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## Q1 Organizational culture and a safety-conscious work environment: The 3 mediating role of employee communication satisfaction

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### ABSTRACT

*Introduction:* A safety-conscious work environment allows high-reliability organizations to be proactive regarding safety and enables employees to feel free to report any concern without fear of retaliation. Currently, research on the antecedents to safety-conscious work environments is scarce. *Method:* Structural equation modeling was applied to test the mediating role of employee communication satisfaction in the relationship between constructive culture and a safety-conscious work environment in several nuclear power plants. *Results:* Employee communication satisfaction partially mediated the positive relationships between a constructive culture and a safety-conscious work environment. *Conclusions:* Constructive cultures in which cooperation, supportive relationships, individual growth and high performance are encouraged facilitate the establishment of a safety-conscious work environment. This influence is partially explained by increased employee communication satisfaction. *Practical application:* Constructive cultures should be encouraged within organizations. In addition, managers should promote communication policies and practices that support a safety-conscious work environment.

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## Q4 1. Introduction

In high-reliability organizations (HROs), a safety-conscious work environment (SCWE) may help prevent catastrophic accidents that can have serious human, economic, and environmental consequences (e.g., INPO [Institute of Nuclear Power Operations], 2013; NEI [Nuclear Energy Institute], 2003). Many types of organizations can be HROs, including chemical plants, aircraft companies, and nuclear power plants, among others.

Accidents are extremely rare in HROs. Nonetheless, failures in system components (e.g., people, equipment, procedures) can interact in unpredictable ways (Perrow, 1984). In addition, because there is high interdependence among system components, failures may cascade into even greater problems before operators can understand the situation (Perrow, 1984). Subsequently, HROs (i.e., nuclear power plants) continuously monitor safety and attempt to anticipate potential problems (Morrow, Koves, & Barnes, 2014).

Therefore, research on SCWEs and their antecedents has practical implications that are relevant for HRO safety. A SCWE is common in those organizations in which employees feel free to raise any concerns to their managers, which managers can use to obtain a complete picture

of the organizational state of operations and to identify “weak cases” or “early warning signs” of safety degradation (e.g., Pidgeon, 1997).

This study, which was conducted in several nuclear power plants, aims to examine the relationship between constructive culture and SCWEs and to assess the mediating role of employee satisfaction with organizational communication in this relationship.

### 1.1. Constructive culture and a SCWE

Previous research suggests that organizational culture is vital for safety in HROs (e.g., the post-accident investigation into the Challenger disaster; Vaughan, 2009). Nonetheless, the myriad conceptualizations of organizational culture (e.g., Reason, 1997; Turner & Pidgeon, 1997) have prevented the accumulation of knowledge (e.g., Sackmann, 2011). This study attempts to counteract this difficulty by detailing the conceptualization of organizational culture we have adopted.

Organizational culture has been alternatively defined as “the way we do things around here” (Deal & Kennedy, 1982) or as shared symbols, rituals, beliefs, stories, ideologies, values, practices, knowledge, or artifacts (Smircich, 1983), among other definitions. By focusing on constructive culture, this study refers to thinking and behavioral norms. In other words, it addresses the “unwritten rules” that are required to “fit in” and “survive” within an organization (Cooke & Szumal, 2000). These norms refer to the approaches applied to address work and to interact with others.

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Constructive cultures encourage members to interact with others and to approach tasks with the aim of meeting their own higher order satisfaction needs (Cooke & Lafferty, 2003). As such, these organizations promote cooperation, supportive relationships among work colleagues, high-level performance, and individual growth (Cooke & Rousseau, 1988; Cooke & Szumal, 2000).

Constructive cultures balance both people and task orientation and support the attainment of higher order satisfaction needs (Denison, Nieminen, & Kotrba, 2014). Both aspects are critical for conceptualizing organizational culture (for a literature review, see Detert, Schroeder, & Mauriel, 2000; Xenikou & Furnham, 1996), and both rest on sound theoretical foundations. The distinction between people orientation (e.g., concern about employees' satisfaction and overall well-being) and task orientation (e.g., accomplishments of specific goals and execution of the applicable steps to be followed) is well established in the field of organizational culture (e.g., Denison et al., 2014) and leadership (Balthazard & Cooke, 2004; Cooke & Szumal, 1993). Additionally, the concept of higher order satisfaction needs (e.g., self-esteem, achievement, and creativity) was first introduced by Maslow (1954) in his hierarchical theory of motivation. This theoretical approach is well-known in the organizational culture literature (e.g., Denison et al., 2014; Ostroff, Kinicki, & Tamkins, 2003; Xenikou & Furnham, 1996).

