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Speaking up about safety concerns in high-risk industries: Correlates of safety voice in the offshore oil rig sector

Gro Ellen Mathisen [a,*], Tore Tjora [a], Linn Iren Vestly Bergh [b]

[a] Faculty of Social Sciences, University of Stavanger, Norway
[b] The Petroleum Safety Authority, Norway

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ABSTRACT

Speaking up about safety issues – or safety voice – is a proactive response involving people at all levels of the organization who are willing to express their concern in response to perceived hazards. This study investigated psychosocial correlates of safety voice and effects of safety voice on safety measures. Drawing on Job Demand Resources theory (JD-R) we suggested that job resources in the form of supportive leadership and job control are positively associated to safety voice and that job demands are negatively associated with safety voice. Furthermore, we studied the association between safety voice and the outcome variables safety risk and personal injuries. Data were derived from the "Trends in risk level in the petroleum activity" (RNNP) survey and included 7505 respondents from the Norwegian offshore oil rig sector. As hypothesized, we found a negative association between job demands and safety voice and positive associations between safety voice and the resource variables leader support and job control. Moreover, safety voice behaviour was negatively associated with the outcome variables safety risk and personal injuries. An implication from these findings is that safety voice should be encouraged in the high-risk industries by nurturing healthy work environments in which employees have the capacity and support to speak up to prevent hazards.

1. Introduction

The communication of concerns about safety-related issues in high-risk industries is important to maintain safe work environments and prevent injuries (e.g. Christian et al., 2009; Nahrgang et al., 2011; Neal and Griffin, 2006). Speaking up about safety issues – or safety voice – is a proactive response whereby people at all levels of the organization express their worries in response to perceived hazards (Noort et al., 2019). Both downward and upward communication about safety issues could be vital to prevent, detect and correct unsafe work environments and procedures. Consequently, accidents, injuries and ill health can be reduced.

Still there is uncertainty to what factors that enforce or hinders voice behavior in the high-risk industries. To date, most of the safety voice research has been performed in the health sector, and there are several differences between the industries that may not make research findings transferable. This study addresses this knowledge gap by investigating correlates of safety voice in the context of the high-risk industries, i.e. the offshore oil rig sector.

Results from studies in the health sector indicate that two main issues seem to be associated with speaking up behavior: to what extent is it perceived as safe to speak up and to what extent will it be effective considering the costs incurred (see Voogt et al., 2019). Voice is an extra role behavior that is time- and energy-consuming and may also be perceived as risky as it might provoke negative reactions. Thus, it is more likely that employees speak out when they perceive their work environment as supportive and not too demanding. Based on this assumption, the theoretical framework for our study is the job demand-resourses model (Bakker & Demerouti, 2007) and we investigate the extent to which job demands, job control, and leader support are associated with safety voice behavior among oil rig employees.

Another area of uncertainty is to what extent safety voice is associated with improved safety measures (Noort et al., 2019). Probably, safety voice contributes to a decrease in safety and health risks as hazardous behaviours and action errors are reduced when employees speak up about them. Our study pinpoints this important knowledge gap by investigating the associations between safety voice and perceived safety risks and personal injuries at offshore oil rigs.

The overall aim of our study is to enhance knowledge about the role of safety voice in the offshore oil rig sector and how to encourage

* Corresponding author.
E-mail address: Gro.e.mathisen@uis.no (G.E. Mathisen).

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employees' willingness to speak out about safety concerns.

1.1. Safety voice

The concept of safety voice is grounded in the more general concept of employee voice. Employee voice can be defined as "relatively discretionary expressions of organizationally relevant content intended to affect the work context (e.g., policies, practices, procedures, work methods, & goals) and targeted explicitly at someone in the organization" (Chamberlin et al., 2017, p.11). Voice is categorized either as "promotive voice" with a focus on opportunities and improvement initiatives or "prohibitive voice" that concerns speaking up about issues that may otherwise become hazardous for individuals or the organization (see Chamberlin et al., 2017). Safety voice generally falls within the category of prohibitive voice and relates to efforts that aim to reduce the risks of injuries (Tucker & Turner, 2014) and may be intended to improve general safety levels on the one hand or prevent hazards in emergency situations on the other (Noort et al., 2019). Safety voice concerns rule or policy violations, action errors and other safety violations and can be crucial to ensure that preventive actions are taken to reduce the occurrence of accidents, injuries and catastrophes. Speaking out about minor incidents could prevent larger accidents from developing. However, studies indicate that 50–80% of work-related injuries and accidents go unreported (Bienefeld & Grote, 2012; Probst et al., 2008). People seem to be generally reluctant to speak up (e.g. Milgram, 1974; Morrison & Milliken, 2000). For instance, a qualitative study distinguished between a number of motives for remaining silent about safety concerns, including self-based (speaking up could lead to negative repercussions like colleagues perceiving one to be annoying), other-based (speaking up could hurt others e.g. they could get fired), relationship-based (speaking up could hurt relationships with others e.g. causing conflicts), climate-based (norms, managerial practice and support does not emphasise voice), issue-based (the perceived severity of the worry) and job-based (job related elements like time pressure, work load) (Manapragada & Bruk-Lee, 2016). Still, there is need to expand the understanding of safety voice, and it is essential to understand the factors that drive as well as hinder employees in speaking up about safety concerns so that measures can be taken to create work environments that nurture safety voice.

To date, the bulk of the research on safety voice has been undertaken in the health sector (Noort et al., 2019). Although this research is relevant to high-risk industries like the offshore oil rig sector, there are also differences that may not make research findings immediately transferable. For instance, health sector work cultures are different from industrial work cultures, one aspect being its hierarchical structure where professional groups such as medical doctors and leading nurses have particularly much power, and this may lead junior doctors and nurses to remain silent due to fear of reprisals or censure on the part of authorities (Morrow et al., 2016; Okuyama et al., 2014; Peadon et al., 2020). Moreover, the types of risk factors are different; risks in the health sector, for example, typically concern human error with serious consequences for individual patients, whereas the offshore oil rig sector's risks encompass major potential catastrophic breakdowns. Thus, the antecedents and consequences of safety voice may differ between the health sector and the offshore oil rig sector, and there is clearly a need for more knowledge about the latter. More specifically, the offshore oil rig sector's activities involve a range of accident risks including fires, falling objects, hydrocarbon leakages and explosions. Moreover, offshore oil rig workers are exposed to a number of stressors, including cramped physical environments, long work shifts, isolated location, noise, vessel motion, as well as heavy physical work that may increase the risk of human error and thereby accidents (Mathisen & Bergh, 2016). Thus, it is highly important that employees speak up when they observe safety risks in this sector.

