Journal of Applied Psychology*, Vol. 65 No. 1, pp. 96-102, doi: 10.1037/0021-9010.65.1.96.

Zohar, D. (2010), "Thirty years of safety climate research: reflections and future directions", *Accident; Analysis and Prevention*, Vol. 42 No. 5, pp. 1517-1522, doi: 10.1016/j.aap.2009.12.019.

Zohar, D. (2014), "Safety climate: Conceptualization, measurement, and improvement", in Schneider B. and Barbera K.M. (Eds), *Oxford Library of Psychology the Oxford Handbook of Organizational Climate and Culture*, Oxford University Press, Oxford p. 317-334.

Zohar, D. and Luria, G. (2005), "A multilevel model of safety climate: Cross-Level relationships between organization and Group-Level climates", *Journal of Applied Psychology*, Vol. 90 No. 4, pp. 616-628, doi: 10.1037/0021-9010.90.4.616.

## Further reading

Abdel-Khalek, A., Bahrami, F., Dadfar, M., Lester, D. and Abdel-Khalek, A.M. (2014), "Death distress in iranian older adults", *Advances in Environmental Biology*, Vol. 8 No. 12, pp. 56-62.

Australian Transport Safety Bureau (ATSB) (2004), "ATSB aviation safety survey e safety climate factors aviation research paper B", Vol. 2003, available at: www.atsb.gov.au/media/36879/Safety_climate_factors.pdf (accessed 2 December 2019)

Basen-Engquist, K., Hudmon, K.S., Tripp, M. and Chamberlain, R. (1998), "Worksite health and safety climate: scale development and effects of a health promotion intervention", *Preventive Medicine*, Vol. 27 No. 1, pp. 111-119.

Borman, W.C. and Motowidlo, S.J. (1993), "Expanding the criterion domain to include elements of contextual performance", in Schmitt, N and Borman, WC (Eds), *Personnel Selection in Organizations*, Jossey-Bass. San Francisco, pp. 71-98.

Brondino, M., Silva, S.A. and Pasini, M. (2012), "Multilevel approach to organizational and group safety climate and safety performance: coworkers as the missing link", *Safety Science*, Vol. 50 No. 9, pp. 1847-1856.

Burke, M.J., Sarpy, S.A., Tesluk, P.E. and Smith-Crowe, K. (2002), "General safety performance: a test of a grounded theoretical model", *Personnel Psychology*, Vol. 55 No. 2, pp. 429-457.

Carless, S.A. (2004), "Does psychological empowerment mediate the relationship between psychological climate and job satisfaction?", *Journal of Business and Psychology*, Vol. 18 No. 4, pp. 405-425.

Carr, J.Z., Schmidt, A.M., Ford, J. and DeShon, R.P. (2003), "Climate perceptions matter: a Meta-analytic path analysis relating molar climate, cognitive and affective states, and individual level work outcomes", *Journal of Applied Psychology*, Vol. 88 No. 4, pp. 605-619.

Clarke, S. (2010), "An integrative model of safety climate: linking psychological climate and work attitudes to individual safety outcomes using Meta-analysis", *Journal of Occupational and Organizational Psychology*, Vol. 83 No. 3, pp. 553-578.

Clarke, S. (2013), "Safety leadership: a Meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviors", *Journal of Occupational and Organizational Psychology*, Vol. 86 No. 1, pp. 22-49.

Clarke, S. and Cooper, C.L. (2004), *Managing the Risk of Workplace Stress: Health and Safety Hazards*, Routledge. London.

Conchie, S.M. (2013), "Transformational leadership, intrinsic motivation, and trust: amoderated-mediated model of workplace safety", *Journal of Occupational Health Psychology*, Vol. 18 No. 2, pp. 198-210.

Curcuruto, M., Mariani, M.G., Conchie, S. and Violante, F. (2015), "The role of prosocial and proactive safety behaviors in predicting safety performance", *Safety Science*, Vol. 80, pp. 317-323.

Davies, F. Spencer, R. Dooley, K. and Britain, G. (2001), "Summary guide to safety climate tools", available at: www.hse.gov.uk/research/otopdf/1999/oto99063.pdf (accessed 2 December 2019)

Davis, L.L. (1992), "Instrument review: getting the most from a panel of experts", *Applied Nursing Research*, Vol. 5 No. 4, pp. 194-197, doi: 10.1016/s0897-1897(05)80008-4.

Deci, E.L. and Ryan, R.M. (2002), "Self-determination research: reflection and future direction", in Deci, EL and Ryan RM (Eds),*Handbook of Self-Determination Research*, Univ. Rochester Press. Rochester, New York, NY, pp. 431-442.

DeJoy, D.M. (2005), "Behavior change versus culture change: divergent approaches to managing workplace safety", *Safety Science*, Vol. 43 No. 2, pp. 105-299.

