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Reliability and Validity of a Safety Climate Questionnaire

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ABSTRACT

Background: It is believed that improved safety culture/climate is a fundamental element to accident prevention. Therefore, development a scale to assess safety climate is a step towards accident control. The purpose of this study was to construct a Persian safety climate questionnaire.

Methods: The study took place in Tehran and Esfahan oil refineries in Iran in 2010. An initial questionnaire was formed from two previous studies. This tool was translated to Persian based on back translation. The 61-item questionnaire was tested on operational staffs (N=324). Principle component analysis and Varimax with Kaiser Normalization was used to extract factors, in statistical software package SPSS 11.0.

Results: The factors were obtained as Management Commitment to Safety and personnel collaboration 23 variables, 17.33 % of the variance, Safety communication five items, 6.97% of the variance, Supportive environment five items, 6.245% of the variance, Work Environment six items, 5.590% of the variance, Formal Training four items, 4.581% of the variance, Priority of Safety five items, 4.177% of the variance, Personal Priorities and Need for Safety three items, 3.333% of the variance.

Conclusions: Achievement of a valid and reliable safety climate tool may bring enormous benefits to the refineries. However, a reliable and valid tool to measure safety climate could be useful in other refineries. Moreover, the generic nature of the safety climate scale may grant its use for other workplaces.

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Introduction

Since the International Atomic Energy Agency IAEA report (1991) on the devastating Chernobyl disaster [1], the concept of safety culture has been presented to the wider world. Some safety culture indicators are related to accident rates [2]. Saari (1990) expressed that technology improvement may not be enough to improve safety, but organizational and cultural factors should be considered more important [3].

This kind of ideas led to motivate numerous researchers to carry out research on different domains of safety culture, usually based on a safety climate questionnaire that has been the predominant measurement instrument [4]. During the past years over 40 different safety climate measures have been developed [5]. However, most of these works were done in Western world and there is, therefore, little to guide practitioners in other parts of the world [6].

There have been sporadic researches in some developing countries in different fields with little notice by the oil industry, which is the main industry in Iran. Even in Iran, in spite of the existence of a few articles on safety culture/climate, there is hardly any study on measurement tools in the oil industry, which is the main industry in the country.

In such circumstances, since safety culture is a multidimensional concept [7] and no universal set of safety climate factors exists [8], one should choose one of two avenues of possibilities to develop a safety climate questionnaire. The first one depends on applying a descriptive model of safety climate as a starting point. The second is to develop a new tool via combination of findings of previous studies [9].

The purpose of this study was to construct a Persian safety climate questionnaire adopted from a few articles with an Iranian sample from oil refining companies.

Methods

The study took place in two Tehran and Esfahan oil refineries in Iran in 2010. To reduce any effects of process types or technologies, we attempted to focus on the previous studies carried out in refinery filed of operation. Since it is unlikely to find a single safety climate questionnaire from previous research exactly appropriate to be used in different countries, the main elements of safety climate were derived from two articles [10, 11], both of which considered oil industries as well as a framework of organizational culture (Table 1). As the initial instrument, a questionnaire was formed on

the basis of Table 1 and translated into Persian via linguistic validity approach.

Table 1: An overview of the elements of safety climate that were considered to be measured

Cox and colleagues [10]	Díaz and colleagues [11]
Management commitment	Company values
Priority of safety	Leadership styles
Communication	Motivation patterns
Safety rules	Training programs
Supportive environment	Downward communication
Involvement	Safety promotion
Personal priorities and need for safety	Usage of accident information
Personal appreciation of risk	-
Work environment	-

To preserve equivalence in cross-cultural adaptation of the safety climate questionnaire, we followed the guidelines proposed by Guillemin et al [12], containing back-translation techniques Brislin [13]. First, an expert panel (N=6), including research team and experienced staffs, reviewed the questions, added more questions and justified them all. Two experienced translators, who were Persian speakers, independently translated the document. Then, they compared their translations and jointly produced a harmonized one. This questionnaire was given to a translator, who got the PhD degree in English language and was not familiar with industrial safety, for back-translation into the English. Questions that conceptuality differed from the original questionnaire were modified and compared again. Finally, the questionnaire was translated into Persian as the research instrument. The final questionnaire consisted of 61 items.