1.2. Antecedents of safety voice

Evidence from a *meta*-study of the driving factors for general voice (not specifically related to safety) showed that "job and organizational attitudes and perceptions" was the category that accounted for most of the variance of the voice predictors (50 percent, Chamberlin et al., 2017). Examples of elements covered by this category were felt responsibility, social support, autonomy, job satisfaction and organisational commitment. Individual dispositions like personality variables and negative affect explained 20 percent of the variance while emotions, beliefs and schemas explained a total of 17 percent. Interestingly, contextual factors including workplace climate and leadership factors like transformational leadership and ethical leadership explained only a moderate proportion of the variance (6 percent and 12 percent respectively). Thus, this study's findings indicate that the job-related perceptions and attitudes are particularly important to promote voice behaviour and should be addressed further.

In a systematic review that included a total of 50 safety voice studies, Noort et al. (2019) concluded that the majority of studies concerned individual factor antecedents like personality, demographics and perceived cost of voice. The most frequently studied individual factor was fear of consequences, which was generally negatively associated with safety voice. Among the most studied group-related predictors of safety voice were openness (positive), good- (positive) or fragile (negative) relationships with receivers, and hierarchy (negative). Among studies classified at the institutional level, the most studied predictors of safety voice were structural factors (e.g. hierarchical structure as a negative predictor), cultural factors (e.g. supportive culture as a positive predictor) and work configuration with high workload as the most studied variables (negative predictor). We have identified only one study concerning safety voice in the oil and gas industry (Conchie et al., 2012) and this study examined the role of transformational leadership and trust in promoting safety voice. However, this study included oil refinery workers and not offshore workers. Offshore workers have distinctively different work environments, as described above. Thus, there is scarce knowledge about promotors and inhibitors of safety voice in the offshore oil rig sector.

Two main issues seem to be particularly important when considering speaking up: to what extent is it safe to speak up and to what extent will it be effective considering the costs incurred (see also Voogt et al., 2019). These are in line with well-known models about psychosocial factors like the Job-Demand-Resources model that proposes that job characteristics can be modelled based on two categories; job demands and job resources (Bakker & Demerouti, 2007). Job demands is defined as "those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological (cognitive and emotional) effort or skills" (p. 312) and Job resources refer to "those physical, psychological, social, or organizational aspects of the job that are either/or: functional in achieving work goals; reduce job demands and the associated physiological and psychological costs; stimulate personal growth, learning, and development" (p. 312). Heavy job demands, if imposed over a long time period, may trigger a cascade of mental processes leading to a decrease in an employee's mental and physical resources, and resulting in exhaustion, health problems, and reduced work engagement and performance. In contrast, job resources are suggested to nurture employees' growth, learning, and development on the one hand, and buffer the stressful and health-impairing experiences on the other, thereby building a stronger engagement to one's work. Job resources have been operationalised in several ways, and support from leaders (e.g. Bowen et al., 2014; Leung et al., 2016; Li et al., 2013) and job control (e.g. Abbe et al., 2011; Goldenhar et al., 2003; Leung et al., 2016) are frequently studied variables also relating to health and safety issues.

In this paper, we suggest that these job characteristics could also constitute a relevant framework within which to enhance the understanding of safety voice.

1.2.1. Job demands and safety voice

Offshore oil rig workers are exposed to a number of adverse work environment factors including long work shifts, isolated location, noise, vessel motion, heavy physical work, and hazardous work operations (Gardner, 2003; Haward et al., 2009; Niven & McLeod, 2009; Parkes, 2012). The work factors may be associated with pressure- and stress-related risk factors and reduced well-being and exhaustion (Sneddon et al., 2013). When facing overwhelming job demands, workers must exert physical effort to deal with them. Eventually, their resources may become depleted, which in turn may lead to emotional exhaustion (Bakker & Demerouti, 2007; Bakker et al., 2000). According to ego depletion theory, depletion caused by initial exertions of self-control makes it harder to initiate and perform subsequent tasks (Baumeister et al., 1998). Hence, when workers are faced with heavy workloads with short deadlines, their ability to solve complex problems and engage in constructive job activities may be reduced. Voice behavior is an extra role behavior that is time- and energy-consuming and may also be perceived as risky as it might provoke negative reactions. As a consequence, there is a risk that workers experiencing high demands will speak out to a lesser extent when they have safety concerns. Consistent with this expectation, Lin and Johnson (2015) found that workers were unlikely to speak up when they felt depleted. Data for this study were obtained via Mechanical Turk, and no information was provided about industry and work tasks. In a *meta*-analysis, Ng and Feldman (2012) found a negative association between voice behaviour and various job stressors such as lack of job challenge and dissatisfaction with work conditions. However, this study did not report results regarding work demands such as workload and short deadlines. Surprisingly, a recent study from the Chinese manufacturing industry, Xia et al. (2020) found that challenge stressors (which include perception of workload, time pressure, job complexity and responsibility) were positively associated with voice behaviour. The authors argued that challenge stressors can promote mastery and personal growth and may therefore prevent depletion and, in this way, increase the likelihood of speaking up. To conclude, the role of demands as an inhibitor or promotor of voice is still unclear. Moreover, the studies reported here studied the general concept of voice and not safety voice as is the focus of the current study. Based on the above reasoning, we suggest that job demands are negatively associated with voice behavior.

Hypothesis 1: There will be negative associations between safety voice and job demands