DeJoy, D.M., Della, L.J., Vandenberg, R.J. and Wilson, M.G. (2010), "Making work safer: testing a model of social exchange and safety management", *Journal of Safety Research*, Vol. 41 No. 2, pp. 163-171.

Gagn¨e, M. ed. (2014), *The Oxford Handbook of Work Engagement, Motivation, and Self-Determination*, Oxford University Press. Oxford.

Gagn¨e, M. and Deci, E.L. (2005), "Self-determination theory and work motivation", *Journal of Organizational Behavior*, Vol. 26 No. 4, pp. 331-362.

Geller, E., Roberts, D. and Gilmore, M.R. (1996), "Predicting propensity to actively care for occupational safety", *Journal of Safety Research*, Vol. 27 No. 1, pp. 1-8.

Håvold, J.I. (2005), "Safety-culture in a Norwegian shipping company", *Journal of Safety Research*, Vol. 36 No. 5, pp. 441-458.

HSE (2009), "Safety climate measurement: user guide and toolkit", Loughborough University Business School, available at: www.lboro.ac.uk/media/wwwlboroacuk/content/sbe/downloads/OffshoreSafetyClimateAssessment.pdf (accessed 2 December 2019).

Hutchinson, A., Cooper, K.L., Dean, J.E., McIntosh, A., Patterson, M., Stride, C.B., Laurence, B.E. and Smith, C.M. (2006), "Use of a safety climate questionnaire in UK health care: factor structure, reliability and usability", *Quality and Safety in Health Care*, Vol. 15 No. 5, pp. 347-353.

Johnson, S.E. (2007), "The predictive validity of safety climate", *Journal of Safety Research*, Vol. 38 No. 5, pp. 511-521.

Keren, N., Mills, T.R., Freeman, S.A. and Shelley, M.C. (2009), "Can level of safety climate predict level of orientation toward safety in a decision making task?", *Safety Science*, Vol. 47 No. 10, pp. 1312-1323.

Kho, M., Carbone, J., Lucas, J. and Cook, D. (2005), "Safety climate survey: reliability of results from a multicenter ICU survey", *Quality and Safety in Health Care*, Vol. 14 No. 4, pp. 273-278.

Kline, R.B. (2004), *Principles and Practice of Structural and Equation Modeling*, 2nd ed., Guildford, New York, NY.

Lu, C.S. and Tsai, C.L. (2008), "The effects of safety climate on vessel accidents in the container shipping context", *Accident; Analysis and Prevention*, Vol. 40 No. 2, pp. 594-601.

Mearns, K., Whitaker, S. and Flin, R. (2003), "Safety climate, safety management practice and safety performance in offshore environments", *Safety Science*, Vol. 41 No. 8, pp. 641-680, doi: 10.1016/S0925-7535(02)00011-5.

National Safety Council (2003), "Report on injuries in America", available at www.nsc.org

Varonen, U. and Mattila, M. (2000), "The safety climate and its relationship to safety practices, safety of the work environment and occupational accidents in eight wood-processing companies", *Accident; Analysis and Prevention*, Vol. 32 No. 6, pp. 761-769.

Wang, G. and Zhou, X. (2019), "Innovation in safety management: a moderated mediation model", *Social Behavior and Personality: An International Journal*, Vol. 47 No. 9, pp. 1-14.

Zhou, Q., Fang, D. and Wang, X. (2008), "A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience", *Safety Science*, Vol. 46 No. 10, pp. 1406-1419.

## Appendix 1

| Themes | Sub-themes | Storylines |
|---|---|---|
| Safety culture | Safety protagonists | Individual is more vital |
| | | Department is more vital |
| | Safety procedures | Safety procedures are available and implemented |
| | | Safety procedures are available but not important |
| | | Safety procedures are not available |
| | Outlook toward safety | Prompting safety procedure observation |
| | | Prompting the importance of safety |
| Supervisory safety performances | Supervisory safety behaviors | It is about principles and approaches toward safety |
| | | Supervisor's safety performance is the target |
| | Supervisory safety performs | level of supervisor collaboration with juniors about safety culture |
| | | Supervisor's arrangement of tasks to do it safely |
| Organization leadership attitudes on safety | Pledge to safety adherence | Organization heads start their speech on safety regularly |
| | | Leader reinforce and up to date on safety policy and procedures |
| | Inspire safety acts | Leaders recognize and appreciate safety acts |
| | | Leader lead by examples on safety practices |
| Safety training | Training help on safety knowledge | Positive makeover and strengthening of positive behaviors toward safety practices |
| | | Build up strong foundation and positive attitude toward safety practices |

