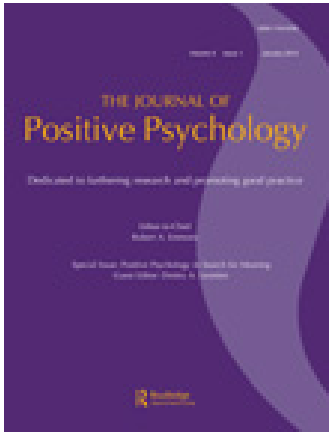


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Positive organizational behavior and safety in the offshore oil industry: Exploring the determinants of positive safety climate

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Positive organizational behavior and safety in the offshore oil industry: Exploring the determinants of positive safety climate

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Much research has now documented the substantial influence of safety climate on a range of important outcomes in safety critical organizations, but there has been scant attention to the question of what factors might be responsible for positive or negative safety climate. The present paper draws from positive organizational behavior theory to test workplace and individual factors that may affect safety climate. Specifically, we explore the potential influence of authentic leadership style and psychological capital on safety climate and risk outcomes. Across two samples of offshore oil-workers and seafarers working on oil platform supply ships, structural equation modeling yielded results that support a model in which authentic leadership exerts a direct effect on safety climate, as well as an indirect effect via psychological capital. This study shows the importance of leadership qualities as well as psychological factors in shaping a positive work safety climate and lowering the risk of accidents.

Keywords: positive organizational behavior; safety critical organizations; safety climate; psychological capital; authentic leadership

Introduction

Workers in safety critical organizations (SCOs) such as the oil and gas industry operate in hazardous settings, with multiple technological, environmental, and human challenges. These work settings carry a high potential for stress, accidents, injuries, and various adverse health outcomes. Given these hazards and the risks associated with them, SCOs have devoted considerable resources toward improving safety and preventing accidents. The concept of safety culture (Guldenmund, 2000) has been used to describe the broad range of human, organizational, and management factors that appear to influence safe behavior in the workplace. Safety climate is seen as the more specific and readily measurable aspects of safety culture, such as the impact of management policies on safety practices in the workplace (Cox & Flin, 1998; Zohar, 2008).

And while there are now many studies linking safety climate to important performance and safety outcomes in the workplace (Mearns, Whitaker, & Flin, 2003; Neal, Griffin & Hart, 2000; Zohar, 2008), little is known about the antecedents of positive safety climate. Indeed, Zohar (2010) argues that the next major challenge in safety research is to ascertain the factors and processes that influence safety climate.

The purpose of the present study is to examine how emerging research in leadership and positive psychology might contribute to safety climate in SCOs. To this end,

we evaluate a conceptual model for how authentic leadership and psychological capital variables may influence safety climate and perceptions of risk on the job across two different occupational settings: offshore oil platform workers and crew members on supply ships for the oil and gas production units. To our knowledge, this research provides one of the first empirical tests of the potential influence of positive psychological variables on safety climate.

The conceptual model under consideration was previously described in a paper by Eid, Mearns, Larsson, Laberg, and Johnsen (2012). This model posits that authentic leadership (Avolio & Gardner, 2005) exerts an influence on safety climate in SCOs, both directly and indirectly through a set of psychological qualities of workers collectively termed ‘psychological capital’ (Luthans, Youssef, & Avolio, 2007). Safety climate in turn affects a range of critical safety outcomes. For example, organizations with positive safety climates experience fewer accidents, and workers perceive a lower risk of accidents and injuries in the workplace. In the following section, we will outline the theoretical basis for our hypothesis in more detail.

There is already significant research indicating that leadership can have an impact on safety behaviors. For example, Barling, Loughlin, and Kelloway (2002) report that transformational leadership predicts various safety outcomes, and that this relationship is mediated by safety

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climate. Zohar and colleagues have likewise identified links between transformational leadership dimensions and safety climate (Zohar & Luria, 2005; Zohar & Tenne-Gazit, 2008). Other studies applying leader–member exchange theory have found that safety related behaviors in the workplace may be influenced by perceived support from leaders and the organization (Hofmann & Morgeson, 1999; Hofmann, Morgeson, & Gerras, 2003). Similarly, Zacharatos, Barling, and Iverson (2005) found that trust in management and perceived safety climate influenced worker safety attitudes and performance.

A promising new concept in the leadership arena is known as ‘authentic leadership’ (Avolio & Gardner, 2005). Authentic leadership is a pattern of leader behaviors that draws upon and promotes both positive psychological capacities and a positive ethical climate to foster self-awareness, an internalized moral perspective, balanced processing of information, and relational transparency (Walumbwa, Avolio, Gardner, Wernsing, & Peterson, 2008). The authentic person has a sense of ownership and responsibility regarding his or her own thoughts, values, beliefs and emotions, and acts in accordance with them. Leaders who are authentic are assumed to exert influence over subordinates in large part through positive role modeling (Avolio, Gardner, Walumbwa, Luthans, & May, 2004). With respect to safety issues, authentic leaders would be expected to put priority on the health and safety of employees, as well as the organization as a whole, and reflect these priorities in their behaviors and statements. Through role modeling and social identification processes, authentic leaders may influence others in the workplace to adopt similar attitudes and behaviors. We propose that these processes of authentic leadership will also encourage more productive leader – follower exchanges; and in SCOs, this should lead to increased focus on safety through higher levels of collective work ownership and engagement, and a stronger commitment to safety climate. This leads to the first research hypothesis:

H-1: Authentic leadership is positively related to follower perceptions of safety climate in SCOs.

The concept of psychological capital has recently emerged within the field of positive organizational behavior, which focuses on positive approaches to developing and managing human resources in the workplace. According to Luthans et al. (2007, p. 3), psychological capital is a higher order factor containing four constructs: self-efficacy, optimism, hope, and resiliency. Within this framework, the person high in psychological capital is characterized as: (a) having the confidence (self-efficacy) to take on and put in the necessary effort to succeed at challenging tasks; (b) making positive attributions (optimism) about succeeding now and in the future; (c) persevering toward goals and, when necessary, redirecting

paths to goals (hope) in order to succeed; and (d) when beset by problems and adversity, sustaining and bouncing back and even beyond original states (resiliency) to attain success.

We consider that psychological capital may be a potentially important avenue leading to positive safety attitudes and behaviors in several ways. Workers with high self-efficacy should be more likely to speak openly to fellow workers and management about safety issues. Furthermore, their goal directed and positive attributions about succeeding with their work objectives should reinforce their safety awareness and instill personal safety objectives into their work performance. Finally, highly resilient workers should be more committed to positive work-related outcomes, and may also fuel greater safety focused behavior. They would be expected to show increased motivation and stamina for safe work operations, despite conflicting priorities and temptations to cut corners in order to save time and avoid hardships associated with more rigorous safety focused procedures.