1.2.2. Job control and safety voice

Job control concerns employeeś perception of autonomy on the job and impact on work outcomes (see Brockner et al., 2004). Autonomy concerns the extent to which workers perceive that they have control over their work behaviour, whereas impact is the extent to which workers perceive that they have control over work outcomes (Brockner et al., 2004; Spreitzer, 1995). Perceived job control is associated with a heightened sense of responsibility (Parker et al., 2006; Tornau & Frese, 2013), creative process engagement (Du et al., 2019) and improved job performance (Brockner et al., 2004). A possible explanation of this association is that workers with high job control think they can influence their work situation and therefore proactively look for possibilities to solve work-related issues (see Tangirala & Ramanujam, 2008). Moreover, workers with more job control are likely to perceive that they have the *capacity* to meet the daily expectations at work and can make more of an effort in solving other issues. Thus, a change-oriented, participatory, extra-role behaviour such as safety voice should be associated with perceived control. In support of this proposition, a *meta*-study on job strain and voice including 11 studies about job autonomy, found that perceptions of lack of job autonomy were negatively associated with voice behaviour (included studies in or before 2010, Ng & Feldman, 2012). Additionally, two more recent studies found positive correlations between control and voice behavior; one study includes Dutch health workers (Voogt et al., 2019) and the other, chemical workers from Central Europe (Curcuruto et al., 2020). The study by Curcuruto et al. (2020) is the only we have identified that studied associations between safety-specific voice behaviour and perceived job control. Thus, there is a need for more knowledge on how job control relates to safety voice. The offshore oil rig sector over the period of recent years has gone through significant change processes with a view to adjusting expenditures to income levels as a result of reduced oil prices and technological developments including digitalisation. Organisational restructuring often entails major transitions for workers, such as new roles and tasks, new leaders and co-workers, losing colleagues, and job insecurity. These have been found to be associated with a loss of perceived control (Proktor & Doukakis, 2003; Tvedt et al., 2009). Thus, examining the perceived job control and safety voice association is highly relevant in this industry. Based on the above reasoning and initial research results, we anticipate that job control is positively associated with safety voice behaviour.

Hypothesis 2: There will be positive associations between safety voice and job control

1.2.3. Leadership support and safety voice

While the above-mentioned *meta*-studies report that there are several variables that influence safety behaviour, a common characteristic is that many of these are relational variables, meaning that employees' engagement in safety behaviour depends on the quality of the relationship with colleagues and leaders. Drawing on social exchange theory, safety voice can be conceptualised as an extra role and unrewarded behaviour that employees are likely to engage in when they believe the organisation supports them (Rhoades & Eisenberger, 2002; Wayne et al., 1997). Thus, safety voice can be considered a reciprocal response to the feeling of being cared for by one's leader or organization. When leaders show their attentiveness to safety by valuing concerns and suggestions for improving safety, employees develop a belief that their organisation has a positive attitude towards safety which may increase the probability that they will participate in safety-related behaviour (Tucker et al., 2008). In support of this notion, in their *meta*-study of safety voice, Noort et al. (2019) identified 5 studies measuring support, all having positive associations with safety voice. Findings from a recent study by Bergeron and Thompson (2020) mirrored the findings from the *meta*-study. However, these studies examined supportive cultures at institutional level and not leader support. In an interview study from a high-tech company, Detert and Trevino (2010) examined the associations between organisational leadership and voice. They concluded that immediate supervisors' supportive behaviour strongly influenced employees' perceptions of voice. Leaders perceived as open, empathic, tolerant and emotionally composed were seen as contributing to voice behaviour. Moreover, a study of the concept of "safety-specific transformational leadership", where one of the components is individualised support to achieve safety goals, has linked the concept to safety voice (Conchie et al., 2012). In the only quantitative study we have identified that examined associations between leadership support and safety voice, Curcuruto et al. (2020) found a positive correlation between the variables with respondents from the chemical industry. In the only study we have found that links support and the broader concept of safety citizenship behaviour from the offshore oil rig sector, reported that organisational support of health was associated with the related concept of safety citizenship behavior (Reader et al., 2017).

We further investigate whether the associations between safety voice and job demands as well as job control are moderated by leader support. The well documented job-demand-resources theory proposes that in addition to their direct positive effect, job resources (i.e. leadership support in our study) buffer the negative effects of job demands (i.e. job demands and reduced job control, Demerouti et al. (2001). Thus, supportive leaders can serve as a resource in demanding times and when control is insufficient because they may help workers to remain motivated to speak up despite the adverse work situation. In support of this, Xia et al. (2020) found that a model wherein there was a good-quality

relationship between leader and follower (LMX, Graen & Uhlbien, 1995) moderated the association between perceived stressors and ego depletion and predicted general voice behaviour. Accordingly, we propose that leader support moderates the association between safety voice and job demands as well as job control.

Hypothesis 3: Leader support will moderate the association between safety voice and job demands as well as the association between safety voice and job control.

1.3. Links between safety voice and perceived safety

A likely effect of safety voice would be a decrease in safety and health risks as hazardous behaviours and action errors will be reduced when employees speak up about them. However, there is a scarcity of research that addresses the effects of safety voice behaviour (Noort et al., 2019). Nevertheless, studies on the broader concept of "safety participation" have concluded that notifications of potential hazardous situations are effective in reducing workplace accidents and injuries (Conchie, 2013; Curcuruto et al., 2015). This concept may be somewhat diffuse as it comprises multiple acts like helping others, safety voice and looking out for the welfare of other and it is difficult to identify the elements that are effective in terms of safety outcomes. Curcuruto and Griffin (2018) conducted a more specific analysis of the concept and distinguished between prosocial (e.g. helping others) and proactive safety behaviours (voice and initiating change) and found the proactive behaviours predicted near-miss events and lost-time injuries in chemical plants. The current study builds on these preliminary findings and suggest that safety voice will reduce the risk of accidents and personal injuries in the petroleum industry.

Hypothesis 4: There will be negative associations between safety voice and a) safety risks, and b) reported personal injuries.

2. Method

2.1. Sample

The trends in risk level in the petroleum activity questionnaire (RNNP) have been distributed electronically to offshore employees in the Norwegian oil and gas industry every other year from 1999/2000. The present study is based on data from 2017 with a response rate of 31.3% (n = 7505; Petroleum Safety Authority Norway, 2017). In spite of 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 (Petroleum Safety Authority Norway, 2017). The sample includes occupations such as craftsmen/operators, electricians, mechanics, institutional cleaners, crane operators or logistics operators. The participants work on rotation with 4 weeks off and 2 weeks on (4 × 2 weeks). Employees usually work 12-hour shifts over a two-week period. In the sample population, 13% were females. 35% were below 41 years of age, 31% between 41 and 50 years old, and 34% older than 51.

2.2. Instruments

All variables were derived from the "Trends in risk level in the petroleum activity" (RNNP) survey. The RNNP was initiated to monitor the risk level on the Norwegian continental shelf (NCS). 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, as well as working environment factors, including physical and psychosocial risks. In this study, data from the part of the RNNP that assesses job demands. job control, leader support, safety voice, safety risk, and injuries were used. In constructing the indices (detailed below) items worded negatively were reversed and mean values were calculated and reported. In four of the indices, we included responses with up to one item missing on each index. On the fifth index, "Safety risk index", which was based on 13 questions, we allowed up to three missing items. All items used in the indices (except "Safety risk index") used the same five-point Likert scale from 1 (fully agree) to 5 (fully disagree), as negatively worded questions were reversed and mean values were used in the indices, the same scale applies for the indices as well as the single items All indices were divided into quartiles used in both descriptive statistics and in the dose–response analyses. The safety voice index (detailed below) was used to construct a dichotomous variable where the lowest decile was defined as "low safety voice".