The notion of constructive culture has been applied in HROs, including nuclear power plants (e.g., García-Herrero, Mariscal, Gutiérrez, & Toca-Otero, 2013; Klein, Bigley, & Roberts, 1995), and in other organizational contexts (e.g., Pool, 2000; Kwantes & Boglarsky, 2004). Moreover, there is extensive research supporting the reliability and validity of the constructive culture construct (e.g., Denison et al., 2014; Xenikou & Furnham, 1996), which is necessary to discriminate among various types of organizations. A comparative study revealed that constructive culture varied among HROs and "conventional" organizations and among different types of HROs (Klein et al., 1995).

Finally, it is notable that an examination of safety culture is outside the scope of this study. Most theoretical developments regarding safety culture derive from a more generalized notion of organizational culture (Glendon & Stanton, 2000) and respond to "analytical or practical reasons to narrow the concept and thus make it more tangible" (Guldenmund, 2000; p. 223). For instance, according to Pidgeon (1991), safety culture refers to "norms and rules for handling hazards, attitudes toward safety, and reflexivity on safety practice" (p. 135). Constructive culture does not refer to safety thinking and behavioral norms, and its theoretical foundations are sufficiently meaningful and broad to establish parallels with alternative models of organizational culture (Detert et al., 2000; Xenikou & Furnham, 1996). In so doing, this approach allows for an accumulation of knowledge in the field of organizational culture (Denison et al., 2014).

This study aims to examine the relationship between constructive culture and the SCWE. The SCWE, which has captured increased practitioner attention in the nuclear sector (INPO, 2013; NRC-Nuclear Regulatory Commission-, 2011), has been considered as a relevant feature of safety culture by some international organizations (INPO, 2013). However, in the field of social sciences, several authors recommend to avoid the use of safety culture as an "umbrella term" (Guldenmund, 2010; p. 1466) and acknowledge its risks. In the words of Guldenmund (2010), safety culture is a "fuzzy" concept, "this fuzziness is both its strength and its weakness" (Guldenmund, 2010; p. 1466).

The SCWE implies that "... personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination" (INPO, 2013; p. 6). NEI (2003) extends the scope of a SCWE to non-safety-related concerns and establishes that SCWE policies should allow employees the freedom to express both safety-related and non-safety-related concerns to management without fear of reprisal. The current study also focuses on employee concerns that are not necessarily related to safety as a way to determine whether employees are proactive. It is important to consider that the distinction between safety- and non-safety-related concerns is not always obvious. For

instance, the event that occurred in 2002 at Davis-Besse nuclear power plant illustrates how discrepancies that did not seem significant in terms of safety (rust particles in containment air filters) were a sign of safety degradation (Perin, 2005). Accordingly, Weick and Sutcliffe (2007) emphasize the need to note small discrepancies whenever they may occur and to address failures in early stages.

Constructive culture is expected to facilitate the establishment of a SCWE for several reasons. Constructive cultures fulfill individual higher order satisfaction needs. Subsequently, based on the social exchange norm of reciprocity (Blau, 1964), employees may feel obligated to support a SCWE (Blau, 1964). Constructive cultures also promote supportive relationships, which allow individuals to feel secure when raising concerns to their managers instead of glossing over or hiding them. Having supportive relationships might reduce interpersonal risks when raising concerns, such that raising concerns is not perceived as an act of disloyalty or a willingness to interfere in the work of co-workers, for example (Navajas, Silla, & Guldenmund, 2014).

Moreover, empirical research has shown that constructive culture benefits organizational functioning (see Cooke & Szumal, 2000 for an integrative review), employee commitment (Haley, 1998; Klein et al., 1995; Roberts, Rousseau, & La Porte, 1994), job satisfaction (Balthazard, Cooke, & Potter, 2006; Cooke & Szumal, 2000; Stebbins, 2008), role clarity (Balthazard et al., 2006; Pool, 2000), cooperation (Murphy, Cooké, & Lopez, 2013), quality of organizational communication (Balthazard et al., 2006), and organizational products/service quality (Balthazard et al., 2006; Murphy et al., 2013).

