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Safety voice climate: A psychometric evaluation and validation

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ABSTRACT

Introduction: Speaking up about safety issues, termed "safety voice," is a proactive response where people across all levels of the organization express their concerns to prevent physical hazards. An understanding of safety voice requires insight into its antecedents. A perceived need to fit in with the organization and fear of consequences can trump the courage to speak out about safety concerns. Safety voice climate can be seen as a manifestation of the social exchanges in an organization and functions as a roadmap of which speaking out behaviors are encouraged and which behaviors are not. This study conceptualizes safety voice climate, presents the Safety Voice Climate Scale (SVCS) as a measurement tool, and gathers initial evidence for its validity. The study also assesses the associations between the SVCS and safety voice behavior. *Method*: The SVCS and the measurement of safety voice behavior were derived from the Trends in Risk Level in the Norwegian Petroleum Activity questionnaire. The SVCS includes the two theoretical dimensions *Work colleagues' encouragement of safety voice* and *Leaders' attitudes towards safety voice*. Psychometric properties were tested with a representative sample from the Norwegian petroleum sector (n = 7,624). *Results*: Confirmatory factor analyses supported the proposed two-factor model, and the internal consistency of the factors was good. Furthermore, a structural equation model including the SVCS as predictors of safety voice behavior showed a good fit, indicating acceptable criterion validity, although only the *Work colleagues' encouragement of safety voice* variable was significantly associated with safety voice behavior. *Conclusion and practical application*: The SVCS can be used as a tool to detect some of the barriers and supporting elements relating to safety voice and guidance on the efforts needed to foster work climates that promote communication of safety issues.

1. Introduction

Employees' active communication about safety-related issues is vital for maintaining safe work environments and preventing injuries (e.g., Christian, Bradley, Wallace, & Burke, 2009; Nahrgang, Morgeson, & Hofmann, 2011; Neal & Griffin, 2006). In light of this, the concept of safety voice (understood as a proactive response where people across all levels of the organization express their concerns to prevent physical hazards) has received considerable attention during recent years (Curcuruto, Strauss, Axtell, & Griffin, 2020; Noort, Reader, & Gillespie, 2019). Safety voice can be about rule or policy violations, action errors, and other safety violations and can be crucial in providing preventive actions to avoid accidents, injuries, and even catastrophes (Mathisen, Tjora, & Bergh, 2022). Speaking out about minor incidents could prevent the development of larger accidents or injuries. Nevertheless, employee silence remains a common reason for communication breakdowns and errors (Haerkens, Jenkins, & van der Hoeven, 2012), and studies indicate that 50–80% of work-related injuries and accidents go unreported (Bienefeld & Grote, 2012; Probst, Brubaker, & Barsotti, 2008), while a more recent systematic review estimated that 44% of people raise safety concerns (Noort et al., 2019). Considering this, it is important to understand the factors that encourage employee safety voice, and organization–employee relationship quality has repeatedly been suggested as a potential important antecedent (Chamberlin, Newton, & Lepine, 2017; DeJoy, Della, Vandenberg, & Wilson, 2010; Morrison, Wheeler-Smith, & Kamdar, 2011; Tucker, Chmiel, Turner, Hershcovis, & Stride, 2008). Various theories have been applied to describe the exchange relationship between organizations and employees, and different organizational climate theories are prevalent among these (Schneider, Ehrhart, & Macey, 2013). This paper presents the safety voice climate concept as a specific type of organizational climate connected to safety voice behavior. This line of research is extended by introducing the Safety Voice Climate Scale (SVCS) and examining the relationship between safety voice climate and safety voice behavior.

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1.1. Definition of safety voice climate

Safety voice climate refers to whether speaking out about safety concerns in the workplace is perceived to be encouraged (see Frazier & Bowler, 2015; Morrison et al., 2011). Thus, the safety voice climate is a facet-specific climate suggested as a precursor of safety voice.

Safety voice is characterized by "(a) communication motivated toward changing perceived unsafe working conditions that have implications for individual and organizational health, (b) can flow through formal and informal channels, and (c) can be directed toward numerous targets (e.g., supervisors/managers, coworkers, union officials, government officials)" (Tucker et al., 2008, p. 320). Safety voice can be intended to improve general safety levels on the one hand, or to prevent hazards in emergency situations on the other (Noort et al., 2019). Examples of safety voice include providing constructive suggestions for change, reporting possible safety risks or violations of safety practice, and challenging the status quo (Conchie, 2013; Conchie, Taylor, & Donald, 2012; Tucker et al., 2008; Turner, Tucker, & Kelloway, 2015). The concept of safety voice could be distinguished from other related concepts like "voice," which is a more general concept that includes expressions of organizationally relevant content (Chamberlin et al., 2017); "safety citizenship behavior," which is also a broader concept that refers to prosocial employee activities essential for managing risk (Curcuruto, Conchie, & Griffin, 2019); and "safety participation," which involves employees' voluntary exhibition of extra-role behaviors in the context of safety beyond their roles (e.g., Bayram, Arpat, & Ozkan, 2022). Alternatively, safety voice could be categorized as one specific type of safety participation behavior. In support of this suggestion, Morrow, Gustavson, and Jones (2016) defined safety voice as employee willingness to proactively participate in communication-related behaviors for the purpose of improving workplace safety. The conceptual distinctiveness of safety voice from the above-mentioned concepts has also been thoroughly discussed elsewhere and will not be further addressed in the current article (e.g., Curcuruto et al., 2020; Krenz & Burtscher, 2021; Morrison, 2011; Morrison et al., 2011; Morrow, Gustavson, & Jones, 2016; Noort et al., 2019). An understanding of safety voice requires insight into its antecedents. Voice behavior is driven by intentional and motivational aspects. A perceived need to fit in with the organization and fear of consequences can trump the courage needed to speak out (Etchegaray, Ottosen, Dancsak, & Thomas, 2020; Manapragada & Bruk-Lee, 2016; Martinez et al., 2015). For instance, lessons from the aviation industry indicate that subjective beliefs about what, when, and to whom it is appropriate to speak out determine voice behavior (Bienefeld & Grote, 2012). These beliefs seem to be influenced by group norms and can be considerably different across contexts. Manapragada and Bruk-Lee (2016) distinguished between a number of motives for staying silent about safety concerns, including self-based (speaking out could lead to negative repercussions such as being perceived as annoying by colleagues), other-based (speaking out could hurt others, e.g., they could get fired), relationship-based (speaking out could hurt relationships with others, e.g., causing conflicts), and climate-based (norms, managerial practice, and support do not encourage voice). Furthermore, a systematic review of safety voice literature that included a total of 50 studies found that the most frequently studied individual antecedent factor was fear of consequences, which was generally negatively associated with safety voice (Noort et al., 2019). Among the most studied group-related antecedents were openness (positive) and good (positive) or fragile (negative) relationships with receivers. On the organizational level, structural factors (e.g., hierarchical structure as a negative factor) and cultural factors (e.g., supportive culture as a positive factor) were frequently studied. Most of the factors identified in the above-summarized studies involve social exchanges and relationships and reflect a recognition that safety at work is part of a dynamic interaction between the members of an organization (DeJoy et al., 2010; Laurent, Chmiel, & Hansez, 2018; Reader, Mearns, Lopes, & Kuha, 2017). Social exchange theory offers a theoretical foundation for understanding these interactions and suggests that individuals will reciprocate benefits (e.g., goods, friendly environment, attitudes, emotions, etc.) with benefits and respond with either indifference or hostility (e.g., threat, dishonor) to harm (Cropanzano, Anthony, Daniels, & Hall, 2017; Cropanzano & Mitchell, 2005; Blau, 1986; Gouldner, 1960). When leaders and colleagues show their attentiveness to safety by valuing concerns and suggestions for improving safety, employees develop a belief that their organization has a positive orientation toward safety, which may increase the probability that they will participate in safety-related behaviors (Tucker et al., 2008). Thus, drawing on the social exchange theory, safety voice can be understood as an extra-role behavior that employees are likely to engage in when they believe the organization rewards and supports them (Rhoades & Eisenberger, 2002; Wayne, Shore, & Liden, 1997). Reflecting this suggestion, in their review study of safety voice, Noort et al. (2019) identified five studies measuring support, all having positive associations with safety voice. In terms of social exchange theory, organizational climate can be seen as a manifestation of the social exchanges in an organization and functions as a roadmap of which behaviors are expected and which are not. In this regard, safety voice climate refers to perceptions of whether speaking out about safety issues is being encouraged and reflects management' as well as colleagues' values and attitudes regarding safety voice behavior. This study proposes that important origins of safety voice behavior may be found in the safety voice climate. For example, where a manager does not have a priority for safety voice, it is expected that safety voice is not often being performed at the workplace.