Substantial research has now demonstrated that psychological capital can influence desirable organizational outcomes and sustained high quality performance in individual workers (Avey, Reichard, Luthans, & Mhatre, 2011; Luthans, Avolio, Avey, & Norman, 2007). Considering that the social environment in organizations is largely a creation of the individuals making up that environment, the positive worker motivation indexed by psychological capital could be an important resource promoting positive safety climate in organizations. Some support for this perspective comes from a study by Avey, Wessing, and Luthans (2008), who found that employees with high psychological capital proactively facilitated various positive changes in organizations. Psychological capital has also been previously identified as a mediator in the relation between organizational support and worker performance (Luthans, Norman, Avolio, & Avey, 2008).

As regards safety climate specifically, Neal and Griffin (2004) argued that safety climate in part reflects the motivation of individual workers to engage in safe behaviors, and includes their knowledge about safety procedures and willingness to abide by safety protocols and regulations. From this, we infer that psychological capital – self-efficacy, hope, optimism, and resiliency – could be a mediating variable in the relation between leadership and safety climate, serving to increase positive emotional states and attitudes that will foster compliance and participation in safety programs and activities (Gardner, Avolio, Luthans, May, & Walumbwa, 2005).

Several component attributes of authentic leadership could well have an influence on the psychological capital of workers. For example, the leader’s balanced processing of information, relational transparency, and self-disclosure in the leader–follower exchange may serve to enhance

self-efficacy and resilience in workers. In the same vein, leader self-awareness and moral perspective could provide a model for workers, inspiring them to believe in positive work outcomes (optimism) and future work accomplishments (hope). From this line of reasoning, we suggest that there may be a second pathway running from leadership to safety climate, with psychological capital acting as a mediating variable in the relationship proposed in H1. This leads to two additional hypotheses:

H-2: Authentic leadership is positively related to psychological capital in that followers who see their leaders as more authentic will also reveal emotional and motivational states corresponding to the psychological capital factors of self-efficacy, optimism, hope, and resilience.

H-3: Psychological capital will serve to partially mediate the relation between authentic leadership and safety climate.

As previously discussed, safety climate is generally thought to include aspects of safety culture which are more readily observable and measurable (Cox & Flin, 1998). From emerging research on safety climate, there is a growing consensus that safety climate is related to other organizational and individual antecedents but is conceptually distinct from them (Mearns et al., 2003). Multiple studies have shown that safety climate in organizations is related to a range of important safety outcomes including accidents, injuries, near misses and near-miss reporting, and work-related illnesses (Neal et al., 2000; Zohar, 2008; Mearns et al., 2003). Also, worker perceptions of a positive safety climate are related to lower estimates of the chance for accidents (risk perception), fewer workplace injuries, improved safety performance, and fewer reported rule violations (Mearns et al., 2003; Mearns, Whitaker & Flin, 2001; Rundmo, 2000; Zohar & Luria, 2005). From this follows the next hypotheses:

H-4: Safety climate will be negatively related to perceived risk of injuries and work-related accidents.

Figure 1 summarizes the theoretical model, showing the presumed relations among authentic leadership, psychological capital, safety climate, and safety outcomes. The model posits that the social identification and role modeling influence of authentic leaders will exert a positive influence on safety climate, both directly and indirectly through psychological qualities of subordinates. The direct influence of authentic leaders on safety climate reflects both their emphasis on safety management procedures and policies, as well as their role modeling influence on subordinates' perceptions of safety importance and procedures. The indirect

influence of leaders on safety climate is through the enhancement of followers' psychological capital. Safety climate in turn will influence important safety-related outcomes; in this case, indexed by crew members' perceptions of risk in the work environment.

Methods

Participants and procedure

Offshore sample

The offshore sample consists mainly of Norwegian offshore workers in a large international petroleum exploration and production company operating on the Norwegian continental shelf. A two-part questionnaire was sent to the company's offshore installations and distributed to all regularly employed offshore personnel in the company during spring 2010. The first part of the questionnaire was administered by the Petroleum Safety Authority Norway and included questions about demographic information, safety climate, risk perception, work environment, health, sleep, accidents, and job demands. This part of the questionnaire was sent to all petroleum companies operating on the Norwegian continental shelf and had a response rate of 32%.

The second part of the questionnaire was administered by researchers from the University of Bergen and included questions about authentic leadership, psychological capital, and personality. This part was sent to a single petroleum company only. Altogether, 261 of the 934 questionnaires distributed were returned, yielding a response rate of 27.9% for this part of the questionnaire.

Data from both questionnaires were then combined based on common identification numbers. Thirty-seven respondents who had answered the second part of the questionnaire failed to provide any responses to the variables of interest from the first part of the questionnaire and were consequently removed from the sample. Similarly, four respondents were removed from the sample because they did not provide any answers to either the authentic leadership questions or the psychological capital questions, resulting in a final study sample of $N = 220$.

The sample of 220 respondents consists of 94% men and 6% women. Altogether 64.5% of respondents were 51 years or older, 17.7% were between 41 and 50 years, and 17.2% were 40 years or younger. The majority of respondents (97.7%) were Norwegian, with the remaining 2.3% from Sweden, Finland, or Denmark. A total of 86.4% had worked full-time or nearly full-time (75–100% time) in an offshore setting during the last year before the survey. Seventy-two per cent had worked offshore for 20 years or more. A comparison of these figures with the company register confirmed that the numbers are representative for the organization.

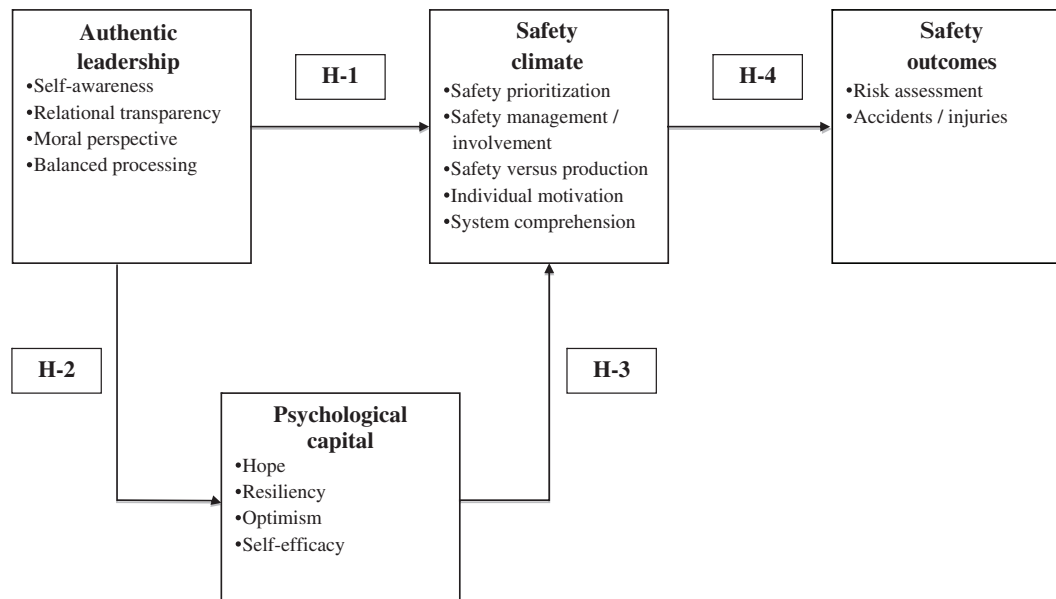


Figure 1. Theoretical model showing hypothesized relations between authentic leadership, psychological capital, safety climate, and safety outcomes.