Although previous research supports the benefits of constructive culture regarding safety (e.g., García-Herrero et al., 2013; Rousseau, 1989), empirical evidence of these benefits remains scarce. García-Herrero et al. (2013) found constructive culture to be positively associated with safety culture. By contrast, Haley (1998) found a positive relationship between constructive culture and reported medication errors and patient falls, which could be explained by the transparency associated with constructive culture. This transparency might account for the increased number of reported incidents and suggests that fewer reported incidents in some organizations may not necessarily reflect the number of incidents actually occurring. Therefore, the following hypothesis was formulated:

**Hypothesis 1.** Constructive culture will be positively associated with a SCWE.

### 1.2. The mediating role of employee satisfaction with organizational communication

This study attempts to more thoroughly evaluate the relationship between constructive culture and a SCWE. This evaluation is achieved by examining the mediating role of employee satisfaction with organizational communication, which is defined as "the collective and interactive process of generating and interpreting messages" (Stohl, 1995; p. 4).

Several arguments support the mediating role of satisfaction with organizational communication. First, organizational culture is expected to influence organizational communication by enabling and constraining it (Bisel, Messersmith, & Keyton, 2010). Thus, in some sense, organizational culture sets the basis for communication (de Cock, de Witte, & van Nieuwerkerke, 1998; Langan-Fox, 2001). The implementation of communication policies and practices will fail if they are not aligned with organizational culture (Xie, Helfert, Lugmayr, Heimgärtner, & Holzinger, 2013). With respect to the connection between constructive culture and communication, Murphy et al. (2013) suggest that constructive culture would increase communication quality and individual interaction. Similarly, Balthazard et al. (2006) provide empirical evidence regarding the positive relationship between constructive culture and communication quality.

Second, employee satisfaction with organizational communication is expected to enhance a stronger SCWE. Organizational communication contributes to employee performance (Agarwal, 2010). For instance, it keeps members informed about ongoing operations and helps them identify “early warnings” of safety degradation (Weick & Sutcliffe, 2007). In addition, well-informed employees may feel legitimized and confident enough to raise any type of concern to their superiors. Finally, communication accomplishes an educational function (Cigularov, Chen, & Rosecrance, 2010) that may support SCWE, instill caution and discourage complacency by providing relevant information, such as information about near misses, system status, etc. (Reason, 1997).

In summary, constructive culture is expected to benefit both organizational communication and SCWEs. Additionally, satisfying organizational communication can promote a SCWE. Based on the arguments discussed above, the following hypothesis was formulated:

**Hypothesis 2.** Employee communication satisfaction will partially mediate the positive relationship between constructive culture and a SCWE.

## 2. Method

### 2.1. Participants and procedure

This study was framed in a research project conducted in several nuclear power plants. Researchers informed all participants about the aims of the study during group sessions, emphasizing the confidential nature of the study and voluntary participation. Questionnaires were completed during work hours.

The sample consisted of 1481 employees. The average response rate across the different nuclear power plants was 69.16% (ranging from 62% to 89%). Approximately 7.08% of the participants were managers and department heads, and 92.92% held lower-level job positions. Most employees were university graduates (university degree: 47.65%; high school graduates: 14.61%; vocational training: 29.81%; elementary school: 7.93%). Regarding organizational tenure, 65.44% of the employees had at least 20 years experience with their respective organization.

Participants stem from three companies geographically distributed across eight different locations that run five different nuclear power plants. Box's M statistic and Levene test for equality of variances were conducted to assess whether data pertaining to the three different companies can be combined and analyzed together. All the variables examined in the hypothesized model were considered. Box's M statistic tests homogeneity of covariance matrices across the three examined companies. The null hypothesis of equal covariance matrices is rejected when  $p \leq .005$  (Huberty & Petoskey, 2000) or  $.001$  (Tabachnick & Fidell, 2007). Results showed the null hypothesis could not be rejected:  $M = 63.223$ ,  $p = .02$ . Seemingly, Levene test supported homogeneity of variances across the three companies. The only exception was one out of the four dimensions of constructive culture: Self-actualizing ( $F = 3.17$ ,  $p = .04$ ). All together, findings suggested that data gathered from the three different companies can be combined and analyzed together.