1.2. Safety voice climate and related constructs

Since the introduction of the concept of organizational climate in the 1970s, several types of organizational climates have emerged in the literature, including service climate, climate for creativity, and safety climate (Kuenzi & Schminke, 2009; Schneider et al., 2013), each of which has its own specific facets and outcomes. In the current study, the focus is on safety voice climate, which is a more specific type of climate than the now well-established concept of safety climate (He, Wang, & Payne, 2019; Zohar, 2010, 2011) and the concept of voice climate (Frazier & Bowler, 2015; Knoll, Neves, Schyns, & Meyer, 2020; Morrison et al., 2011). The related concept of speak-up-related climate has also been introduced, but this is specifically related to patient safety (Richard, Pfeiffer, & Schwappach, 2017; Schwappach & Richard, 2018). Moreover, Sexton et al. (2006) presented safety attitudes as being a climate concept, and it includes a number of subtopics like teamwork climate, perceptions of management, and safety climate, but no subtopics related to safety voice.

Whereas voice climate is concerned with general types of voice, such as communication about issues of production, efficiency, and performance (Frazier & Bowler, 2015; Tangirala & Ramanujam, 2008), safety voice climate is about the promotion or hampering of voicing safety concerns (see also Noort et al. (2019) for a discussion on the distinction between voice and safety voice). It is possible that the expression of safety voice is perceived as more challenging than general voice because there may be larger social risks involved. As its contents are generally about prohibiting risky behaviors that may lead to incidents and accidents, it is likely that recipients may perceive the message as negative critique (Detert & Burris, 2007; Tucker et al., 2008). On this basis, the need for

encouragement to speak out may be stronger for safety voice than general voice. Thus, the emphasis on encouragement to speak out may need to be even stronger in a safety voice climate than in the case of general voice climate.

Whereas safety climate is widely defined as the "shared perceptions with regard to safety policies, procedures and practices" in an organization (e.g., Zohar, 2011, p. 143), safety voice climate refers to whether speaking out about safety concerns in the workplace is perceived to be encouraged (see Frazier & Bowler, 2015; Morrison et al., 2011). Measures of safety climate include a combination of formal aspects, such as policies for safety, and more informal behavioral aspects (i.e., practices; Zohar, 2008), whereas the safety voice climate concerns more specifically perceived levels of encouragement to speak out about safety issues. Moreover, whereas safety climate is often conceptualized at the team or organizational level (Zohar, 2008, 2010), this study considers safety voice climate as mainly manifested by subjective perceptions. The level of conceptualization and analysis of climate is a continuing debate among researchers; climate can be investigated at different levels of the organization (Rousseau, 1985). Subjective safety voice climate, which is the main focus of the present study, reflects individual perceptions that speaking out about safety concerns in the workplace is encouraged. Thus, when considered from an individual perspective, safety voice climate represents a cognitive interpretation of a work group or organization (James, James, & Ashe, 1990). Proponents of the subjective climate perspective suggest that individuals react to these cognitive and subjective representations of environments rather than to actual and objective work climates (James & Sells, 1981). Subjective climates can be regarded as dynamic products of the employees' experiences and can differ as a function of diverse contexts and workgroup processes (bottom-up emergent phenomena; Kozlowski, 2015).

Hypothesis 1. *Most of the variance of safety voice climate is explained on the individual level.*

1.3. Safety voice climate dimensions

In their presentation of a group voice climate, Morrison and colleagues (2011) suggested a two-dimensional construct. The first dimension, group voice safety beliefs, is the belief about whether speaking out is safe or dangerous. The second dimension, group voice efficacy, is the belief about whether group members have the capability to voice effectively. Numerous empirical studies have included this model in different settings (e.g., Duan, Xu, & Frazier, 2019; Knoll et al., 2020). Richard et al. (2017) and Schwappach and Richard (2018) suggested a three-dimensional model of speaking out climate related to patient safety consisting of the variables "psychological safety for speaking up," "encouraging environment for speaking up," and "resignation towards speaking up." Possibly, work environments that encourage speaking out behavior will also facilitate safety for speaking out so that they could be overlapping dimensions. A possible limitation of the above-mentioned voice climate models is that they don't include leadership encouragement or support as a dimension even though leaders play a central role in the development of climates and as role models. For instance, Momeni (2009) found that more than 70% of employees' perceptions of organizational climate were shaped directly by their leader's style of leadership and behavior.