Supply shipping sample

Data for the supply shipping sample were collected from seafarers working in the offshore oil and gas shipping resupply industry. Questionnaires were administered to 817 crew members aboard 39 vessels operating in the North Sea and Arctic waters. Questionnaires were mailed from the shipping companies' onshore main offices and returned in anonymous envelopes to the principal researchers. Altogether, 594 questionnaires were returned, yielding a response rate of 73%. After excluding the Masters (i.e. ship captains), 541 crew members remained and constituted the potential sample of this study. From this sample, 28 respondents were removed due to missing values on all items belonging to one or more of the measuring instruments of interest to this study, yielding a final study sample of $N = 513$.

Overall, respondents were mainly Filipino (262, 51.1%) and Norwegian (122, 23.8%) nationals, with the remainder divided between British nationals (3.3%), Polish nationals (8.8%), and other (4.5%) or did not report nationality (8.6%). The sample was predominately male (502, 97.9%) with a mean age of 39.86 (ranging from 18 to 71). Norwegian crew members received surveys written in Norwegian, while the others were given their surveys in English. In these shipping companies, all crew workers are required to be fluent in English as a condition of employment.

Ethical considerations

This research was reviewed and approved by the Regional Ethics Committee of Western Norway, as well

as by the Norwegian Social Science Data Service; the institution that serves as the University of Bergen's Privacy Ombudsman for Research. Participants gave their informed consent and were informed that they could withdraw from the study at any time.

Instruments

Authentic leadership

The 16-item Authentic Leadership Questionnaire (Walumbwa et al., 2008) was used to measure authentic leadership. This instrument measures the four components believed to comprise authentic leadership: Relational Transparency (e.g. 'My leader admits mistakes when they are made'), Moral Perspective (e.g. 'My leader demonstrates beliefs that are consistent with actions'), Balanced Processing (e.g. 'My leader listens carefully to different points of view before coming to conclusions'), and Self-Awareness (e.g. 'My leader shows that he or she understands how specific actions impact others'). The Norwegian version of the instrument was translated using a back-translation procedure. Respondents were asked to rate the behaviors of their immediate leader (offshore sample) or Masters (supply shipping sample) on a scale of 1 (*not at all*) to 5 (*frequently, if not always*). Cronbach's α coefficients for the offshore sample were 0.87 for Relational Transparency, 0.77 for Moral Perspective, 0.82 for Balanced Processing, and 0.87 for Self-Awareness. The corresponding Cronbach's α coefficients in the supply shipping sample were 0.73 for Relational Transparency, 0.70 for Moral Perspective, 0.63 for Balanced Processing, and 0.75 for Self-Awareness.

Although Cronbach's alpha is the most widely reported indicator of a test's reliability, it is also known to yield severe underestimates of reliability in many cases (see Sijtsma, 2009, for a discussion on this topic). While a detailed discussion of this issue is beyond the scope of this paper, Sijtsma (2009) has shown that Cronbach's alpha coefficient cannot provide an accurate index of a test's reliability based on the information from a single test administration. Instead of Cronbach's alpha, Sijtsma recommends other estimates of reliability, most notably the greater lower bound (glb). According to Ten Berge, Snijders, and Zegers (1981), the glb for reliability represents the smallest reliability possible, given the observed covariance matrix under the restriction that the sum of error variances is maximized for errors that correlate 0 with other variables. Because Cronbach's alpha is such a well-known indicator, we have chosen not to omit it, but rather offer glb as a supplemental indicator for the reliability of authentic leadership and the instruments in the following sections. It should also be noted that the glb can be positively biased for small samples (<1000) and is therefore not without limitations.

The glb estimates for the offshore sample were 0.91 for Relational Transparency, 0.84 for Moral Perspective, 0.83 for Balanced Processing, and 0.89 for Self-Awareness. The corresponding glb estimates in the supply shipping sample were 0.78 for Relational Transparency, 0.74 for Moral Perspective, 0.67 for Balanced Processing, and 0.78 for Self-Awareness. The glb values were computed using the FACTOR statistical program (Lorenzo-Seva & Ferrando, 2006).

Safety climate

Safety climate was measured with the Norwegian Offshore Risk and Safety Climate Inventory (NORSCI; Tharaldsen, Olsen, & Rundmo, 2008). The version of NORSCI used in the present study contains subscales to measure six different dimensions. The first dimension is referred to as Safety Prioritization (eight items; $\alpha = 0.67$ and $\text{glb} = 0.76$ in offshore sample; $\alpha = 0.68$ and $\text{glb} = 0.77$ in supply shipping sample) and reflects safety prioritization and involvement, such as violations and following procedures. An example item is: 'I sometimes violate safety rules to get the job done.' The second dimension is called Safety Management and Involvement (11 items; $\alpha = 0.84$ and $\text{glb} = 0.88$ in offshore sample; $\alpha = 0.82$ and $\text{glb} = 0.89$ in supply shipping sample) and reflects the management's priorities towards safety (e.g. 'The emergency preparedness is good') and the employees' feelings of involvement and influence in safety matters (e.g. 'I can influence the HSE-conditions at my workplace'). The third dimension, named Safety versus Production (four items; $\alpha = 0.74$ and $\text{glb} = 0.75$ in offshore sample; $\alpha = 0.58$ and $\text{glb} = 0.60$ in supply

shipping sample), reflects the relative significance of safety versus production (e.g. 'In practice concern for production precedes the concern for HSE'). The fourth dimension is called Individual Motivation (five items; $\alpha = 0.76$ and $\text{glb} = 0.82$ in offshore sample; $\alpha = 0.59$ and $\text{glb} = 0.71$ in supply shipping sample) and measures individual motivation for and prioritization of safety, as well as the use of personal protective equipment (e.g. 'I report dangerous situations when I see them'). Dimension number five, System Comprehension (three items; $\alpha = 0.63$ and $\text{glb} = 0.66$ in offshore sample; $\alpha = 0.73$ and 0.74 in supply shipping sample), is intended to measure the functionality and individual understanding of safety-related procedures and management systems (e.g. 'I always know which person within the organization to report to'). Finally, the sixth dimension, Competence (four items; $\alpha = 0.72$ and $\text{glb} = 0.82$ in offshore sample; $\alpha = 0.65$ and $\text{glb} = 0.79$ in supply shipping sample), is meant to reflect the safety competence of employees (e.g. 'I have the necessary competence to perform my job in a safe manner').