2.2.1. Background variables:

Age group 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 year or older". Gender was also reported. Tenure was measured with two questions, one for onshore workers ("How long have you worked onshore?") and a similar question for offshore workers: ("How long have you worked offshore?") These two questions were combined into one, as no respondent answered both questions, and the response options were identical: "0–3 months", "4 months–1 year", "2–5 years", "6–10 years", "11–19 years", and "20 years or more".

2.2.2. Safety Voice:

The fairly internally consistent (Cronbach alpha = 0.65) safety voice index included the mean of four items: "I would rather not discuss HSE with my immediate supervisor", "My colleagues will stop me if I work unsafely", "I ask my colleagues to stop work which I believe is performed in an unsafe manner" and "I report any dangerous situations I see". The CFA showed good fit (CFI = 0.99, RMSEA = 0.05), however the average variance extracted (AVE) was below 0.40 (AVE = 0.32). This average of 32% variance explained by the latent constructed "safety voice" index across the four included items is considered to be low. However, as the composite reliability (CR) score was above 0.60 (CR = 0.68) we used the index despite low AVE (Bagozzi & Yi, 1988).

2.2.3. Job demands:

The mean of following three items were used to construct a fairly internally consistent (Cronbach alpha = 0.66) index reflecting job demands: "Does your work require so much attention that you find it a strain?", "Do you have so many tasks that it becomes hard to concentrate on each one?" and "Is it necessary to work very fast?" As factors based on only three indicators just can be identified, the model has no degrees of freedom and fit-indicators like CFI and RMSEA cannot be calculated, and was omitted. The average variance extracted (AVE) was between 0.40 and 0.50 (AVE = 0.40), and therefore we calculated the composite reliability (CR) score in addition. The CR was above 0.60 (CR = 0.67) thus we used the index despite an AVE-score under 0.50 (Bagozzi & Yi, 1988).

2.2.4. Job control:

The index on job control had good internal consistency (Cronbach alpha = 0.79) and was constructed as the mean of 3 items: "Can you set your own work speed?", "Can you influence decisions which are important to your work?", "Can you influence the way you perform your work?" As factors based on only three indicators just can be identified, the model has no degrees of freedom and fit-indicators like CFI and RMSEA cannot be calculated, and was omitted. The average variance extracted (AVE) was over 0.50 (AVE = 0.55).

2.2.5. Leader support:

The mean of the following three items were used to construct a consistent index (Cronbach alpha = 0.78) reflecting leader support: "Does your immediate supervisor value your work results?", "Does your

immediate supervisor help and support you in your work, if you need it?" and "Does your immediate supervisor give you feedback on your work performance?" As factors based on only three indicators just can be identified, the model has no degrees of freedom and fit-indicators like CFI and RMSEA cannot be calculated, and was omitted. The average variance extracted (AVE) was over 0.50 (AVE = 0.55).

2.2.6. Safety risk:

The internally consistent (Cronbach alpha = 0.92) safety risk index included 13 items: "Helicopter accident", "Gas leak ", "Fire", "Explosion", "Blowout", "Discharge of toxic gases/substances/chemicals", "Radioactive sources", "Collisions with ships/vessels/floating objects", "Sabotage/acts of terror", "Collapse of the installation's load-bearing structures or loss of buoyancy", "Serious work accidents", "Falling objects" and "IT/control systems failure". All items were reported using the same six-point scale ranging from 1="very slight hazard" to 6="very great hazard". The CFA showed poor fit (CFI = 0.86, RMSEA = 0.13), and due to poor fit and relatively many items we ran an exploratory factor analysis on above mentioned items. The eigenvalues dropped below 1 from one factor (Eigenvalue = 6.57) to two factors (Eigenvalue = 0.64) indicating that safety risk is unidimensional. The average variance extracted (AVE) was above 0.50 (AVE = 0.52).

2.2.7. Personal Injuries:

Personal Injuries were measured with one yes–no question: "Have you been injured in a work accident while at the facility during the past year?"

2.3. Analyses

Stata/IC 15.1 for Windows was used for most statistical analyses, Mplus 8 for Windows was used for calculating index fit indicators (CFI, RMSEA and AVE) (detailed above). First, we performed two-way analyses of variance (ANOVA), examining how background variables and five key-predictors ("leader support", "job control", "job demands", "safety risk", "personal injuries") were distributed across low safety voice (Table 1). We also divided the constructed indices into quartiles to further investigate how low safety voice was distributed across each index. The quartiles were later used in dose–response analysis. The analysis using background variables were included, as we later used the variables as covariates in the logistic regressions.

Second, to test the hypotheses, we wanted to examine the degree to which increasing levels of these key indices were associated with a higher chance of low safety voice. We did this by examining the dose–response associations between key indices and low safety voice in logical regression models (Table 2). Chi-square tests were used both to test differences at each level in the dose–response analyses, and to test homogeneity and trends (Table 2). As the dose–response model (Table 2) does not allow adjustment for covariates, we also did a standard logistic regression model comparing the highest and lowest categories from the dose–response association (Table 2). In addition to running the crude models, we also adjusted each model for the effect of background variables (age group, gender and tenure) and the four high-low dichotomic variables not used as predictive variable (Table 3).

Third, to examine whether level of leader support had a moderating effect on the association between safety voice and job demands and safety voice and job control, we did two linear regression models with leader support as an interaction term (Table 4). We used the mean safety voice value as the outcome variable in both regressions, and the standardized values of job control and leader support in the first, and job demands and leader support in the second regression model. We chose to use the non-standardized values on the outcome variables so that the values could be directly compared to the original scale on the safety voice index (Figs. 1 and 2). We chose to use the standardized values on

Table 1
The distribution of low safety voice across age group, gender, tenure, key indices, and personal injury, percentage in brackets.