Based on these considerations, this study conceptualizes safety voice climate as having two dimensions. The first, *Work colleagues' encouragement of safety voice*, combines the abovementioned factors "voice safety beliefs" and "encouraging environment for speaking up." Thus, the dimension comprises a perception of whether there is a work environment among colleagues where it is safe to speak out and that this type of behavior is encouraged. The dimension involves an evaluation of outcome expectancy and is consistent with studies suggesting that employees often believe that they will be punished if they speak out, particularly about sensitive issues such as safety concerns (Detert & Burris, 2007; Morrison et al., 2011). The dimension concerns whether employees perceive pressure against or encouragement for speaking out about safety concerns and to what extent they perceive it as uncomfortable or difficult to speak out. Work colleagues' encouragement of safety voice possibly relates to psychological safety, which is a separate stream of research with a focus on perceived safety to engage in interpersonal behaviors influencing learning and performance or beliefs about whether a particular context is safe for interpersonal risk-taking (Edmondson, 1999). However, work colleagues' encouragement of safety focuses specifically on the perceived psychological safety of voicing safety issues as opposed to other forms of interpersonally risky behavior.

The second dimension is a perception of *Leader's attitudes toward safety voice*. A key factor that influences whether employees have the courage to speak out is the signals that the leader sends. Leaders may stimulate their employees to voice safety concerns by actively appreciating and inviting input (Alingh, van Wijngaarden, van de Voorde, Paauwe, & Huijsman, 2019). In their analysis of organizational silence, Morrison and Milliken (2000) suggested that managers played a key role and proposed two important factors that would suppress voicing behavior. First, managers' fear of receiving negative feedback, particularly from subordinates. Consequently, they will avoid getting negative feedback or ignore, dismiss, or attack the sender when they receive negative feedback. Second, managers hold implicit beliefs about employees as self-interested and untrustworthy, that management knows best, and that dissent is bad while unity is good. Findings from several studies resonate with these suggestions. For instance, transformational leadership (that represents the adverse leadership thinking than described above, characterized by intellectual stimulation and inspirational motivation) is positively associated with employee safety voice (Bazzoli, Curcuruto, Morgan, Brondino, & Pasini, 2020; Conchie et al., 2012). In addition, studies have documented that voice behavior, not specifically related to safety, is positively associated with leadership behaviors such as supportive leadership (Elsaied, 2019), servant leadership (Chughtai, 2016; Yan & Xiao, 2016), inclusive leadership (Chen, Liang, Feng, & Zhang, 2023; Lee & Dahinten, 2021), self-sacrificial leadership (Zhang, Li, & Huang, 2020), and empowering leadership (Jada & Mukhopadhyay, 2018). Thus, encouraging leadership is a vital factor in the promotion of voice as well as safety voice.

Moreover, Zohar and Luria (2005) suggested that focal climate facets could represent competing operational requirements in relation to other facets (e.g., safety vs. service, creativity vs. efficiency). Therefore, the best indicators of an organization's true priorities as distinguished from their formally stated counterparts are the actual prioritizations leaders give to safety voice, and these should be more important parts of an organizational climate than the formal rules and policies (Zohar, 2008). Thus, the dimension "Leader's attitudes towards safety voice" reflects whether the leaders listen when safety concerns are presented, take the message seriously, and express that they appreciate safety voice behavior.

A few studies have applied items to assess voice climate. However, most of these (Duan et al., 2019; Frazier & Bowler, 2015; Hsiung & Tsai, 2017; Knoll et al., 2020; Lee, Wang, & Liu, 2017; Liu, Mao, & Chen, 2017; Morrison et al., 2011) were based on a voice *behavior* scale developed by LePine and Van Dyne (1998), and the distinction between voice behavior and voice climate was unclear. Moreover, these studies measured general voice climate and not safety voice climate. A scale has been developed to measure the related, but broader, concept of safety citizenship

behavior that incorporates items similar to safety voice (e.g., "I make suggestions to management to improve the safety of the work environment;" Reader et al., 2017). However, this is not a climate measure. A few scales have been specifically developed to measure safety voice or speaking out climate in the health sector, but they contain few items with unclear theoretical basis (Nembhard, Yuan, Shabanova, & Cleary, 2015), items that specifically concern patient safety (Richard et al., 2017; Schwappach & Richard, 2018) or the target response group for the scale were patient groups (Martinez et al., 2015). In the current study, a safety voice climate measure is presented, named the Safety Voice Climate Scale (SVCS), which can be applied across sectors. In testing the reliability and factor structure, the study offers a psychometric validation of the SVSC.

Hypothesis 2. *The Safety voice climate scale (SVCS) is identified by two sub-factors: "Work colleagues' encouragement of safety voice" and "Leader's attitudes towards safety voice."*

1.4. Associations between safety voice climate and safety voice behavior

The relationship between climate dimensions and voice behavior is not straightforward. Results from two simulation studies from the health sector showed conflicting evidence regarding whether trainees' voice behavior toward their supervisors could be manipulated by supervisors displaying encouraging or discouraging communication (Friedman et al., 2015; Salazar et al., 2014). Furthermore, studies on the organizational level indicate that the relationships between climate, psychological safety, and voice behavior are also somewhat unclear (Etchegaray et al., 2020; Gilmartin et al., 2018). While several studies show that the complex relationships between organizational climate and voice behavior are still not clearly understood, this can also be interpreted in light of how the main concepts are defined, operationalized, and assessed. While safety voice behavior is closely linked to safety concerns connected to specific events that trigger these concerns and are thus highly context-sensitive, perceived climates (including the more specific safety climate) are more generalized perceptions of procedures and behaviors among coworkers. As Zohar (2008) commented, personnel develop attitudes and related behaviors that are domain-specific for organizational functioning. Within high-risk industries, there will typically be attitudes and behaviors developed that are specifically related to safety. A study from the health sector explored more specific measurements of speak-up-related climate and speaking-up frequency (Schwappach & Richard, 2018). This study concluded that perceptions of a speaking-up climate reduced decisions to remain silent among staff in hospitals. Still, there is a need for a measure that can be applied across sectors to identify differences in safety voice climate and for studies that can detect the process link between safety voice climate and safety voice behavior.