Psychological capital

Subjects rated themselves on the four dimensions of psychological capital according to Luthans and colleagues' (2007) Psychological Capital Questionnaire (PCQ). Psychological capital is construed as a higher order construct made up of the four related and mostly state-like dimensions of optimism (e.g. 'When things are uncertain for me at work I usually expect the best'), resiliency (e.g. 'I can get through difficult times at work because I've experienced difficulty before'), hope (e.g. 'At the present time, I am energetically pursuing my work goals'), and self-efficacy (e.g. 'I feel confident presenting information to a group of colleagues'). Six items each are used to measure the four dimensions. The PCQ was translated into Norwegian using a back-translation procedure. In the present study, two negatively keyed items were dropped from the optimism scale due to low reliability. Final reliability estimates' (Cronbach's α and glb) coefficients in the offshore sample were 0.63 and 0.69 for optimism, 0.79 and 0.86 for resiliency, 0.77 and 0.84 for hope, and 0.84 and 0.88 for self-efficacy. In the supply shipping sample, these coefficients were 0.57 and 0.65 for optimism, 0.60 and 0.71 for resiliency, 0.74 and 0.81 for hope, and 0.80 and 0.86 for self-efficacy.

Subjective perceptions of risk

Building on the Risk Perception Inventory (Hellesøy, Moss, & Gogstad, 1985), our measure of risk perception in the offshore sample consists of 13 items asking about industry-specific risk scenarios, including helicopter accident, fire, serious work accidents, gas leak, blow-out,

emissions of toxic gases/substances/chemicals, collisions with vessels or floating objects, sabotage/terrorism, and collapse of the installation's load-bearing structures or loss of buoyancy (Cronbach's $\alpha = 0.91$, $g_{lb} = 0.96$). Respondents were asked to indicate what degree of danger these scenarios represented on a six-point scale ranging from 1 (*very little danger*) to 6 (*very great danger*), with reference to their current work context.

To measure risk perception in the supply shipping sample, three questions were asked about crew members' perception of accident risk levels on board their vessels. These questions were 'How do you rate the probability that someone can get seriously injured on board,' 'How do you rate the general risk of mishaps/accidents on board,' and 'In general, how do you rate the maintenance of safety on board' (Cronbach's $\alpha = 0.57$, $g_{lb} = 0.70$). The responses were given on a scale from 1 (*very low*) to 5 (*very high*).

Statistical analyses

Structural equation modeling (SEM) was used to assess the appropriateness and fit of our proposed theoretical model. In conducting SEM analysis of full latent variable models, it is important to first verify the validity of the measurement portion of the model (Byrne, 2006). Thus, we first conducted confirmatory factor analyses in order to establish good fit for the measurement model. Subscale mean scores were used as indicators for the latent variables safety climate, authentic leadership, and psychological capital. In the offshore sample, we formed item parcels to be used as indicators for a latent risk perception variable. Based on the recommendations of Bandalos and Finney (2001), four parcels were formed by combining together items with the highest level of congruence within the risk perception dimension (three parcels combining three items and one parcel combining four items). Although item parceling is not without controversy, we find the use of item parcels in the present study defensible given that our primary interest is on the structural rather than the measurement parameters. In the supply shipping sample, the three items measuring perceptions of risk were combined and the mean score was used as a manifest risk perception indicator.

After confirming a good fit for the measurement model, we proceeded to assess the full structural model and examine the proposed theoretical relationships. Model fit was judged by examining the magnitude and statistical significance of factor loadings, the chi-square (χ^2) value, and a series of commonly used goodness-of-fit statistics. Specifically, to assess model fit, we used the comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA), together with its 90% confidence interval.

SEM analyses were performed using the EQS 6.1 statistical software (Bentler, 2005) with maximum likelihood estimation followed by Satorra-Bentler corrections (Satorra & Bentler, 2001). Satorra-Bentler corrections are scaling corrections providing a more robust χ^2 statistic, CFI, and RMSEA when distributional assumptions regarding normality are violated. Missing data were replaced by the use of the Hot Deck imputation procedure (Myers, 2011). Hot deck imputation involves replacing a missing value with the value of a randomly selected record in the data-set that matches the missing value record on other variables.

Results

Offshore sample

To assess the measurement part of our model in the offshore sample, a confirmatory factor analysis with four intercorrelated first-order factors was specified. Results for this four-factor measurement model yielded a Satorra-Bentler corrected S-B χ^2 of 241.497 ($df = 129$, $p < 0.001$), a S-B CFI value of 0.93, a SRMR value of 0.064, and a S-B RMSEA value of 0.063 (90% confidence interval = 0.051–0.075). Based on common practices and recommended SRMR and RMSEA values below 0.08 and CFI values in the range of 0.90–0.95 as representing acceptable fit data (Hu & Bentler, 1998; Kline, 1998; McDonald & Ho, 2002), our measurement model yielded a reasonable fit to the data.

Although the significant χ^2 suggested misfit, this measure of absolute fit is known to be overly sensitive and often signals statistically significant misfit even for trivial departures from perfect fit (Kelloway, 1995). Further, all factor loadings were statistically significant and relatively large (ranging between 0.65 and 0.92) and all latent factors showed satisfactory reliability (see Table 1).

Based on these results, we proceeded to the next step of testing the full structural model. Results presented in Figures 2 and 3 serve as basis for evaluating the proposed hypotheses of this study.

Support for Hypothesis 1 and Hypothesis 2 was found, with authentic leadership being positively related to perception of safety climate ($\beta = 0.45$, $p < 0.001$), as well as having a statistically significant path to psychological capital ($\beta = 0.24$, $p = 0.013$). Our Hypothesis 3 stated that psychological capital will serve to partially mediate the relation between authentic leadership and safety climate. As can be seen in Figure 2, psychological capital had a statistically significant and positive effect on perceptions of safety climate ($\beta = 0.24$, $p = 0.006$). An indirect effect of authentic leadership on safety climate through psychological capital can be obtained by multiplying the path from authentic leadership to

Table 1. Descriptive statistics and intercorrelations among latent factors in the offshore sample ($N = 220$).

	<i>M</i>	<i>SD</i>	1	2	3	4
1. Authentic leadership	3.28	0.75	0.91			
2. Psychological capital	4.57	0.53	0.24**	0.82		
3. Safety climate	4.82	0.52	0.51***	0.35***	0.84	
4. Risk perception	2.61	0.90	-0.21*	-0.10	-0.40***	0.90

Note: All correlations are standardized. Composite reliability (Raykov's rho) presented in boldface along the diagonal.
 * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