In addition, one-way MANOVA was carried out to detect whether the three companies differ along the combination of variables examined in the hypothesized model (constructive culture dimensions, employee communication satisfaction, and safety-conscious work environment). Findings showed statistically significant differences:  $F(12, 2806) = 11.07$ ,  $p < .001$ ; Wilk's  $\Lambda = 0.91$ , partial  $\eta^2 = .04$ . In addition, when one-way ANOVA was conducted on each dependent variable, statistically significant differences emerged on achievement ( $F(2, 1408) = 6.54$ ;  $p < .01$ ;  $\eta^2 = .01$ ), affiliative ( $F(2, 1408) = 3.62$ ;  $p = .03$ ;  $\eta^2 = .005$ ), employee communication satisfaction ( $F(2, 1408) = 25.80$ ;  $p < .01$ ;  $\eta^2 = .03$ ), and safety-conscious work environment ( $F(2, 1408) = 9.40$ ;  $p < .01$ ;  $\eta^2 = .01$ ). Differences in Humanistic-Encouraging and Self-actualizing were statistically non-significant ( $p \geq .05$ ). Based on

these findings, company was included in the hypothesized model as control variable (see data analysis).

### 2.2. Measures

The measures used in this study are described hereafter. Scale reliability and the factorial structure are presented in the “Results” section.

#### 2.2.1. Constructive culture

The Organizational Culture Inventory®<sup>1</sup> developed by Cooke and Lafferty (2003) was used to measure constructive culture. A five-point Likert scale ranging from 1 (“1. Not at all”) to 5 (“5. To a very great extent”) was used. Constructive culture was measured using the following four subscales (Cronbach's alpha: .96): Humanistic-Encouraging, Affiliative, Achievement, and Self-actualizing (Cooke and Szumal, 2000; p. 149). Ten items were used to measure Humanistic-Encouraging culture (Cronbach's alpha: .93), which represents organizations in which “[m]embers are expected to be supportive, constructive, and open to influence in their dealings with one another.” The affiliative culture scale (Cronbach's alpha: .92) consisted of 10 items and features organizations in which “[m]embers are expected to be friendly, cooperative, and sensitive to the satisfaction of their work group.” The achievement culture (Cronbach's alpha: .86), was assessed with a 10-item scale and determines whether “[m]embers are expected to set challenging but realistic goals, establish plans to reach those goals, and pursue them with enthusiasm.” The self-actualizing culture scale (Cronbach's alpha: .83) consisted of 10 items and represents organizations in which “[m]embers are expected to enjoy their work, develop themselves, and take on new and interesting tasks.”

Employee communication satisfaction was assessed using a single-item measure, with a response scale ranging from 1 (low satisfaction) to 7 (high satisfaction). This item reads as follows “Choose the side that best describes your opinion of communications at your organization, taking into consideration aspects such as the information load, interaction with your immediate boss and others, and the accuracy of available information, among others.”

The SCWE was measured using four items with a response scale ranging from 1 (“1. Completely agree”) to 7 (“7. Completely disagree”) (S. Haber, personal communication, September 2006). This scale, which was elaborated following NEI (2003) and NRC (2005) guidelines on SCWEs, assesses the extent to which employees feel free to raise concerns and challenge decisions. In addition, the scale measures the level of employee confidence that management will willingly listen to their concerns, address them constructively and will not engage in retaliation; a sample item is “Management does not tolerate retaliation of any kind for raising concerns.” Cronbach's alpha was .85.

### 2.3. Data analysis

Descriptive statistics, the correlation matrix between variables, and alpha coefficients were computed (Table 1). Additionally, confirmatory factor analyses (CFAs) were performed to examine the validity of the scales presented above. Finally, structural equation modeling (SEM) was used to test the hypotheses.

The measurement model included the constructive culture and SCWE items. A maximum likelihood method (ML) was used to estimate model parameters, and a covariance matrix served as analysis input. With respect to the constructive culture scale, the measurement model consisted of one second-order factor (constructive culture) and four first-order factors: humanistic-encouraging, affiliative, achievement, and self-actualizing. Several studies (e.g., Denison et al., 2014; Xenikou & Furnham, 1996) provide empirical evidence that support

<sup>1</sup> Organizational Culture Inventory® is a registered trademark of Human Synergistics International, Plymouth, MI, USA; Copyright 1973–2006 by Human Synergistics International. Used by permission.

**Table 1**  
Descriptive statistics, alpha coefficients and correlations.

Variable	M	SD	1	2	3	4	5
1. Company I (CI)	-	-	-	-	-	-	-
2. Company II (CII)	-	-	-	-	-	-	-
3. Constructive culture	3.49	.63	.02	-.07**	(.96)	-	-
4. Employee communication satisfaction	4.63	1.39	-.01	-.18**	.44**	-	-
5. Safety-Conscious Work Environment (SCWE)	4.41	1.52	-.11**	.07*	.31**	.40**	(.85)

Note: \*p < .05 and \*\*p < .01. Reliabilities (coefficient alpha) are given in parentheses.

the notion that conceptualizing constructive culture as a higher order factor is reliable and valid. In addition, Denison et al. (2014) argue that it is possible to conceptually connect to other theoretical organizational culture models through higher order factors by helping to overcome the difficulty of accumulating empirical evidence caused by diverse coexisting models. A single-factor model was tested for the SCWE scale.