Hypothesis 3. *Safety voice climate is positively associated with safety voice behavior.*

2. Method

2.1. Sample

The Trends in Risk Level in the Norwegian Petroleum Activity (Risiko Nivå i Norsk Petroleumsvirksomhet; RNNP) questionnaire has been distributed to employees in the Norwegian petroleum industry every other year from 1999/2020. The present study is based on data from 2019, in which there was a response rate of 22.2% (n = 7,624) (Petroleum Safety Authority Norway, 2019b). Despite a rather low response rate, the sample has proved to be relatively stable from year to year over variables such as gender, age group, facility, and the area of work ratio between operators and entrepreneurs, permanent and temporary employees, and proportion with managerial responsibilities. For more information, see Petroleum Safety Authority Norway (2019b). The sample includes occupations such as craftsmen/operators, electricians, mechanics, institutional cleaners, crane operators, and logistics operators. The sample includes employees at offshore oil rigs as well as at land-based plants. Of the participants, 916 (12%) were females, and 2,752 (36.1%) were under 41 years, 2,214 (29.1%) between 41 and 50 years, 2,642 (34.7%) were 51 years or older and 16 (0.2 %) did not report age.

2.2. Instrument

The Safety Voice Climate Scale (SVCS) and the measurement of safety voice behavior were derived from the RNNP survey. Key stakeholders in the petroleum industry (trade unions, employees, and authorities) have collaborated in developing the RNNP over the years. The RNNP monitors personal risk, risk of acute emissions, incidents that can cause major accidents, and working environment factors. All items use a five-point Likert scale ranging from 1 (fully disagree) to 5 (fully agree).

2.2.1. Demographic variables

Age was measured with one question, and the response options included: "20 years or younger," "21–24 years," "25–30 years," "31–40 years," "41–50 years," "51–60 years" and "61 years or older." Age was divided into three groups, detailed above. Gender was also reported. Leader responsibility was measured with one question: "Do you have management responsibility?" and the response options were "No," "Yes, with personnel responsibility" and "Yes, without personnel responsibility." Union representation was measured with one yes/no question: "Are you currently an employee representative?" The authors constructed a role variable by coding all non-leaders as 0, all leaders as 1 and all union representatives as 2. Facility was reported with a free text field. Data-owner has coded these facilities and given them random numbers to keep confidentially. As the question was free text many have not reported facility or it has been difficult to code facility connection, which have resulted in more missing data (detailed in results).

2.2.2. Safety Voice Climate Scale (SVCS)

The internally consistent (Cronbach's $\alpha = 0.81$) SVCS included eight items as reported in Table 3. All eight items used the same five-point Likert scale. Five of the items were negatively worded questions resulting in a negative scale ranging from −5 to 4.33. Negatively worded items were reversed in the aggregated scale. The item allocation to each of the two factors, "*Work colleagues' encouragement of safety voice*" and "*Leader's attitudes towards safety voice*," is reported in Table 3.

2.2.3. Outcome factor: Safety voice behavior

The fairly internally consistent (Cronbach's $\alpha = 0.63$) safety voice behavior index included three items, as shown in Table 4.

2.3. Analyses

Initial analyses and data management were performed using Stata 15.1 for Windows. To test H1 and calculate basic descriptive results, one-way ANOVA was used to compare means across role and/or gender and facility. Posthoc Tukey tests were also used to pairwise investigate statistical significance across all combinations

of role and gender. The study used the alpha command to calculate the scales and the collapse function to calculate the mean SVCS score of gender and role (Fig. 1).

Confirmatory factor analyses (CFA) and structural equation modeling (SEM) were performed using Mplus version 8 for Windows. First, the study calculated Cronbach's α in Stata using the alpha command. Second, the study performed a CFA splitting the SVCS into two factors (M1, Table 2, Fig. 2) to test H2. All eight variables were defined as categorical and the Mplus default WLSMV estimator was used. The study also used Mplus to calculate the average variance extracted (AVE) to measure discriminant validity. The ML estimator was used when calculating AVE. Third, the authors performed SEM to calculate the SVCS' ability to predict safety voice behavior (M2, Table 2, Fig. 3) to test H3. The authors also defined the three items (detailed above) in the safety voice behavior factor as categorical and used the Mplus default WLSMV estimator in M2.

3. Results

The SVCS mean for all participants was 4.49 (SD = 0.84, range = 0.00–9.33). There was a larger within-group variance than between-group variance between all facilities (SS = 2418.26 vs. SS 143.95, F = 4.33, p < 0.001), supporting H1. Females (mean = 4.61, SD = 0.81) had a significantly higher mean compared to males (mean = 4.48, SD = 0.84, Table 1). There was a larger within-group variance than between-group variance in gender (SS = 5198.83 vs. SS 14.21, F = 20.49, p < 0.001), supporting H1. Leaders had the highest mean (4.66, SD = 0.80), union representatives had the lowest (4.31, SD = 0.85), and the remaining employees were in the middle (mean = 4.43, SD = 0.84, Table 1). There was a larger within-group variance than between-group variance in role (SS = 5114.83 vs. SS 106.97, F = 53.48, p < 0.001), supporting H1. A pairwise Tukey test showed that all three combinations were significantly different from each other. Being a leader had a moderate effect on the SVCS mean (Cohen's d = −0.26, CI = −0.31 – −0.21) compared to all others. Being a union representative had an opposite moderate effect on the SVCS mean (Cohen's d = 0.25, CI = 0.17 – −0.33).