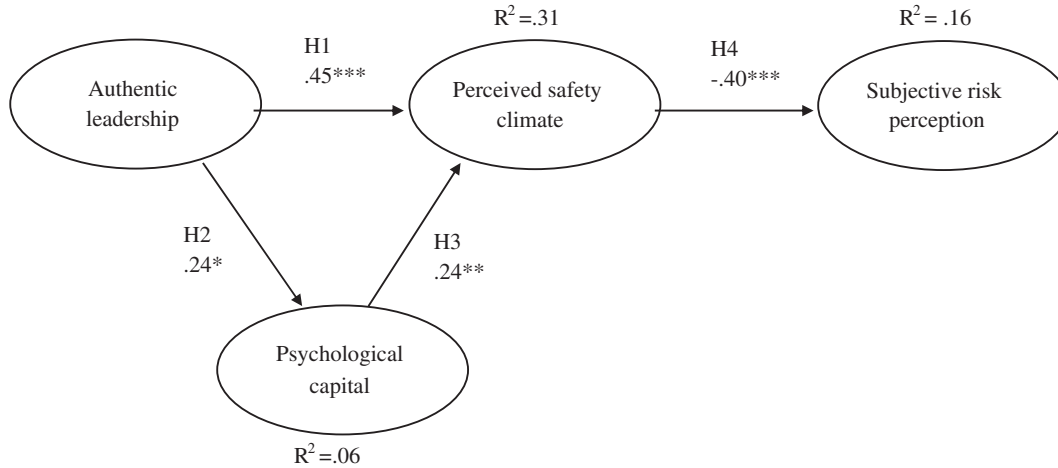


Figure 2. Model depicting the hypothesized structural relations among leadership, safety climate, psychological climate, and risk perception in the offshore sample. Only latent variables are depicted; manifest indicators, error terms, and endogenous disturbances have been omitted for space and clarity. Satorra-Bentler χ^2 ($df = 131$) = 242.483, $p < 0.001$; S-B CFI= 93; SRMR = 0.064; S-B RMSEA = 0.062, with 90% confidence interval = 0.050–0.074.
 * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

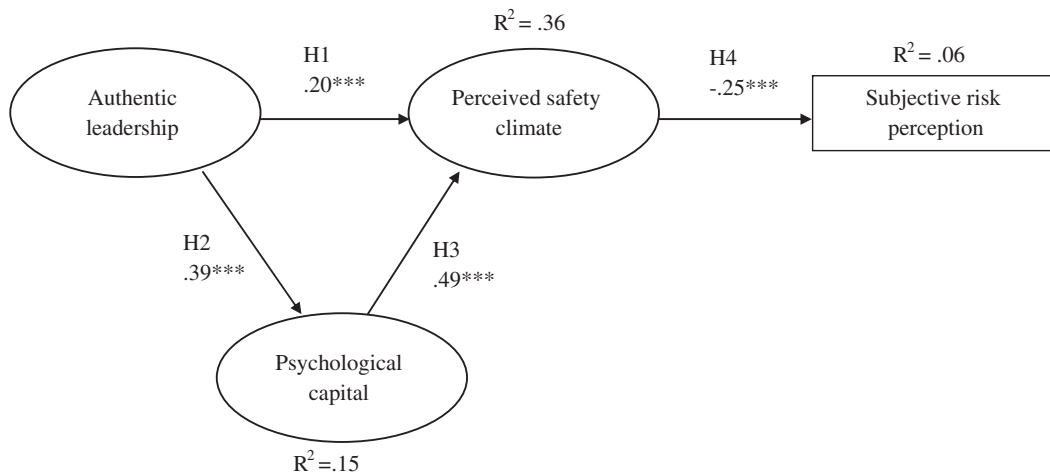


Figure 3. Model depicting the hypothesized structural relations among leadership, safety climate, psychological climate, and risk perception in the supply shipping sample. Only latent variables and the manifest risk indicator are depicted; all other manifest indicators, error terms, and endogenous disturbances have been omitted for space and clarity. Satorra-Bentler χ^2 ($df = 74$) = 218.473, $p < .001$; S-B CFI = 92; SRMR = 0.052; S-B RMSEA = 0.062, with 90% confidence interval = 0.052–0.071.
 *** $p < 0.001$.

Table 2. Descriptive statistics and intercorrelations among latent factors in the supply shipping sample ($N = 513$).

	<i>M</i>	<i>SD</i>	1	2	3
1. Authentic leadership	4.01	0.58	0.86		
2. Psychological capital ^a	4.85	0.47	0.40***	0.71	
3. Safety climate ^b	4.35	0.39	0.39***	0.58***	0.75

Note: All correlations are standardized. Composite reliability (Raykov's rho) presented in boldface along the diagonal.

^aMean score does not include responses to two negatively keyed items that were dropped from the Optimism subscale due to low reliability.

^bMean score does not include the subscale Safety vs. Production that did not load significantly onto the latent safety climate variable.

*** $p < 0.001$.

psychological capital with the path from psychological capital to safety climate. This resulted in an indirect effect of 0.06, giving a total effect of authentic leadership on perceptions of safety climate of 0.51. Finally, in support of our Hypothesis 4, the path from safety climate to risk perception was significant and negative ($\beta = -0.40$, $p < 0.001$), suggesting that a good and positive safety climate is associated with lower subjective perceptions of risk.

Supply shipping sample

As with the offshore sample, a confirmatory factor analysis was first specified to assess the measurement model in the supply shipping sample. Three intercorrelated first-order factors were modeled (authentic leadership, psychological capital, and safety climate). Results showed that this model did not fit the data very well, with a S-B χ^2 of 454.102 ($df = 74$, $p < 0.001$), a S-B CFI value of 0.81, a SRMR value of 0.082, and a S-B RMSEA value of 0.100 (90% confidence interval = 0.091–0.109). An examination of the individual factor loadings revealed that Safety vs. Production did not load significantly onto the latent safety climate variable ($\beta = 0.04$, $p = 0.34$). This could indicate that this dimension is not as salient in the shipping industry, as compared to the offshore oil industry, where there can be more pressure to meet regular production quotas. Considering this, we respecified the measurement model for the supply shipping sample omitting this indicator. The result was a reasonably well-fitting model (S-B $\chi^2 = 186.820$, $df = 62$, $p < 0.001$; S-B CFI = 0.93; SRMR = 0.052; S-B RMSEA = 0.063, with a 90% confidence interval of 0.052–0.073). All factor loadings were statistically significant (ranging between 0.36 and 0.89) and the composite reliability was satisfactory for all latent factors (see Table 2).

The results from the full structural model corroborated the results found for the offshore sample. As can be seen in Figure 3, authentic leadership showed a direct and positive influence on followers' perceptions of safety

climate ($\beta = 0.20$, $p < 0.001$), as well as a significant and positive path to psychological capital ($\beta = 0.39$, $p < 0.001$). Further, psychological capital was significantly and positively related to perceptions of safety climate ($\beta = 0.49$, $p < 0.001$), lending further support to Hypothesis 3 of an indirect effect of leadership on safety climate. The indirect effect of authentic leadership in the supply shipping sample was 0.19, giving a total effect of 0.39. Finally, perceptions of safety climate had a significant and negative effect on the perception of risk on board ($\beta = -0.25$, $p < 0.001$).