		Low safety voice [%]			
		No	Yes	N	diff**
Age-group	20 years or younger	133 [91.1%]	13 [8.9%]	146	$\chi^2 = 12.54$, df = 6, p = 0.051
	21–24 years	173 [87.4%]	25 [12.6%]	198	
	25–30 years	566 [85.8%]	94 [14.2%]	660	
	31–40 years	1,342 [86.5%]	210 [13.5%]	1,552	
	41–50 years	1,958 [86.2%]	313 [13.8%]	2,271	
	51–60 years	1,810 [88.3%]	241 [11.8%]	2,051	
	61 year or older	452 [90.4%]	48 [9.6%]	500	
Gender	Male	5,518 [87.2%]	811 [12.8%]	6,329	$\chi^2 = 0.06$, df = 1, p = 0.813
	Female	830 [87.5%]	199 [12.5%]	949	
Tenure	0–3 months	95 [88.8%]	12 [11.2%]	107	$\chi^2 = 3.64$, df = 5, p = 0.602
	4 months–1 year	138 [90.8%]	14 [9.2%]	152	
	2–5 years	740 [87.9 %]	102 [12.1 %]	842	
	6–10 years	1,405 [86.3 %]	224 [13.8 %]	1,629	
	11–19 years	1,993 [87.2 %]	293 [12.8 %]	2,286	
	20 years or more	2,063 [87.2 %]	304 [12.4 %]	2,367	
Job demands	Low (Q1)	2,598 [93.3 %]	188 [6.8 %]	2,786	$\chi^2 = 220.26$, df = 3, p < 0.001
	Low-mid (Q2)	1,127 [88.7 %]	143 [11.3 %]	1,270	
	High-mid (Q3)	1,800[84.4 %]	332 [15.6 %]	2,132	
	High (Q4)	859 [76.8 %]	260 [23.2 %]%	1,119	
Job control	Low (Q1)	1,515 [74.9%]	508 [25.1%]	2,023	$\chi^2 = 438.47$, df = 3, p < 0.001
	Low-mid (Q2)	1,947 [88.6%]	251 [11.4%]	2,198	
	High-mid (Q3)	1,397[92.4%]	115 [7.6%]	1,512	
	High (Q4)	1,523[96.5%]	56 [3.6%]	1,579	
Leader support	Low (Q1)	1,890 [75.8%]	605 [24.3%]	2,495	$\chi^2 = 503.05$, df = 3, p < 0.001
	Low–mid (Q2)	2,025 [90.2 %]	220 [9.8 %]	2,245	
	High-mid (Q3)High-mid (Q3)	941 [94.6 %]	54 [5.4 %]	995	
	High (Q4)	1,503 [97.2 %]	43 [2.8 %]	1,546	
Safety risk	Low (Q1)	1,789 [95.4 %]	86 [4.6 %]	1,875	$\chi^2 = 295.70$, df = 3, p < 0.001
	Low-mid (Q2)	1,762 [90.0 %]	195 [10.0 %]	1,957	
	High-mid (Q3)	1,522 [85.2 %]	264 [14.8 %]	1,786	
	High (Q4)	1,302 [76.9 %]	392 [23.1 %]	1,694	
Personal injury	No	6,025 [87.8 %]	839 [12.2 %]	6,864	$\chi^2 = 24.68$, df = 1, p < 0.001
	Yes	230 [78.0 %]	65 [22.0 %]	295	

Table 2
Logistic regression, dose–response odds ratio for low safety voice across key indices and variables.

		Odds ratio	Confidence interval	Significance test
Job demands	Low (Q1)	REF	REF	
	Low-mid (Q2)	1.75	1.39–2.20	
	High-mid (Q3)	2.55	2.11–3.08	
	High (Q4)	4.18	3.39–5.15	
	Test of homogeneity:			$\chi^2 = 220.23$, df = 3, p < 0.001
	Score test for trend of odds:			$\chi^2 = 215.44$, df = 1, p < 0.001
Job control	High (Q4)	REF	REF	
	High-mid (Q3)	2.24	1.61–3.11	
	Low-mid (Q2)	3.51	2.60–4.73	
	Low (Q1)	9.12	6.77–12.29	
	Test of homogeneity:			$\chi^2 = 438.41$, df = 3, p < 0.001
	Score test for trend of odds:			$\chi^2 = 386.41$, df = 1, p < 0.001
Leader support	High (Q4)	REF	REF	
	High-mid (Q3)	2.01	1.33–3.02	
	Low-mid (Q2)	3.80	2.71–5.32	
	Low (Q1)	11.19	8.04–15.57	
	Test of homogeneity:			$\chi^2 = 502.98$, df = 3, p < 0.001
	Score test for trend of odds:			$\chi^2 = 430.76$, df = 1, p < 0.001
Safety risk	Low (Q1)	REF	REF	
	Low-mid (Q2)	2.30	1.77–3.00	
	High-mid (Q3)	3.61	2.79–4.66	
	High (Q4)	6.26	4.86–8.07	
	Test of homogeneity:			$\chi^2 = 295.66$, df = 3, p < 0.001
	Score test for trend of odds:			$\chi^2 = 290.81$, df = 1, p < 0.001
Personal injury	No	REF	REF	$\chi^2 = 21.00$, df = 1, p < 0.001
	Yes	2.03	1.53–2.70	

predictors and the moderator so the two figures could be easily compared. If the interaction term was significant, we plotted the results of the simple slope predictions from minus two standard deviation to plus two standard deviation on the predictors and the moderator (Figs. 1 and 2).

3. Results

The background variables (age-group, gender and tenure) showed no significant association with low safety voice (Table 1).

3.1. Hypothesis 1: Job demands and safety voice

The lowest quartile (Q1) on job demands had a significantly lower percentage (6.8%) in the low safety voice category compared to the highest (23.2%) quartile (Q4) (Table 1). With the lowest job control quartile (Q1) as a reference, there was a significant dose–response trend from Q1 to Q4 on increasing odds-ratios: Participants in the second lowest quartile (Q2) had 1.8 times the chance of being in low safety voice (OR = 1.75, CI = 1.39–2.20) (Table 2). Participants in the third category (Q3) had 2.6 (OR = 2.56, CI = 2.11–3.08) greater chance, and participants in the lowest quartile on job demands (Q4) had 4.2 times the chance of being in the low safety voice category (OR = 4.18, CI = 3.39–5.15) (Table 2). There was a significant difference between each level of job demands (Test of homogeneity: $\chi^2 = 220.23$, df = 3, p < 0.001), and the score test for trend indicated that there was a dose–response relationship (Score test for trend of odds: $\chi^2 = 215.44$, df = 1, p < 0.001) (Table 2). Being in the highest quartile on job demands had 2.8 times (OR = 2.75, CI = 1.43–5.30) greater chance of being in the low safety category also after adjusting for the other relevant variables (Table 3). These findings indicate that there is a dose–response and negative association between job demands and safety voice, supporting our hypothesis 1.