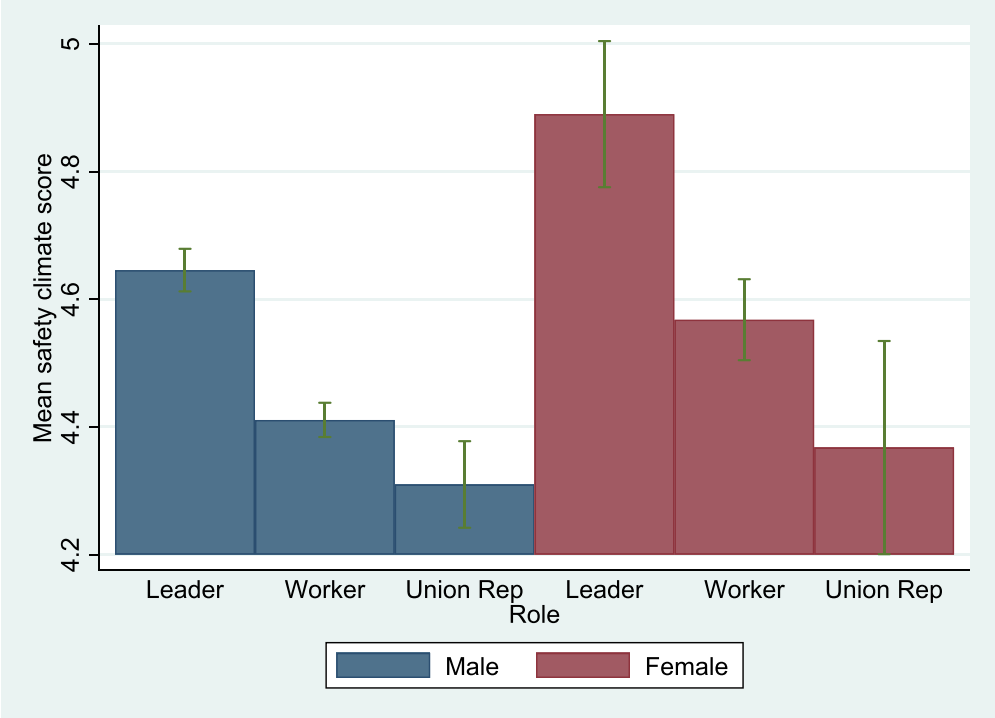
When roles and gender were combined, findings were more mixed, and 10 of 15 pairwise comparisons were significant. However, female leaders were the only group significantly different from all others, with the highest mean of all combinations: 4.89 (SD = 0.78). Male leaders were significantly different from both male employees and male union representatives and had the highest mean amongst males (mean = 4.65, SD = 0.84). Male employees (mean = 4.41, SD = 0.84) differed significantly from female employees (mean = 4.57, SD = 0.81), however female union representatives (mean = 4.37, SD = 0.78) did not differ significantly from male union representatives (mean = 4.31, SD = 0.85, Table 1 and Fig. 1). There was a large within-group variance than between-group variance also when role and gender were combined (SS = 5056.62 vs. SS 130.35, F = 26.07, p < 0.001), supporting H1.

3.1. Confirmatory factor analysis (CFA)

The CFA splitting the SVCS into two factors, one reflecting work colleagues' encouragement of safety voice and one reflecting leader's attitudes towards safety voice, gave fair fit (M1: RMSEA = 0.066, CFI = 0.980, Table 2, Fig. 2).

Factor 1: Work colleagues' discouragement of safety voice.

The loadings of the four items of the variable are reported in Table 3 and Fig. 2. Three of the four items were negatively worded but positively loaded on factor 1, resulting in factor 1 being negative in relation to safety voice climate. The factor had poor discriminant validity (AVE = 0.343). Still, AVE is a conservative estimate of the validity of the measurement model, and according to Fornell and Larcker (1981), "on the basis of p_n (composite reliability)



Note: The sum of the two SVCS scales is shown.

Fig. 1. Scores on the SVCS across demgraphic groups. Note: The sum of the two SVCS scales is shown.

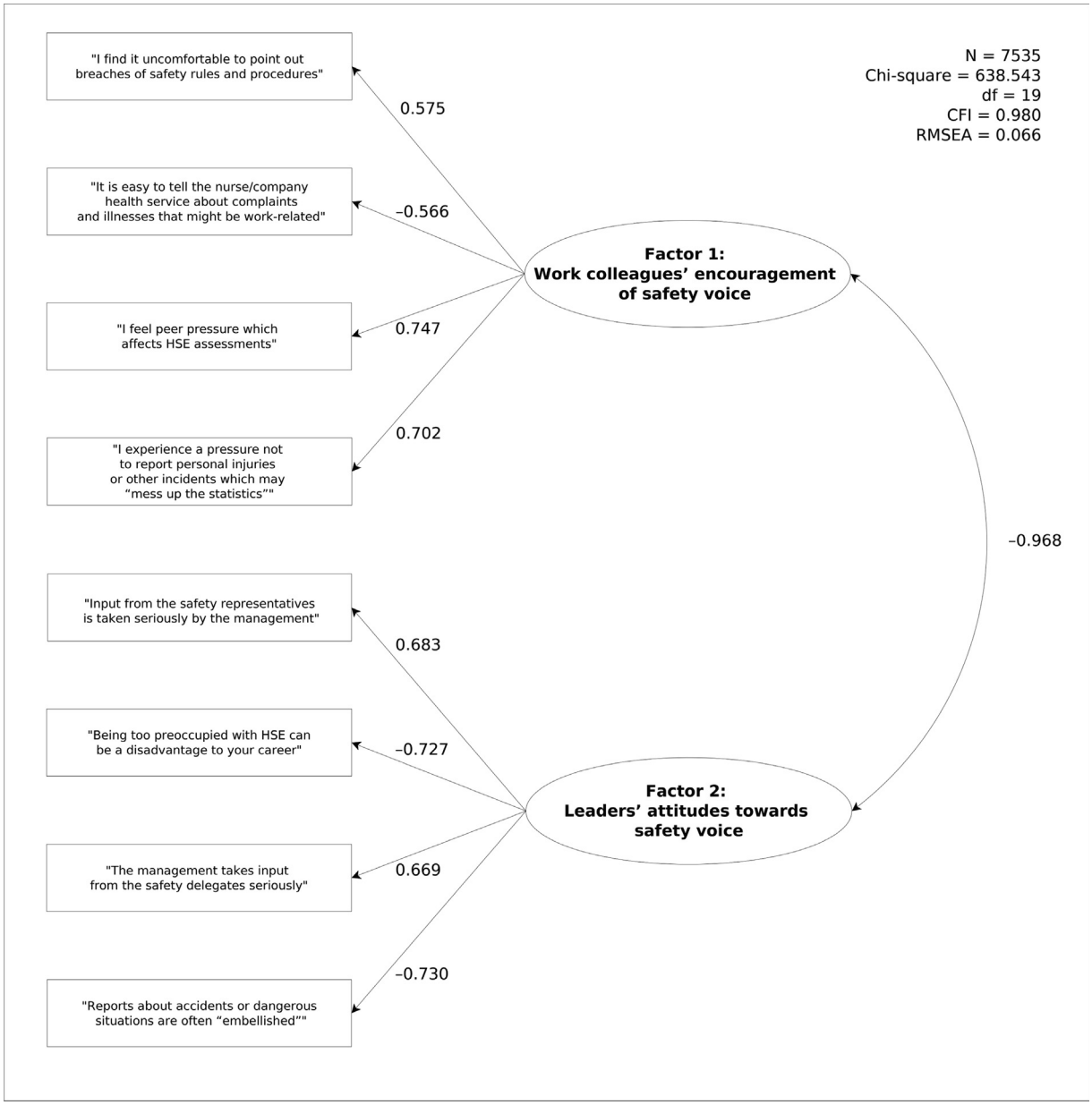


Fig. 2. Model 1. CFA shows standard estimates and fit indices.