Discussion

This study is one of the first to empirically examine the relationship between positive organizational behavior and important safety outcomes in high-risk job settings. Our point of departure was a conceptual model examining authentic leadership and psychological capital (self-efficacy, hope, resiliency, and optimism) as potential antecedents of organizational safety climate and risk perception. The results provide support for the hypothesized model (see Figure 1) wherein authentic leadership has a direct and positive influence on followers' perceptions of safety climate in SCOs (H1). Results also show that authentic leadership has an indirect effect on safety climate, as it is mediated by psychological capital (H3). Authentic leadership showed a positive relation to psychological capital (H2), which in turn had a positive and significant effect on safety climate. In support of previous studies demonstrating relations between safety climate and a range of safety outcomes (e.g. Mearns et al., 1998, 2001, 2003; Neal et al., 2000; Zohar & Luria, 2005), our study also found an association between workers' perceptions of safety climate and risk for accidents (H4).

While all pathways in the model were significant across both samples investigated, some differences were apparent. Most notably, the direct effect of authentic leadership on safety climate was substantially stronger in the offshore oil platform sample (0.45, $p < 0.001$) as compared to the supply shipping sample (0.20, $p < 0.001$). This is most likely a function of the greater proximity of leaders and workers in the offshore oil platform sample. In this sample, workers rated their individual work section leaders; whereas in the supply shipping sample, workers rated the ship Masters (or captains). At least on board the larger vessels, crew members often do not have the same opportunities to observe and interact with their leaders, as compared to offshore oil rig workers who interact more directly with their section leaders. Furthermore, the offshore installation workers had longer tenure and enjoyed a more stable work situation compared to the supply ship workers, who would also tend to rotate between ships, serving with different co-workers if empty slots in the organization needed to be filled. Our results could indicate

that with better knowledge of and proximity to the leader, the association between authentic leadership style and perceived safety climate is stronger.

In contrast, for the supply ship sample, the mediating influence of psychological capital appears to be stronger. Here, the correlation of authentic leadership with psychological capital is 0.39 ($p < 0.001$), and psychological capital with safety climate is 0.49 ($p < 0.001$). This could suggest that when knowledge of leaders is incomplete, such as when workers are more distant from their leaders, the role of individual psychological factors may be more prominent in shaping organizational safety climate. More positive, optimistic, and self-efficacious workers are likely to be more engaged and motivated to develop their knowledge about safety procedures, understand company safety priorities, and engage in safe practices (Neal & Griffin, 2004). This could indicate that safety focused programs aimed at maritime workers may represent an important pathway to increase safety climate in these organizations.

Limitations and conclusions

The current study provides empirical evidence from the offshore oil and gas industry and the supply ship industry that processes of positive organizational behavior, specifically authentic leadership and psychological capital, can influence worker perceptions of safety climate. Although this represents a promising new perspective on antecedents of safety climate and behavior, some limitations to this research should be noted. One pertinent question raised by the slight differences between the model parameters in our samples relates to the generalizability of our findings to other SCOs. To date, scant empirical evidence is available, but a recent study points in the same direction as our findings in that psychological capital was linked to safety climate indicators in the aviation industry (Bergheim et al., 2013). Clearly, the role of positive organizational behavior in SCOs calls for further investigation. It would also be of interest in future studies to examine the potential influence of destructive or derailed leadership (Ashforth, 1994; Einarsen, Aasland, & Skogstad, 2007). One could speculate that in organizations where leaders 'walk as they talk' (i.e. authentic leaders), the model could be working through both paths, as opposed to in organizations with dysfunctional leaders where the work motivation and personal qualifications of individual workers (i.e. psychological capital) would be more prominent antecedents of safety climate and safety outcomes. Some empirical evidence for this also comes from a study by Kelloway, Mullen, and Francis (2006) that demonstrated divergent effects of transformational and passive leadership on safety climate and safety consciousness.

Research into the development and validation of metrics and measures for assessing the positive organizational constructs of authentic leadership and psychological capital has progressed rapidly over the last few years. Although it could be objected – and we certainly agree – that more research is still needed on these constructs, we believe that both authentic leadership and psychological capital are well grounded in positive organizational behavior theory, and sufficiently well operationalized to merit greater attentions in safety research. Research perspectives from positive organizational behavior have been subjected to rigorous studies, to include a meta-analysis of the core construct of psychological capital (Avey et al., 2011) finding good support for the reliability and validity of the construct. That said, our results indicate that there are some notable differences in psychometric properties of the four elements of psychological capital. For example, both samples in our study showed low reliability for the optimism scale of psychological capital, forcing us to drop two of the six items comprising this scale. Additionally, there may be other variables beyond the four presently included in psychological capital that could influence worker attitudes and behaviors vis-à-vis workplace safety. For example, psychological hardiness, composed of commitment, internal control, and challenge, has been shown to influence worker performance and health outcomes in a variety of occupations and stressful conditions. (Bartone, 1991; Bartone, Ursano, Wright, & Ingraham, 1989; Bartone, Hystad, Eid, & Brevik, 2012). Future studies should consider this and other individual worker qualities that may influence safety climate.

Some measurement limitations were also seen in the present study with respect to the safety climate measure, suggesting the need for additional development work in measuring this construct. The Cronbach's alphas for some of the subscales were relatively low, even among respondents working offshore, the context wherein the scale was originally developed. As previously noted, Cronbach's alpha is an overtly conservative estimate of scale reliability. However, the greater lower bound estimate of reliability corroborated the results of low reliability for the Comprehension subscale ($g_{lb} = 0.66$, $\alpha = 0.63$). It is worth noting that the reliability found in the present study is comparable to reliabilities reported in the previous studies in the oil industry (e.g. Høivik, Tharaldsen, Baste, & Moen, 2009; Hope, Øverland, Brun, & Matthiesen, 2010; Rasmussen & Tharaldsen, 2012; Tharaldsen et al., 2008). Future research in this area will certainly benefit from work leading to improved measures of both psychological capital and safety climate.

On a related issue, the Safety vs. Production scale did not load significantly onto the latent Safety Climate factor in our supply shipping sample. This could

indicate that the items in this scale are more domain-specific. For example, the higher focus on daily production quotas and subsequent monetary gains or losses is more critical in the oil production industry than in the maritime industry. Whereas shutting down an oil installation is a major decision with high costs involved, a delay in arrival or departure due to technical repair is seen as a fairly routine issue in the shipping industry.

Despite these limitations, it should be noted that as a group our measurement indicators proved sufficiently reliable, as indicated by estimated composite reliability coefficients (Raykov's Rho) ranging from 0.71 to 0.91 (Tables 1 and 2). This lends further confidence to the present research results.

Another limitation concerns the cross-sectional nature of the study. For both samples, data were collected at a single point in time. Ideally, variables that appear later in the model would be measured later in time than those appearing earlier in the model. As it is, causal inferences should not be made from the data presented here. Although it may be difficult to accomplish in these work settings, future studies in this area should strive to incorporate prospective designs.

While this study used consistent measures across the two samples studied, it should be noted that the outcome measure of risk perception was not the same. For the offshore oil worker sample, we had a more extensive and detailed measure of risk covering 13 different risk areas. In contrast, only three risk items were available for the supply ship sample. In addition to self-report measures, future studies in this area should seek to include more objective safety outcome measures by drawing on official records of accidents, injuries, near misses, and safety violations.