Table 3
Highest vs lowest group in key indices by low safety voice, crude and adjusted models.

		Crude model		Adjusted model**	
		Odds ratio	Confidence interval	Odds ratio	Confidence interval
Job control	High (Q4)	REF	REF	REF	REF
	Low (Q1)	9.12*	6.86–12.13	2.45	0.82–7.30
Job demands	Low (Q1)	REF	REF	REF	REF
	High (Q4)	4.18*	3.41–5.12	2.75*	1.43–5.30
Leader support	High (Q4)	REF	REF	REF	REF
	Low (Q1)	11.19*	8.15–15.46	10.78*	2.80–41.53
Safety risk	Low (Q1)	REF	REF	REF	REF
	High (Q4)	6.26*	4.91–7.99	2.14*	1.44–3.19
Personal injury	No	REF	REF	REF	REF
	Yes	2.03*	1.53–2.70	2.84*	1.48–5.46

* = significant at p < 0.05.
** = adjusted for other indices and variables, age group, years of experience and gender.

3.2. Hypothesis 2: Job control and safety voice

As with job demands, the lowest quartile (Q1) on job control had a significantly higher percentage (25.1%) in the low safety voice category compared to the highest (3.6%) quartile (Q4) (Table 1). With the highest job control quartile (Q4) as a reference, there was a significant dose–response trend from Q4 to Q1. Participants in the second highest quartile (Q3) had 2.2 times the chance of being in low safety voice (OR = 2.24, CI = 1.61–3.11) (Table 2). Participants in the third category (Q2) had 3.5 (OR = 3.51, CI = 2.60–4.73) greater chance, and participants in the lowest quartile on job control (Q1) had 9.1 times the chance of being in the low safety voice category (OR = 9.12, CI = 6.77–12.29) (Table 2). There was a significant difference between each level of job control (Test of homogeneity: $\chi^2 = 438.41$, df = 3, p < 0.001), and the score test for trend indicated that there was a dose–response relationship (Score test for trend of odds: $\chi^2 = 386.41$, df = 1, p < 0.001) (Table 2). However, being in the lowest quartile on job control was not significant after adjusting for the other indices, age group and gender (Table 3). Thus, these mixed findings lend some support to hypothesis 2.

3.3. Hypothesis 3: Supportive leadership moderates the associations between job demands, job control and safety voice

Leader support was directly associated with safety voice much the same way as job control and job demands (detailed in Table 1, 2 and 3). Leader support was a significant moderator on both the association between job demands and safety voice (interaction term t = 3.97, p > 0.001) and job control and safety voice (interaction term t = -5.64, p > 0.001).

The simple slope predicting safety voice with job demands showed

Table 4
Linear slopes for predicting safety voice with two predictors and a moderator.

			dy/dx	T	p> |t|	CI
Job demands	Leader support	− 2 SD	-0.12	−9.97	0.000	−0.14 to −0.10
		0 SD (mean)	-0.08	−13.25	0.000	−0.09 to −0.07
		+ 2 SD	-0.04	−3.18	0.001	−0.06 to −0.01
Job control	Leader support	− 2 SD	0.17	14.81	0.000	0.14–0.19
		0 SD (mean)	0.11	16.96	0.000	0.10–0.12
		+ 2 SD	0.05	4.42	0.000	0.03–0.08

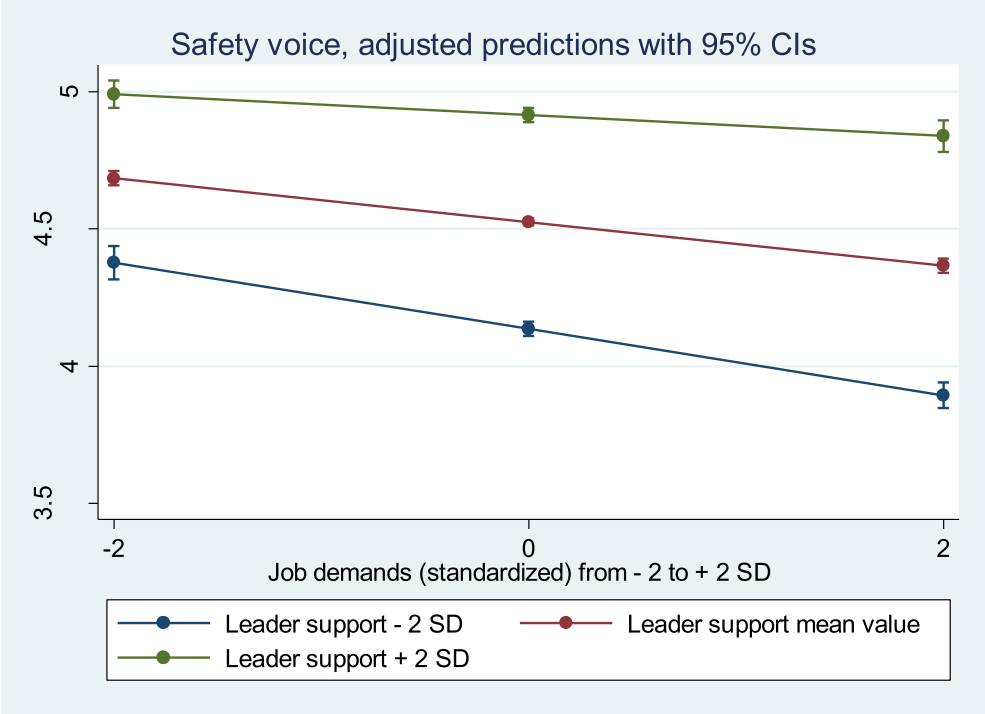

Fig. 1. Predicted safety voice with job demands as predictor and leader support as moderator.

significant different slops for different levels of leader support: Leader support two standard deviations below mean had a slope of -0.12 (t = -9.97, p > 0.001, CI = -0.14 to −0.10) (Table 4). At mean the slope was -0.08 (t = −13.25, p > 0.001, CI = −0.09 to −0.07), and at two standard deviations above mean on leader support the slope was −0.04 (t = −3.18, p > 0.001, CI = −0.06 to −0.01). None of the confidence intervals were overlapping. This indicates that leader support moderates the effect on job demands on safety voice: With higher levels of leader support, the intercepts were higher, and the negative slopes were slighter, indicating increasing job demands having smaller influence on safety voice for participants experiencing high leader support (Fig. 1).