Using structural equation modeling (SEM), three competing models were examined for purposes of testing the hypothesized model (Fig. 1). These models combined CFA and path analysis. To reduce the number of parameters to be estimated, the humanistic-encouraging, affiliative, achievement, and self-actualizing subscales served as indicators of constructive culture. Maximum likelihood (ML) methods were used to estimate model parameters, and a covariance matrix was employed for analysis input. Finally, in order to avoid potential confounding effects, Company was introduced as a control variable (see one-way MANOVA and ANOVA results in Section 2.1 "Participants and procedure"). Company is a categorical variable with three levels, thus, two dummy variables (k - 1) were introduced as control variables (Company I and Company II).

Our hypothesized partial mediation model predicts that a constructive culture will be positively associated with a SCWE (Hypothesis 1) and that employee communication satisfaction will mediate this relationship (Hypothesis 2). This partial mediation model was compared with two competing models: a full mediation model and a direct effects model. The full mediation model tests whether the effect of constructive culture on the SCWE is fully exerted indirectly through the mediator. The direct effects model (non-mediated model) tests the influence of constructive culture and employee communication satisfaction on the SCWE.

To assess model fit, we examined the standardized root mean residual (SRMR), root mean square of approximation (RMSEA) and comparative fit index (CFI) (Kline, 2005). For SRMR and RMSEA, lower values indicate a better fit. Upper limits of .08 for SRMR and RMSEA (RMSEA ≤ .05 = close

fit; .05 < RMSEA ≤ .08 = reasonable fit) have been recognized as acceptable. By contrast, higher CFI values indicate a better fit: a value ≥ 0.90 indicates a good fit. Additionally, the  $\chi^2$  fit statistics of the various models were statistically compared using  $\Delta \chi^2_{(df1 - df2)} = \chi^2_{(df1)} - \chi^2_{(df2)}$  (Mueller & Hancock, 2008).

**3. Results**

Descriptive statistics, alpha coefficients, and correlations for all measures are presented in Table 1. Pearson correlations revealed positive relations among constructive culture, employee communication satisfaction and a SCWE (p < .01).

The measurement model consisting of constructive culture (second-order factor model) and SCWE (single-factor model) showed an acceptable fit to the data (SRMR = .05; RMSEA = .066; CFI = .85). SRMR and RMSEA values were satisfactory. Additionally, RMSEA with a 90% CI (.065, .068) was also acceptable. However, CFI was below the minimum requirements.

To test our hypotheses, the partial mediation model was tested (See Fig. 1). In addition, the fit of this model was compared with the fit of each of the other two models: full mediation and direct effects (Table 2). The partial mediation model showed an acceptable fit to the data ( $\chi^2 = 247.762, df = 39, p < .01$ ; SRMR = .03; RMSEA = .06; CFI = .97), as did the full mediation model ( $\chi^2 = 278.956, df = 40, p < .01$ ; SRMR = .05; RMSEA = .07; CFI = .97). However, the chi-square difference test showed that the partial mediation model was a significantly better fit than the full mediation model:  $\chi^2$  difference ( $df=1$ ) = 31.19, p < .01. With respect to the direct effects model (non-mediated model), the goodness of fit indexes displayed a poor fit ( $\chi^2 = 535.430, df = 40, p < .01$ ; SRMR = .11; RMSEA = .09; CFI = .94).

The findings indicated that the preferred model is the partial mediation model. Additionally, all the estimated parameters were statistically significant (p < .05) and supported the hypotheses (Fig. 1). Constructive culture exerted a positive direct effect on SCWE (Hypothesis 1) and employee communication satisfaction. Constructive culture effects on SCWE were partially mediated by employee communication satisfaction, with the standardized indirect effect estimated at .16 (p < .01) (Hypothesis 2). Finally, the R<sup>2</sup> for the variance explained in SCWE was .23. In conclusion, the hypotheses described above were fully supported.