Despite these limitations and concerns, the present study nevertheless advances organizational safety behavior research, bridging positive organizational behavior and safety science. Findings provide empirical support for both authentic leadership and psychological capital as important factors and potential determinants of safety climate in SCOs. Emerging research on authentic leadership and psychological capital provides evidence that these capacities may be increased through training and targeted interventions (Avolio, 2010; Luthans, Avey, Avolio, & Peterson, 2010). The present findings lend further support to the importance of both authentic leadership and psychological capital, and mark these as fruitful areas for attention by organizations concerned with safety and risk reduction.

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References

- Ashforth, B. E. (1994). Petty tyranny in organizations. *Human Relations, 47*, 755–778. doi:10.1177/001872679404700701
- Avey, J. B., Reichard, R. J., Luthans, F., & Mhatre, K. H. (2011). Meta-analysis of the impact of positive psychological capital on employee attitudes, behaviors and performance. *Human Resource Development Quarterly, 22*, 127–152. doi:10.1002/hrdq.20070
- Avey, J. B., Wensing, T. S., & Luthans, F. (2008). Can positive employees help positive organizational change? Impact of psychological capital and emotions on relevant attitudes and behaviors. *Journal of Applied Behavioral Science, 44*, 48–70. doi:10.1177/0021886307311470
- Avolio, B. J. (2010). Pursuing authentic leadership development. In N. Nohria & R. Khurana (Eds.), *The handbook of leadership theory and practice: A Harvard Business School centennial colloquium on advancing leadership* (pp. 739–768). Boston, MA: Harvard Business School Press.
- Avolio, B. J., & Gardner, W. L. (2005). Authentic leadership development: Getting to the root of positive forms of leadership. *Leadership Quarterly, 16*, 315–338. doi:10.1016/j.leaqua.2005.03.001
- Avolio, B. J., Gardner, W. L., Walumbwa, F. O., Luthans, F., & May, D. R. (2004). Unlocking the mask: A look at the process by which authentic leaders impact follower attitudes and behaviours. *The Leadership Quarterly, 15*, 801–823. doi:10.1016/j.leaqua.2004.09.003
- Bandalos, D. L., & Finney, S. J. (2001). Item parcelling issues in structural equation modelling. In G. A. Marcoulides & R. E. Schumacker (Eds.), *New developments in and techniques in structural equation modelling* (pp. 269–296). Mahwah, NJ: Lawrence Erlbaum.
- Barling, J., Loughlin, C., & Kelloway, E. K. (2002). Development and test of a model linking safety-specific transformational leadership and occupational safety. *Journal of Applied Psychology, 87*, 488–496. doi:10.1037//0021-9010.87.3.488
- Bartone, P. T. (1991). *Development and validation of a short hardiness measure*. Washington, DC: Paper presented at the Annual Convention of the American Psychological Society.
- Bartone, P. T., Hystad, S. W., Eid, J., & Brevik, J. I. (2012). Psychological hardiness and coping style as risk/resilience factors for alcohol abuse. *Military Medicine, 177*, 517–524.
- Bartone, P. T., Ursano, R. J., Wright, K. M., & Ingraham, L. H. (1989). The impact of a military air disaster on the health of assistance workers: A prospective study. *Journal of Nervous and Mental Disease, 177*, 317–328. doi:10.1097/00005053-198906000-00001
- Bentler, P. M. (2005). *EQS: Structural equations program manual*. Encino, CA: Multivariate Software.
- Bergheim, K., Eid, J., Hystad, S. W., Nielsen, M. B., Mearns, K., Larsson, G., & Luthans, B. (2013). The role of psychological capital in perception of safety climate among air traffic controllers. *Journal of Leadership and Organizational Studies, 20*, 232–241. doi:10.1177/1548051813475483
- Byrne, B. M. (2006). *Structural equation modeling with EQS: Basic concepts, applications and programming* (2nd ed.). New York, NY: Lawrence Erlbaum.
- Cox, S., & Flin, R. (1998). Safety culture: Philosopher's stone or man of straw? *Work and Stress, 12*, 189–201. doi:10.1080/02678379808256861
- Eid, J., Mearns, K., Larsson, G., Laberg, J. C., & Johnsen, B. J. (2012). Leadership, psychological capital and safety