alone, the researcher may conclude that the convergent validity of the construct is adequate, even though more than 50% of the variance is due to error" (p. 46).

Factor 2: Leader's positive attitudes toward safety voice.

The loadings of the four items of the variable are reported in Table 3 and Fig. 2. Two of the four items were both negatively worded and negatively loaded on factor 2, resulting in factor 2 being positively associated with safety voice climate. The factor had fair discriminant validity (AVE = 0.411).

Factors 1 and 2 were strongly negatively associated ($\beta = -0.968$, $p < 0.001$, Table 3, Fig. 2), a finding that was expected as three of the four items in factor 1 were negatively worded. The R^2 value of the eight observed variables in the model ranged from 0.321 to 0.558; hence, the residual variance ranged from 0.442 to 0.679.

Overall, the two-factor CFA model gives some support to H2, claiming that the Safety voice climate scale (SVCS) is identified by two sub-factors: "Work colleagues' encouragement of safety voice" and "Leader's attitudes towards safety voice." The model fit is fair, and the average explained variances (AVEs) are low. Thus, H2 is moderately supported.

3.2. SEM

The structural equation model using the SVCS variables to predict safety voice behavior factor gave a good fit (M2: RMSEA = 0.068, CFI = 0.969, Table 2, Fig. 3). The factor loadings for the CFA part of model 2 are reported in Table 4 and Fig. 3.

There was a negative regression path from factor 1, work colleagues' encouragement of safety voice, to the safety behavior factor ($\beta = -0.630$, $p < 0.001$, Table 4, Fig. 3). The regression path from factor 2 to the safety behavior factor was not significant ($\beta = 0.129$, $p = 0.489$, Table 4, Fig. 3). The high negative correlation between factor 1 and factor 2, in combination with the significant regression path on factor 3 gives support to H3, that Safety voice climate was positively associated with safety voice behavior.

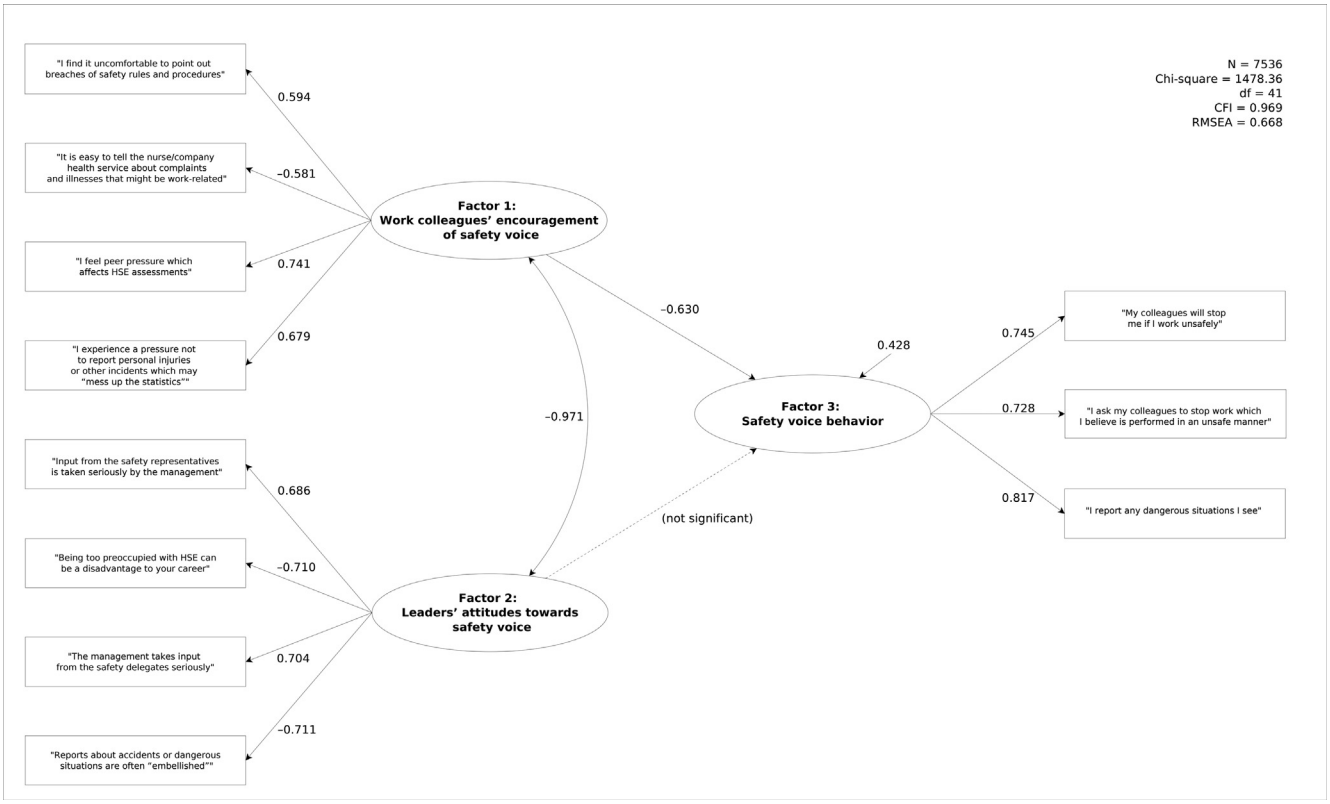


Fig. 3. Model 2 (M2). CFA showing standard estimates and fit indices.