**4. Discussion**

The purpose of this study was to examine the mediating role of employee communication satisfaction in the relationship between constructive culture and a SCWE. Consistent with Hypothesis 1, constructive culture was accompanied by a more SCWE. Additionally, employee

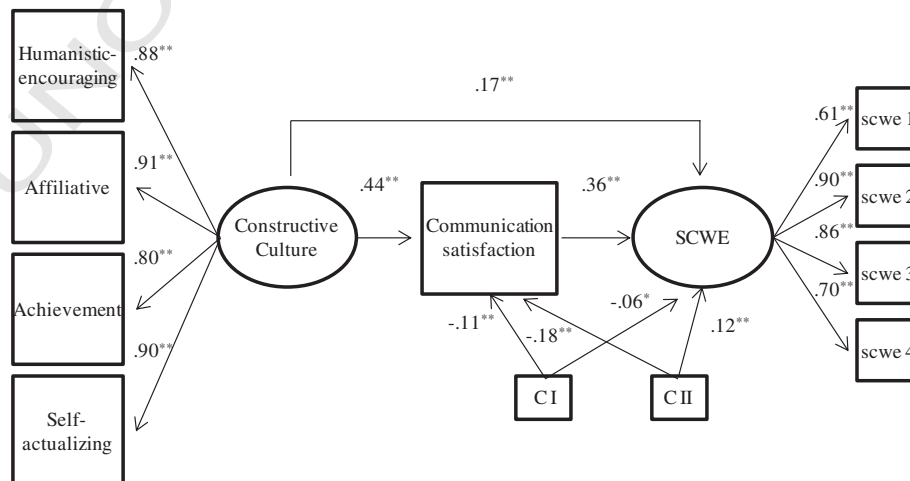


Fig. 1. Structural equation modeling results: Partial mediation model. \*p < .05; \*\*p < .01.

t2.1 **Table 2**  
 t2.2 Goodness of fit indicators of the three competing models.

t2.3		$\chi^2$	Df	SRMR	RMSEA	90% CI for RMSEA	CFI
t2.4	1. Partial mediation	247.762	39	.03	.06	.05–.07	.97
t2.5	2. Full mediation	278.956	40	.05	.07	.06–.07	.97
t2.6	3. Direct effects	535.430	40	.11	.09	.09–.10	.94

406 communication satisfaction partially mediated this relationship  
 407 (Hypothesis 2), and the findings supported the formulated hypotheses.  
 408 Regarding control variables, findings showed that company was a signif-  
 409 icant predictor of communication satisfaction and a SCWE. Finally, unre-  
 410 ported analyses provided additional support to Hypothesis 2 by means  
 411 of showing that the indirect effect of employee communication satisfac-  
 412 tion was equal across companies. In particular, multiple group compari-  
 413 sons using SEM were conducted, and the indirect effect was constrained  
 414 to be equal in the three companies. The model showed an acceptable fit  
 415 to the data ( $\chi^2 = 325.887$ ,  $df = 101$ ,  $p < .01$ ;  $SRMR = .05$ ;  $RMSEA =$   
 416  $.069$ ;  $CFI = .971$ ).

417 These findings are consistent with previous research supporting  
 418 constructive culture benefits for safety culture (e.g., García-Herrero  
 419 et al., 2013) and for relevant individual and organizational outcomes  
 420 (e.g., Balthazard & Cooke, 2004; Cooke & Szumal, 2000). Moreover, the  
 421 results are also consistent with several theoretical arguments that  
 422 support the mediating role of employee communication satisfaction.  
 423 Several authors have noted the influence of organizational culture on  
 424 communication (e.g., Langan-Fox, 2001; Xie et al., 2013) and the  
 425 positive association between constructive culture and communication  
 426 quality (Balthazard et al., 2006; Murphy et al., 2013). Additionally, the  
 427 previous literature supports the relationship between communication  
 428 and a SCWE. In particular, some authors have focused on communica-  
 429 tion, as it positively impacts performance (Agarwal, 2010) and has an  
 430 educational function (Cigularov et al., 2010), which may promote a  
 431 SCWE by encouraging caution.

432 This study has several theoretical implications. It provides evidence  
 433 of the applicability of constructive culture theoretical foundations in  
 434 HROs. Most research on the benefits of constructive culture has been  
 435 conducted in “conventional organizations” and thus cannot be easily  
 436 transferred to HROs (Waller & Roberts, 2003), which are known for  
 437 unique characteristics that must be considered when developing pre-  
 438 dictive theoretical models (e.g., Johns, 2006). It appears that the knowl-  
 439 edge developed in HROs cannot apply directly to “conventional  
 440 organizations” because practices such as on-the-job training, peer-  
 441 checks, or emergency drills (Sagan, 1993) may not be cost-effective in  
 442 “conventional organizations.”