The simple slope predicting safety voice with job control showed significant different slops for different levels of leader support: Leader support two standard deviations below mean had a slope of 0.17 (t = 14.81, p > 0.001, CI = 0.14–0.19). At mean the slope was 0.11 (t = 16.96, p > 0.001, CI = 0.10–0.12), and at two standard deviations above mean on leader support the slope was 0.05 (t = 4.42, p > 0.001, CI = 0.03–0.08) (Table 4). None of the confidence intervals were overlapping. This indicates that leader support moderates the effect on job control on safety voice: With higher levels of leader support, the intercepts were higher, however the slopes were slighter, indicating increasing job control having smaller influence on safety voice for participants experiencing high leader support (Fig. 2).

These findings lead support to hypothesis 3: That leadership moderates the associations between both job demands and safety voice and job control and safety voice.

3.4. Hypothesis 4a: Safety voice and safety risks

The lowest quartile (Q1) on safety risk index had a significantly lower percentage (4.6%) in the low safety voice category compared to the highest (23.1%) quartile (Q4) (Table 1). With the lowest safety risk quartile (Q1) as a reference, there was a significant dose–response trend from Q1 to Q4 on increasing odds-ratios: Participants in the second lowest quartile (Q2) had 2.3 times the chance of being in low safety voice (OR = 2.30, CI = 1.77–3.00) (Table 2). Participants in the third category (Q3) had 3.6 (OR = 3.61, CI = 2.79–4.66) greater chance, and participants in the lowest quartile on safety risk (Q4) had over 6 times the chance of being in the low safety voice category (OR = 6.26, CI = 4.86–8.07) (Table 2). There was a significant difference between each level of safety risk (Test of homogeneity: $\chi^2 = 295.66$, df = 3, $p < 0.001$), and the score test for trend indicated that there was a dose–response relationship (Score test for trend of odds: $\chi^2 = 290.81$, df = 1, $p < 0.001$) (Table 2). Being in the highest quartile on safety risk had 2.1 times the chance (OR = 2.14, CI = 1.44–3.19) of being in the low safety category also after adjusting for the other relevant variables (Table 3). These findings indicate that there is a dose–response and direct association between safety risk and safety voice, supporting hypothesis 4a.

3.5. Hypothesis 4b: Safety voice and personal injuries

Participants reporting a work accident resulting in personal injury had a significantly higher percentage (22.0%) in the low safety voice

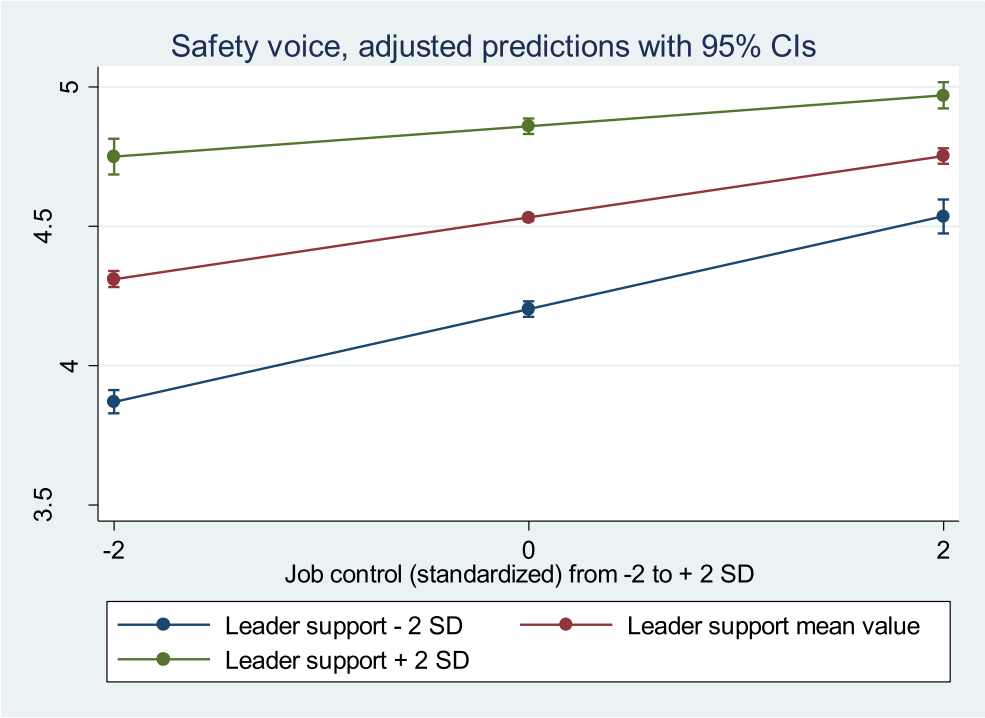

Fig. 2. Predicted safety voice with job control as predictor and leader support as moderator.

category compared to those not reporting a personal injury (12.2%) ($\chi^2 = 24.68$, df = 1, $p < 0.001$) (Table 1). Participants reporting a personal injury had twice the chance of being in low safety voice category (OR = 2.03, CI = 1.53–2.70), a finding also significant after adjusting for the other relevant variables (Table 3). These findings indicate that there is a dose–response and direct association between having an personal injury and safety voice, supporting hypothesis 4b.

4. Discussion

In this study, we investigated correlates and effects of safety voice in the offshore oil rig sector, drawing on the job-demand-resources model. We studied the role of job demands (job requiring too much attention, task overload and need to work at a high pace) and job resources (job control and leadership support) and their relationship with safety voice. In line with the proposed hypotheses, we found that job demands were negatively associated with safety voice (H1) whereas job control was positively associated with safety voice (H2). Heavy workload may lead to a state of depletion or a lack of capacity and thereby worries as to whether speaking up about safety concerns will increase the already excessively heavy burden. Thus, it may be better to keep silent. In accordance with social exchange theory, not reporting one's concerns may also be a way to take revenge on a non-supportive leader. Conversely, with job control, employees have an overview of their tasks and how to perform them and may have better capacity and feel safer to speak up about safety issues. Leadership support was also positively associated with safety voice. In harmony with social exchange theory, if employees receive general support from their leader, they may also expect to receive support when informing about safety concerns, so that it feels safe to voice their concerns. Based on this we also suggested that leadership support would moderate the association between safety voice and job demands and job control, and our finding supported this hypothesis (H3). Support from a leader did appear to reduce the negative effect of job demands on safety. Further, support from a leader also increased the effect of job control on safety voice.