- research: Conceptual issues and future research questions. *Safety Science*, 50, 55–61. doi:[10.1016/j.ssci.2011.07.001](https://doi.org/10.1016/j.ssci.2011.07.001)
- Einarsen, S., Aasland, M. S., & Skogstad, A. (2007). Destructive leadership behaviour: A definition and conceptual model. *The Leadership Quarterly*, 18, 207–216. doi:[10.1016/j.leaqua.2007.03.002](https://doi.org/10.1016/j.leaqua.2007.03.002)
- Gardner, W. L., Avolio, B. J., Luthans, F., May, D. R., & Walumbwa, F. (2005). “Can you see the real me?” A self-based model of authentic leader and follower development. *The Leadership Quarterly*, 16, 343–372. doi:[10.1016/j.leaqua.2005.03.003](https://doi.org/10.1016/j.leaqua.2005.03.003)
- Guldenmund, F. W. (2000). The nature of safety culture: A review of theory and research. *Safety Science*, 34, 215–257. doi:[10.1016/S0925-7535\(00\)00014-X](https://doi.org/10.1016/S0925-7535(00)00014-X)
- Hellesøy, O. H., Moss, L. M., & Gogstad, A. C. (1985). The Stafford project, its background, purpose and organization. In O. H. Hellesøy (Ed.), *Work environment Stafford field. Health and safety on a North Sea oil platform* (pp. 27–43). Oslo: Norwegian University Press.
- Hofmann, D. A., & Morgeson, F. P. (1999). Safety-related behavior as a social exchange: The role of perceived organizational support and leader–member exchange. *Journal of Applied Psychology*, 84, 286–296. doi:[10.1037//0021-9010.84.2.286](https://doi.org/10.1037//0021-9010.84.2.286)
- Hofmann, D. A., Morgeson, F. P., & Gerras, S. J. (2003). Climate as a moderator of the relationship between leader-member exchange and content-specific citizenship behavior: Safety climate as an exemplar. *Journal of Applied Psychology*, 88, 170–178. doi:[10.1037/0021-9010.88.1.170](https://doi.org/10.1037/0021-9010.88.1.170)
- Høivik, D., Tharaldsen, J. E., Baste, V., Moen, B. E. (2009). What is most important for safety climate: The company belonging or the working environment? – A study from the Norwegian continental shelf. *Safety science*, 47, 1324–1331. doi: <http://dx.doi.org/10.1016/j.ssci.2009.04.001>
- Hope, S., Øverland, S., Brun, W., & Matthiesen, S. B. (2010). Associations between sleep, risk and safety climate: A study of offshore personnel on the Norwegian continental shelf. *Safety Science*, 48, 469–477. doi: <http://dx.doi.org/10.1016/j.ssci.2009.12.006>
- Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods*, 3, 424–453. doi:[10.1037//1082-989X.3.4.424](https://doi.org/10.1037//1082-989X.3.4.424)
- Kelloway, E. K. (1995). Structural equation modeling in perspective. *Journal of Organizational Behavior*, 16, 214–224. doi:[10.1002/job.4030160304](https://doi.org/10.1002/job.4030160304)
- Kelloway, E. K., Mullen, J., & Francis, L. (2006). Divergent effects of transformational and passive leadership on employee safety. *Journal of Occupational Health Psychology*, 11, 76–86. doi:[10.1037/1076-8998.11.1.76](https://doi.org/10.1037/1076-8998.11.1.76)
- Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York, NY: Guilford.
- Lorenzo-Seva, U., & Ferrando, P. J. (2006). FACTOR: A computer program to fit the exploratory factor analysis model. *Behavioral Research Methods*, 38, 88–91. doi: <http://dx.doi.org/10.3758/BF03192753>
- Luthans, F., Avey, J. B., Avolio, B. J., & Peterson, S. J. (2010). The development and resulting performance impact of positive psychological capital. *Human Resource Development Quarterly*, 21, 41–67. doi: [10.1002/hrdq.20034](https://doi.org/10.1002/hrdq.20034)
- Luthans, F., Avolio, B. J., Avey, J. B., & Norman, S. M. (2007). Positive psychological capital: Measurement and relationship with performance and satisfaction. *Personnel Psychology*, 60, 541–572. doi:[10.1111/j.1744-6570.2007.00083.x](https://doi.org/10.1111/j.1744-6570.2007.00083.x)
- Luthans, F., Norman, S. M., Avolio, B. J., & Avey, J. B. (2008). The mediating role of psychological capital in the supportive organizational climate–employee performance relationship. *Journal of Organizational Behavior*, 29, 219–238. doi:[10.1002/job.507](https://doi.org/10.1002/job.507)
- Luthans, F., Youssef, C. M., & Avolio, B. J. (2007). *Psychological capital*. New York, NY: Oxford University Press.
- McDonald, R. P., & Ho, M.-H. R. (2002). Principles and practice in reporting structural equation analyses. *Psychological Methods*, 7, 64–82. doi:[10.1037//1082-989X.7.1.64](https://doi.org/10.1037//1082-989X.7.1.64)
- Mearns, K., Flin, R., Gordon, G., & Fleming, M. (1998). Measuring safety culture on offshore installations. *Work and Stress*, 12, 238–254. doi:[10.1080/02678379808256864](https://doi.org/10.1080/02678379808256864)
- Mearns, K., Whitaker, S., & Flin, R. (2001). Benchmarking safety climate in hazardous environments: A longitudinal, interorganisational approach. *Risk Analysis*, 21, 771–786. doi:[10.1111/0272-4332.214149](https://doi.org/10.1111/0272-4332.214149)
- Mearns, K., Whitaker, S., & Flin, R. (2003). Safety climate, safety management practice and safety performance in offshore environments. *Safety Science*, 41, 641–680. doi:[10.1016/S0925-7535\(02\)00011-5](https://doi.org/10.1016/S0925-7535(02)00011-5)
- Myers, T. A. (2011). Goodbye listwise deletion: Presenting hot-deck imputation as an easy and effective tool for handling missing data. *Communication Methods and Measures*, 5, 297–310. doi:[10.1080/19312458.2011.624490](https://doi.org/10.1080/19312458.2011.624490)
- Neal, A., & Griffin, M. A. (2004). Safety climate and safety at work. In J. Barling & M. Frone (Eds.), *The psychology of workplace safety* (pp. 15–34). Washington, DC: American Psychological Association.
- Neal, A., Griffin, M. A., & Hart, P. M. (2000). The impact of organizational climate on safety climate and individual behaviour. *Safety Science*, 34, 99–109. doi:[10.1016/S0925-7535\(00\)00008-4](https://doi.org/10.1016/S0925-7535(00)00008-4)
- Rasmussen, H. B., & Tharaldsen, J. E. (2012). The impact of safety climate on Norwegian and Danish production platforms. In C. Bérenguer, A. Grall & C. Guedes Soares (Eds.), *Advances in safety, reliability and risk management* (pp. 1833–1839). London, UK: CRC Press. doi:[10.1201/b11433-256](https://doi.org/10.1201/b11433-256)
- Rundmo, T. (2000). Safety climate, attitudes and risk perception in Norsk Hydro. *Safety Science*, 34, 47–59. doi:[10.1016/S0925-7535\(00\)00006-0](https://doi.org/10.1016/S0925-7535(00)00006-0)
- Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika*, 66, 507–514.
- Sijtsma, K. (2009). On the use, the misuse, and the very limited usefulness of Cronbach’s alpha. *Psychometrika*, 74, 107–120. doi: <http://dx.doi.org/10.1007/s11336-008-9101-0>
- Ten Berge, J. M. F., Snijders, T. A. B., & Zegers, F. E. (1981). Computational aspects of the greatest lower bound to reliability and constrained minimum trace factor analysis. *Psychometrika*, 46, 201–213.
- Tharaldsen, J. E., Olsen, E., & Rundmo, T. (2008). A longitudinal study of safety climate on the Norwegian continental shelf. *Safety Science*, 46, 427–439. doi:[10.1016/j.ssci.2007.05.006](https://doi.org/10.1016/j.ssci.2007.05.006)
- Walumbwa, F. O., Avolio, B. J., Gardner, W. L., Wernsing, T. S., & Peterson, S. J. (2008). Authentic leadership: Development and validation of a theory-based measure. *Journal of Management*, 34, 89–126. doi:[10.1177/0149206307308913](https://doi.org/10.1177/0149206307308913)
- Zacharatos, A., Barling, J., & Iverson, R. D. (2005). High-performance work systems and occupational safety. *Journal*

- of *Applied Psychology*, 90, 77–93. doi:[10.1037/0021-9010.90.1.77](https://doi.org/10.1037/0021-9010.90.1.77)
- Zohar, D. (2008). Safety climate and beyond: A multi-level multi-climate framework. *Safety Science*, 46, 376–387. doi:[10.1016/j.ssci.2007.03.006](https://doi.org/10.1016/j.ssci.2007.03.006)
- Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis and Prevention*, 42, 1517–1522. doi:[10.1016/j.aap.2009.12.019](https://doi.org/10.1016/j.aap.2009.12.019)
- Zohar, D., & Luria, G. (2005). A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90, 616–628. doi:[10.1037/0021-9010.90.4.616](https://doi.org/10.1037/0021-9010.90.4.616)
- Zohar, D., & Tenne-Gazit, O. (2008). Transformational leadership and group interaction as climate antecedents: A social network analysis. *Journal of Applied Psychology*, 93, 744–757. doi:[10.1037/0021-9010.93.4.744](https://doi.org/10.1037/0021-9010.93.4.744)