443 Our findings suggest that organizational cultures supporting higher  
 444 order satisfaction needs and balancing out people and task orientation  
 445 (which is the case with constructive culture) would benefit HROs.  
 446 Similarly, Rousseau (1989) postulated that humanistic and satisfaction-  
 447 oriented values are necessary in HROs during periods of crisis that require  
 448 decentralized decision making.

449 By contrast to these arguments, high reliability and normal accident  
 450 theorists postulate the need for a “strong” organizational culture during  
 451 normal operations (Sagan, 1993). These authors argue that a strong  
 452 organizational culture “in the form of intense socialization [and] strict  
 453 discipline (...) can encourage safety with hazardous technologies”  
 454 (Sagan, 1993; p. 252–253). A “strong” organizational culture depends  
 455 on high control and centralization according to high reliability theorists,  
 456 who argue that this type of organization ensures that front-line em-  
 457 ployees will act predictably and support safety to achieve hierarchical  
 458 approval. However, high reliability theorists also acknowledge the  
 459 potential side effects of fostering a “strong” organizational culture. For in-  
 460 stance, it may encourage excessive conformity and institutional loyalty  
 461 and instill a fear of retaliation when mistakes are articulated (Sagan,  
 462 1993). All these aspects would be counterproductive for a SCWE. Addi-  
 463 tionally, a “strong” culture would not be helpful when employees face

464 unexpected circumstances. This study encourages further research to  
 465 address the influence of constructive culture on other safety related  
 466 outcomes to shed additional light on this debate.

467 This study contributes to the development of an integrative theoretical  
 468 model on SCWEs and on their antecedents and intervening variables. In  
 469 particular, this study suggests that constructive cultures support a SCWE  
 470 in a relationship partially mediated by employee communication satisfac-  
 471 tion. Many practitioners acknowledge the relevance of a SCWE (INPO,  
 472 2013; NRC, 2011) and note some antecedents. Nonetheless, research in  
 473 this field of social science remains scarce.

474 Finally, this study suggests that social exchange theory may illumina-  
 475 te the understanding of SCWE (Blau, 1964) antecedents in HROs.  
 476 Constructive cultures may help employees feel that their organization  
 477 values their contributions and encourages them to feel obligated to  
 478 support a SCWE (Blau, 1964).

479 These findings have relevant practical implications and suggest that  
 480 organizational policies that support a constructive culture should be en-  
 481 couraged. Szumal (2009) postulated that shaping an environment that  
 482 is conducive to learning and development and viewing members as an  
 483 important source of ideas promotes a constructive culture. Additionally,  
 484 communication policies supporting a SCWE should be implemented.  
 485 For instance, effective communication channels help inform employees  
 486 regarding the big picture of the organization such that they can identify  
 487 signs of safety degradation (e.g., Roberts & Bea, 2001). Additionally,  
 488 practices such as good two-way communication channels and a reward  
 489 system that reinforces the actions of employees who raise concerns may  
 490 further strengthen a SCWE.

491 Research on SCWE antecedents also has some practical implications  
 492 for our society. A HRO system failure may lead to substantial human,  
 493 economic, and environmental costs. A SCWE enables the organization  
 494 to identify signs of safety degradation before an accident occurs. This  
 495 proactive approach is crucial in HROs in which multiple small independ-  
 496 ent failures may lead to safety degradation without any of these  
 497 failures necessarily being documented in accident statistics (HSE  
 498 [Health and Safety Executive], 2011) until it is too late.

499 This study also has multiple limitations. Due to its cross-sectional na-  
 500 ture, causal relationships cannot be assumed. Despite several theoretical  
 501 arguments suggesting that organizational culture influences communi-  
 502 cation, this relationship might be reversed or reciprocal. Organizational  
 503 culture enables and constrains communication (Bisel et al., 2010). How-  
 504 ever, cultures are created, sustained, transmitted, and changed through  
 505 communication and social interaction (Schall, 1983). In any case, it may  
 506 be argued that social and cultural rules are relatively stable, although  
 507 they might evolve through social interaction (Conrad & Haynes,  
 508 2001). An additional limitation is that this study was based on self-  
 509 reported data.

510 Moreover, employee communication satisfaction was measured  
 511 through a single-item measure. However, in some instances such as  
 512 overall job satisfaction single-item measures has been considered ro-  
 513 bust (Nagy, 2002; Wanous, Reichers, & Hudy, 1997). These authors  
 514 argue that, first; single-item measures are much more efficient. Second,  
 515 single-item measures may be more convenient than summing up facet  
 516 scales which may neglect relevant job features for a given employee.  
 517 Third, they provide empirical evidence suggesting that overall job satis-  
 518 faction single-item measures are acceptable for measurement purposes.  
 519 Finally, future studies should incorporate objective SCWE measure-  
 520 ments (e.g., number of reported “near incidents”).