In order to promote safety voice, there is a need to balance job demands and control. It is possible that leadership support will be perceived as false or manipulative when job demands and job control are not addressed as part of the support.

Our findings support and extend the conclusion from earlier studies that employees' participation in safety is associated with organisational safety performance. Safety voice was negatively associated with perceived safety risks as well as with reported personal injuries, and this also supported our hypotheses (H4a and H4b). As the majority of safety voice studies so far have been performed in the healthcare sector and in the United States, there is a strong study context bias relating to the topic (Noort et al., 2019) and a contribution of the current study is to investigate the offshore oil rig sector in Norway. The findings from our study indicate that safety voice is crucial in understanding and thereby reducing safety risks and injuries in the offshore oil rig sector and outside the United States. Moreover, our research is an important contribution to the field since studies that investigate the complete safety voice process (antecedents, voice behavior, outcomes) are scarce (Noort et al., 2019). In particular, studies have emphasized the antecedents of safety voice whereas a research gap remains when it comes to the outcomes (Noort et al., 2019).

4.1. Theoretical implications

At a theoretical level, our study contributes to the job demands-resources (JD-R) literature extending its scope of outcomes to the involvement in safety voice behaviour. Thus, our study demonstrates that the JD-R model applies to the safety voice literature and that psychosocial factors can be routed along two pathways: one that promotes safety voice and one that hampers safety voice. The JD-R model has been documented through several studies as a relevant factor relating to safety behaviour and safety output (see Derdowski & Mathisen, 2019). Our study adds to this body of literature and is the first that investigates safety voice with this theoretical framework.

Our study also contributes towards clarifying the boundaries between the safety voice and the general voice concepts. Our findings reveal that similar psychosocial factors which have previously been associated with general voice were also associated with safety voice. Thus, even if the concepts can be distinguished relating to focus area

(general vs specific), our findings give some indications that the psychosocial factors that promote or hamper the occurrence of general voice and safety voice are common. However, more evidence is required to further clarify similarities and differences. Possibly, the expression of safety voice is perceived as more challenging than general voice due to larger social risks involved. Its contents are generally about preventing incidents and accidents, and recipients may perceive the message as negative criticism. Based on this, we may assume that the promoting factors like leadership support and perceived control need to be strengthened to trigger safety voice, more so than is the case for general voice. Future research should examine this. We also studied a delimited number of variables; future studies might investigate associations with safety voice and general voice and other psychosocial factors such as quality of relationships among colleagues, role clarity and psychological safety.

4.2. Practical implications

At a practical level, our study makes an important contribution to the high-risk industries and more specifically to the offshore oil rig sector. The Norwegian Petroleum Safety Authority (PSA) has focused over the years on areas and topics relevant to safety voice. As part of the follow-up of HSE culture in the industry, the PSA highlights the importance of having a "reporting culture" to prevent incidents and accidents. For example, in the HSE culture folder, the PSA highlights the importance of having a reporting culture and promoting a good working environment (Petroleum Safety Authority Norway, 2019). However, a study on the related concept of whistleblowing in the Norwegian workplace indicates that safety voice at the workplace is under pressure. The study finds a reduction in reporting behaviour and that there may be an increased risk of sanctions against employees if their organisation has gone through a restructuring process. The study also reports that psychosocial issues seem to be the most difficult problems to report (Trygstad & Ødegård, 2019). On the other hand, the PSA has registered an increasing number of reported concerns and incidents during recent years (Ministry of Labour and Social Affairs, 2017). Almost half of the reported cases come from trade unions or safety delegates and 80 per cent of the reports are related to offshore activity. Most of the cases reported to the PSA are related to organisational and psychosocial work environment (Ministry of Labour and Social Affairs, 2017). These reports in combination with the findings from our study underline the need for stronger attention to safety voice at work and in particular in the petroleum sector.

Our research has implications for both leaders and workers. First, it highlights the important role of safety voice in reducing safety risks and personal injuries. Thus, the message to leaders should be to stimulate safety voice by supporting and rewarding this type of behaviour. Second, our study demonstrates the importance of securing a work environment with acceptable levels of job demands and job control to promote safety voice. Thus, leaders need to monitor and balance these psychosocial risks. The gains from doing so are numerous, along with promoting safety voice: for instance, enhancement of well-being, work engagement and innovative behaviour (Kwon & Kim, 2020; Lesener et al., 2019).

4.3. Limitations and suggestion for future studies

Our study has some limitations that should be addressed by future studies. The indices used in this study was constructed based on available items, and a theoretical and historical approach. However, our study found that one index had a poor AVE under 0.40, and one was acceptable (between 0.40 and 0.50). Future studies on this topic should introduce other relevant items so that items with high residual variance could be excluded, or other more suitable indices may be constructed to replace especially the index with AVE under 0.40.

Although a relationship between safety voice and safety risks as well as personal injuries was found in this study, the data were collected through self-reports, and not objective data. Future studies on this topic should introduce models that also include objective effect measures such as near-misses, falling objects, explosions and personal injury reports.

As our study applied a cross-sectional design, conclusions concerning causality are impossible. It is possible that the levels of safety voice shape job demands, leadership support or job control, however from a theoretical perspective this does not seem very likely. A reciprocal relationship between the variables may also exist in that, for instance, a perceived job control leads to safety voice behaviour that in turn increases the perception of job control. Longitudinal studies would provide more knowledge on reciprocal relationships.

A possible conceptual issue is that some studies have distinguished between challenge demands and hindrance demands, and Xia et al. (2020) found that challenge demands were positively linked to general voice behaviour, whereas hindrance demands were negatively associated with general voice behaviour. In our study, we did not distinguish between these two types (or other types) of challenges. Future studies could apply more specific measures of demands to get a more detailed understanding of what the most relevant types of demands relating to hampering or promoting safety voice are.

4.4. Conclusions and implications

This study demonstrated that psychosocial factors are strongly associated with safety voice behaviour, and this was explained by the job-demand-resources model. Furthermore, the study showed that safety voice in the offshore oil rig sector is linked to safety risks and personal injuries. This contributes to the occupational safety literature by providing and demonstrating a framework through which work practices impact upon safety.

These findings indicate that the expression of safety voice is decisive for the prevention of safety hazards in the offshore oil rig sector. Knowledge from this study may also provide useful information for the inspection authority's follow-up and may set direction for leadership development with a view to improving safety measures. This may prove especially important in a period of downsizing the industry.

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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