**Table A1.** Identified themes, sub-themes and storylines for safety climate

## Appendix 2

**Table A2.** Results of exploratory factor analysis

| Factors | Reference studies |
|---|---|
| *Factor 1: Organization commitment to safety* | |
| 1. The management ensures reliable and safe equipment | Zohar (1980) |
| 2. The management eliminates potential safety issues | Glennon (1982) |
| 3. My company engages an HSE third-party audit to ensure that safety rules and regulations are followed | Ghahramani and Khalkhali (2015) |
| 4. The company maintains records of all first-aid treatments, inspections, incident investigations and training activities | Evans *et al.* (2007) |
| 5. The management conducts regular hazard inspections in your work area | Zohar (1980) |
| 6. My organization enforces a PTW system in all types of work | Glennon (1982) |
| 7. The management provides and participates in safety campaigns | Lin *et al.* (2008) |
| 8. My company provides sufficient personal protective equipment and gas detectors for the workers | Brown and Holmes (1986) |
| 9. My management encourages raising near misses, unsafe acts and unsafe conditions | Brown and Holmes (1986) |
| 10. The management considers safety as a core organizational value | Brown and Holmes (1986) |
| 11. The management investigates near misses, unsafe acts and unsafe conditions in a timely manner | Brown and Holmes (1986) |
| 12. The management considers production to be more important than safety | Mazrouei *et al.* (2019) |
| 13. My company has clear hydrocarbon and chemical spill response procedures | Alexander *et al.* (1995) |
| 14. My company provides enough safety training programs | Zohar (1980) |
| 15. The management considers production to be more important than environmental pollution | Alexander *et al.* (1995) |
| 16. The management exercises safety consequences management standards in case of violation of safety measures | Zohar (1980) |
| *Factor 2: Supervisor–subordinate commitment to safety* | |
| 17. My immediate supervisor conducts sufficient toolbox talks | Mazrouei *et al.* (2019) |
| 18. My immediate supervisor discusses safety issues with others before performing tasks | Mazrouei *et al.* (2019) |
| 19. My immediate supervisor ensures that the workload and work patterns are adequate | Mazrouei *et al.* (2019) |
| 20. My immediate supervisor enforces safe work behaviors | Mazrouei *et al.* (2019) |
| 21. My immediate supervisor corrects near misses, unsafe acts and unsafe conditions | Mazrouei *et al.* (2019) |
| 22. My immediate supervisor considers human error as part of the risk assessment | Mazrouei *et al.* (2019) |
| 23. My immediate supervisor investigates workplace accidents | Mazrouei *et al.* (2019) |
| 24. My immediate supervisor cascades the corporate HSE KPIs to the employees | Mazrouei *et al.* (2019) |
| 25. My immediate supervisor ensures work permits are obtained and signed | Mazrouei *et al.* (2019) |
| 26. My immediate supervisor ensures that the employees' skills and abilities match the job tasks | Alexander *et al.* (1995) |
| *Factor 3: Training on safety* | |
| 27. New recruits are trained adequately to learn the safety rules and procedures | Cox and Cheyne (2000) |
| 28. My company ensures that contractors are trained to perform their tasks safely | Evans *et al.* (2007) |
| 29. The safety training given to me is adequate to enable me to assess hazards in the workplace | Evans *et al.* (2007) |
| 30. The safety training is specific to the job, including hazardous materials, equipment, noise, fire and other physical hazards | Zohar (1980) |

(*continued*)

| Factors | Reference studies |
|---|---|
| 31. The safety training includes hazard control measures, such as department-specific safe operating procedures, acceptable practices, lock-out/tag-out and working after hours or alone | Zohar (1980) |
| 32. The employees' training hours are linked to the overall performance of my department | Zohar (1980) |
| 33. The safety training provided is adequate for responses to emergency seniors and to control safety incidents | Zohar (1980) |
| 34. Employees changing jobs or taking extra responsibilities are trained on the new safety regulations | Wills *et al.* (2005) |
| *Factor 4: Employee engagement to safety* | |
| 35. I feel that my organization is keen on eliminating process safety incidents | Ghahramani and Khalkhali (2015) |
| 36. I believe that it is possible to achieve zero process safety events/incidents in my organization | Ghahramani and Khalkhali (2015) |
| 37. Employees regularly break the safety rules if they think they will not get caught | Ghahramani and Khalkhali (2015) |
| 38. Safety professionals are viewed as law enforcement officers | Ghahramani and Khalkhali (2015) |
| 39. Safety performance does not improve despite adequate OSHA compliance, leadership commitment and training | Ghahramani and Khalkhali (2015) |
| 40. Employees' participation in safety committees, training and other safety-related meetings is low | Zohar (1980) |
| *Factor 5: HSE compliance* | |
| 41. My organization performs an assessment and audit of compliance with applicable HSE laws | Gershon *et al.* (2000) |
| 42. My organization conducts mock drills to evaluate the emergency response plan | Gershon *et al.* (2000) |
| 43. My organization has HSE measurable performance metrics | Brown *et al.* (2000) |

**Table A2.**

**Corresponding author**
Mohmaed Almazrouei can be contacted at: emarrati@hotmail.com