521 With respect to future research, social scientists should address the  
 522 theoretical development and empirical validity of the SCWE construct.  
 523 Despite international organizations (INPO, 2013; NRC, 2011) having  
 524 emphasized its relevance in high reliability organizations based on  
 525 their expert judgment, to date, research in the field of social science is  
 526 scarce. In addition, practitioners refer to the SCWE as a relevant attribute  
 527 of safety culture. These pragmatic approaches (experience-based) makes  
 528 it difficult to prevent safety culture to become a fuzzy concept. Notice  
 529 that pragmatic approaches include under the term “safety culture”:

“the structure and processes of an organization, which, because of their dynamic interplay, will subsequently influence the culture and, in due course, behavior and performance” of an organization (Guldenmund, 2010; p. 1470). Along these lines, several researchers acknowledge that it is common to use the concept of safety culture as an “umbrella” term “to explain everything relating to safety failures that cannot be explained in another way” (Guldenmund, 2010, p. 1466).

To our knowledge research on how to measure SCWE is scarce. Thus, research on SCWE construct validity (e. g., does SCWE correlates with safety performance or management commitment to safety?) and predictive equivalence (e.g., Is the SCWE-safety performance relationship robust across different types of organizations, e.g., HROs and non HROs?) would be valuable. This study operationalizes SCWE as the extent to which employees feel free to raise concerns and challenge decisions, and the level of employee confidence that management will willingly listen to their concerns and address them constructively. One may argue that SCWE should only address safety concerns. Nonetheless, notice that HROs are complex and unpredictable organizations due to the high interdependence among system components. Thus, the distinction between safety- and non-safety-related concerns is not always obvious (e.g., rust particles in containment air filters were a sign of safety degradation in the event that occurred in 2002 at Davis–Besse nuclear power plant; Perin, 2005).

Future research should also identify other potential intervening factors in the relationship between organizational culture and SCWE. For instance, a potential moderating factor might be the type of concern to be raised. Reporting an individual's potential error may have negative consequences that might discourage employees from raising concerns (Dekker, 2007), even when a constructive culture is promoted.

Finally, future studies should test the generalizability of the results with “conventional” organizations. Some studies have documented distinctive characteristics of HROs (Roberts, 1990), but less is known about their similarities with “conventional” organizations. Qualitative studies may help further explain this difference. Such an investigation would not justify a generalization of our findings, but it might be insightful to create new knowledge (e.g., Tamuz & Harrison, 2006; Vogus & Welbourne, 2003; Waller & Roberts, 2003). For instance, any “conventional” organization pursuing production process reliability (e.g., organizations manufacturing jet engines) may benefit from research conducted in HROs.

Along these lines, future research should contribute to develop more comprehensive models on organizational culture that addresses socio-cultural, organizational, and individual variables (e. g., Erez & Gati, 2004; Fischer, Ferreira, Assmar, Redford, & Harb, 2005; Rousseau, 1985). For instance, Ostroff et al. (2003) emphasize the influence of national culture, industry and business environment, and organizational vision and strategy on individuals' perception of organizational culture. Cross-level research addressing the effects of higher-level characteristics on lower-level processes would shed light into these and other research questions such as how strongly individuals perceptions of organizational culture are influenced by company, organizational branch or work group.

## 5. Conclusion

The concept of a SCWE is gaining increased attention among practitioners because it allows organizations to anticipate potential problems and prevent accidents in HROs (INPO, 2013; NEI, 2003; NRC, 2011). Additionally, some international organizations have developed guidelines regarding how to maintain and encourage a SCWE (INPO, 2013; NEI, 2003; NRC, 2011). Nonetheless, in the field of social sciences, research on the antecedents of SCWEs is scarce.

This study fills this research gap by contributing to evidence-based safety management. The findings suggest that organizational cultures that support the attainment of higher order satisfaction needs and that balance task and people orientation (which is the case for

constructive culture) support a SCWE. Additionally, a constructive culture also influences a SCWE by increasing employee communication satisfaction.

The practical implications of these results are relevant for human society because accidents in HROs can have catastrophic consequences in terms of human, environmental and economic costs. Finally, this study encourages future research to examine the influence of constructive culture on other safety-related outcomes.

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