Table 1
ANOVA and pairwise comparison across gender, roles, and the combination of gender and roles.

Gender	Role	Mean	SD	n	Sig
Male	All roles	4.48	0.84	6,601	*
Female		4.61	0.81	901	*
Both gender	Leader	4.66	0.80	2,395	*
	Employee	4.43	0.84	4,408	*
	Union Rep	4.31	0.85	697	*
Male	Leader	4.65	0.80	2,206	
	Employee	4.41	0.84	3,758	
	Union Rep	4.31	0.85	609	
Female	Leader	4.89	0.78	180	*
	Employee	4.57	0.81	630	
	Union Rep	4.37	0.78	87	

*$p < 0.05$ compared to all other categories pairwise Tukey test.

Table 2
Fit indices for the tested models.

Model	N	χ^{2***}	df***	CFI	RMSEA
M1: 2-factor CFA* Safety Voice Climate Scale	7535	638.543	19	0.980	0.066
M2: SEM**: Predicted safety behavior	7536	1478.36	41	0.969	0.068

* CFA = Confirmatory factor analyses.
** SEM = Structural equation modeling.
*** Chi-square test of model fit.

The residual variance of the safety behavior factor was 0.428, indicating that factors 1 and 2 combined explained 57.2% of the variance (Table 4).

4. Discussion

The overall objectives of this study were to conceptualize safety voice climate, present the SVCS as a tool to measure it, and gather initial evidence for the validity of the SVCS as a measurement of subjective climate. As predicted in H1, it was found that SVCS varied mostly on an individual level; however, there was a significant variation in gender and role.

Based on a theoretical approach, the SVCS was split into two variables, one reflecting work colleagues' encouragement of safety voice and the other reflecting leaders' attitudes towards safety voice. The scales' psychometric properties, the CFA model fit, and

Table 3
Model 1 (M1). Item loadings of the two SVCS variables.

Factors	Items	Standardized β weights	R^2	Standard error	Residual variance	P
Factor 1: Work colleagues' encouragement of safety voice	I find it uncomfortable to point out breaches of safety rules and procedures	0.575	0.467	0.011	0.533	<0.001
	It is easy to tell the nurse/company health service about complaints and illnesses that might be work-related	−0.566	0.330	0.011	0.670	<0.001
	I feel peer pressure which affects HSE assessments	0.747	0.528	0.011	0.472	<0.001
	I experience a pressure not to report personal injuries or other incidents which may "mess up the statistics"	0.702	0.448	0.012	0.552	<0.001
Factor 2: Leaders' attitudes towards safety voice	The management takes input from the safety delegates seriously	0.683	0.533	0.010	0.467	<0.001
	Being too preoccupied with HSE can be a disadvantage to your career	−0.727	0.321	0.012	0.679	<0.001
	My manager appreciates me pointing out matters of importance to HSE	0.669	0.558	0.012	0.442	<0.001
	Reports about accidents or dangerous situations are often "embellished"	−0.730	0.492	0.012	0.508	<0.001
	Factor 1/Factor 2 association	−0.968		0.006		<0.001

Note. HSE: Health, Safety, and Environment.

Table 4
Model 2 (M2). Item loadings of the two SVCS variables and the safety voice behavior variable.

Factors	Items	Standardized β weights	R^2	Standard error	Residual variance	P
Factor 1: Work colleagues' encouragement of safety voice	I find it uncomfortable to point out breaches of safety rules and procedures	0.594	0.470	0.011	0.530	<0.001
	It is easy to tell the nurse/company health service about complaints and illnesses that might be work-related	−0.581	0.353	0.011	0.647	<0.001
	I feel peer pressure which affects HSE assessments	0.741	0.503	0.011	0.497	<0.001
	I experience a pressure not to report personal injuries or other incidents which may "mess up the statistics"	0.679	0.495	0.012	0.505	<0.001
Factor 2: Leaders' attitudes towards safety voice	The management takes input from the safety delegates seriously	0.686	0.506	0.010	0.494	<0.001
	Being too preoccupied with HSE can be a disadvantage to your career	−0.710	0.338	0.012	0.662	<0.001
	My manager appreciates me pointing out matters of importance to HSE	0.704	0.549	0.012	0.451	<0.001
	Reports about accidents or dangerous situations are often "embellished"	−0.711	0.461	0.012	0.593	<0.001
Factor 3: Safety voice behavior	My colleagues will stop me if I work unsafely	0.745	0.555	0.014	0.445	<0.001
	I ask my colleagues to stop work which I believe is performed in an unsafe manner	0.728	0.529	0.014	0.471	<0.001
	I report any dangerous situations I see	0.817	0.668	0.016	0.332	<0.001
Regression paths	Factor 1 regressed on Factor 3	−0.630		0.187		0.001
	Factor 2 regressed on Factor 3	0.129		0.187		0.489
Associations	Factor 1 association to factor 2	−0.971		0.006		<0.001
Residual variance	Factor 3: Safety voice behavior		0.572	0.015	0.428	<0.001

Note. HSE: Health, Safety, and Environment.

average explained variance (detailed in results) combined gave some support to H2.

It was also found that SVC was associated with safety voice behavior in a model with good fit (detailed in results), supporting H3 that safety voice climate is related to safety voice behavior. Thus, the findings from this study support the importance of a climate that encourages safety voice. There is a greater chance that employees will speak out about safety issues when their general perception is that this type of behavior is encouraged and supported within their organization. However, a surprising finding is that it appears that leaders' attitudes toward safety voice are inferior to colleagues' encouragement of safety voice, as only the latter was significantly associated with safety voice behavior. A possible explanation of this finding could be that keeping good relationships with close colleagues is more important than with one's leaders' as coworkers are a vital part of the social environment (Chiaburu & Harrison, 2008). Consequently, employees will be reluctant to speak out when this can be perceived as annoying, hurting others, and causing conflicts among colleagues (see Manapragada & Bruk-Lee, 2016). Still, the two variables are strongly associated, and one could therefore argue that colleagues encourage safety voice as a consequence of their leaders' positive attitudes toward safety voice and that the effect of leaders' attitudes toward safety voice on safety voice behavior "go through" work colleagues' encouragement of safety voice.

The findings show that leaders, particularly female leaders, perceive the climate to be more supportive of safety voice than employees and union representatives do. Leaders are generally expected to show commitment and positive attitudes toward their organization. According to social exchange theory, actions that provide benefits to another party will generally be reciprocated in the future, for instance, by bonuses or promotions (Blau, 1986). Thus, a psychological contract may develop between leaders and top management where leaders are expected to emphasize the positive aspects of the job climate, and negative perceptions may generally be repressed. Furthermore, since leaders are generally less involved in hands-on work operations, there is a risk that they are not aware of possible shortcuts and rule violations conducted during operations. Consequently, they might believe that safety voice climate is stronger than it really is. Thus, leaders and their

employees can develop different perceptions of safety voice climate. Other studies on the more general concept of safety climate show similar perceptual differences between leaders and employees (e.g., Huang et al., 2014; Marin, Lipscomb, Cifuentes, & Punnett, 2019).

The union representatives scored lowest on the SVCS. Union representatives may, to a greater extent than other employees, observe or be informed about elements at work that can harm employees. Their psychological contract will be to alert management when they observe safety issues. However, management can sometimes perceive union representatives to be annoying and may not support them when they speak out about safety issues. In a study that supports this argument, Gormley (2011) found that union-represented staff nurses reported significantly lower mean scores than other members of the organization on all work environment variable measurements.

4.1. Research contributions and practical implications

The current study contributed to the advancement of the theory on safety voice climate by differentiating two distinct factors: *Work colleagues' encouragement of safety voice* and *Leaders' attitude towards safety*. In testing the psychometric properties and criterion validity of the SVCS, this study was the first to offer a general measure of safety voice climate applicable across sectors and testing it in a large sample of industrial employees. The sample is derived from the petroleum sector and covers both offshore rigs and land-based plants as well as numerous occupations, and thus it is possibly relevant across sectors, at least in the high-risk industries.

Ultimately, the purpose of developing the SVCS is to aid in the continuous improvement of safety in high-risk organizations by helping to identify why employees speak out (or do not) about safety issues witnessed at work. The SVCS can be used as a tool to detect some of the barriers and supporting elements relating to safety voice and to guide the efforts needed to foster work climates that promote communication of safety issues. When SVCS scores are low, organizations should initiate preventive efforts such as training leaders to be more encouraging of safety voice and safety participation. However, as these findings indicate that colleagues' encouragement of safety voice is more closely linked to safety voice behavior than how they perceived their leaders' attitudes toward safety voice, organizational efforts to improve safety voice behavior could emphasize the enhancement of collegial support of speaking out.

This study contributes to high-risk industries and specifically to the offshore petroleum sector. The Petroleum Safety Authority Norway emphasizes that an effective reporting culture is vital to prevent accidents (Petroleum Safety Authority Norway, 2019a). Still, a study on the related concept of whistleblowing in Norwegian organizations reported that there had been a reduction in reporting behavior (Trygstad & Ødegård, 2019). A cause for worry in this regard is that the Petroleum Safety Authority has registered an increasing number of reported concerns and incidents, 80% of which are related to offshore activities (Ministry of Labour and Social Affairs, 2017). These reports underline the need for monitoring and follow-up on safety voice climates in the petroleum industry and other industries. The current study contributes by presenting an instrument to assess the safety voice climate.

4.2. Limitations and future research avenues

The present study is not without its limitations. Even though the sample covered many occupations and settings within the petroleum sector, the SVCS requires further validation on different types of samples across time. Future studies should examine safety voice climates across high-risk industries such as mining, construction, and aviation. Furthermore, as the current study was performed in Norway, where the national culture may influence safety voice climates, studies from other countries are needed. A limitation is that the response rate was low (22%) and could be biased by selective non-response. However, the RNNP samples have proven to be relatively stable from year to year over variables such as gender, age group, facility, and the area of work ratio between operators and entrepreneurs, permanent and temporary employees, and proportion with managerial responsibilities, increasing the likelihood for acceptable external validity.

The current study argued for operationalizing safety voice climate on the individual level. Nevertheless, other researchers have proposed that groups or organizations can develop climates about speaking out or not speaking out, which refer to shared perceptions of the group or organization (Morrison & Milliken, 2000). Thus, a group or organizational safety voice climate could be operationalized by aggregating the individual perceptions, given that there is sufficient perceptual consensus (Chan, 1998). The current study also tested safety voice climate as a group or organizational climate in the initial analyses of the data. That is, the authors tested a level 2 model by running a two-level confirmatory factor analysis. However, the study was not able to get a satisfying model fit on this Multilevel CFA. Possibly, a reason for this is that the level 2 data were on oil rig / land-based plant level as these industries are not necessarily organized in teams or groups but often projects or contractors working individually for some time on an installation. Consequently, operationalizing safety voice climate on the individual level is most suitable, at least for the type of sample that was available. Other studies in other types of industries that are organized differently could test whether the level 2 climate model would be more suitable for these industries.

As this study applied a cross-sectional design, conclusions concerning causality are impossible regarding the safety voice climate and safety voice behavior variables. It is possible that the levels of safety voice behavior shape safety voice climate. A reciprocal relationship between the variables is also likely so that a perceived safety voice climate leads to safety voice behavior that, in turn, increases the perception of safety voice climate. Longitudinal studies would provide more knowledge on reciprocal relationships.

This study did not include any effect measures such as operational risks or safety indicators; because the intention of this study was mainly to explore the associations between the SVCS and safety voice behavior, operational effect measures were not prioritized. Future studies on this topic should introduce models that also include effect measures. Furthermore, future studies could apply more objective measures of safety voice behavior than the self-reports used in this study. Thus, the safety voice behavior measure captured reports of behavior, not behavior itself.

There is a need for future studies that test the discriminant and incremental validity of the SVCS. Particularly, safety climate, voice climate, and safety voice climate are "close relatives," and the authors would expect safety climate scales and the SVCS to be moderately correlated.

Finally, the unexpected finding that only *Work colleagues' encouragement of safety voice* was associated with safety voice would need attention in future studies to investigate whether the finding would be replicated, and the theoretical framework would need to be adapted accordingly.

4.3. Conclusion

A climate that encourages safety voice is an important component of a safe work environment. When employees perceive that voicing safety concerns is encouraged, organizations have better opportunities to correct safety issues and take preventative actions against accidents and injuries. Studying the motives behind safety

voice can help researchers understand why employees choose to speak out so that targeted interventions can be developed to nurture these elements. The current study contributes, in this regard, by presenting a validated instrument to assess one of the motives behind safety voice—safety voice climate.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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