Since according to Tabachnick and Fidell (2001), five to one is adequate as the number of subjects-to-number of variables ratio [14], the 61-item questionnaire was tested on a sample of 324 operational staffs.

Voluntary participation and anonymity were emphasized. Therefore, names or identifying information were not requested on the questionnaire. For each statement, participants were required to represent the level of their agreement on a five-point Likert-type scale, where one equals strong disagreement, and five equals strong agreement. Some of the items were negatively worded; and thus, the numerical scoring was reversed to permit a score of 5 to reflect the most positive safety climate.

Principle component analysis and Varimax with Kaiser Normalization was used to extract factors. The application of Eigenvalue and scree plot enabled us to determine the number of factors extracted as well as the questions with low correlation.

Correlations of subscales with the total scale score was calculated to show the validity of the instrument. Since the main purpose of exploratory factor analysis is data reduction to define a set of common underlying dimensions known as factors, priori criteria should be established in order to get a certain number of factors extracted. The most commonly criteria include: eigenvalues higher than 1 latent root criteria), and scree test criterion [15]. Besides, the reliability for each factor separately was tested via Cronbach's α.

Rotation of factors could be a helpful tool to interpret the factor solutions. Before using factor rotation, a researcher has to determine the method of rotation: oblique or orthogonal. The decision is purely theoretically based – orthogonal rotation methods are based on the theoretical conceptualization of factors not being correlated, whereas oblique rotations allow factors to be correlated.

In this study, we conceptualize the factors to be correlated. To interpret the factors, criteria have to be made regarding the item loadings that are worth considering. The literature recommends the following rule of thumb: item loadings 0.30 are considered to meet the minimal level, loadings of 0.40 are accepted as more important, and finally, if the loadings are greater than 0.50 factors are considered to be especially important.

Statistical software package SPSS 9.0 was used to run exploratory factor analysis.

Results

The 61 items questionnaire was disturbed among 324 of staffs in two oil refining companies. The average age of participants was 41.79 years, ranging from 22 to 60 years. Average work experience was 18.9 years, ranging from less than a year to 41 years.

An initial common factor analysis (Principal Component) with varimax rotation was performed to identify underlying factors in the questionnaire. We used Barlett's test to examine whether inter-correlation matrix contains sufficient common variance to make EFA suitable. We obtained a strong significance for Bartlett's test (chi-square value of 10330 and significance level of .000.) Furthermore, Kaiser-Meyer-Olkin measure was measured as 0.949

Varimax rotation, with an Eigenvalue over 1 the (Latent Root Criteria), was applied. Results of the analysis revealed 13 factors with eigenvalues over 1.0 accounting for 63.2% of the cumulative variance. Six factors that loaded less than 0.4 were removed.

Cronbach's alpha coefficient was calculated to measure the internal consistency of the instrument with 0.70 specified as an acceptable level [16] and was found to be equal to 0.93 for the entire questionnaire. The alphas were also calculated separately for each factor as .954 for the first, .830 for the second, .793 for the third, .803 for the fourth, .774 for the fifth, .740 for the sixth and .547 for the seventh (Table 2).

The results were assessed and numbered in a descending order of the amount of variance to determine the underlying features. Each factor was subjectively labeled in accordance with sets of individual items. The first factor, *Management Commitment to Safety and personnel collaboration*, loaded on 23 variables and accounted for about 17.33% of the cumulative variance. The second factor, *Safety communication*, contained five items, accounted for about 6.97% of the total variance. The third factor, *Supportive environment*, had five items which accounted for about 6.245% of the variance. The fourth factor, *Work Environment*, had six items which accounted for about 5.590% of the variance. The fifth factor, *Formal Training*, had four items which accounted for about 4.581% of the variance. The sixth factor, *Priority of Safety*, had five items, which accounted for about 4.177% of the variance. The seventh factor, *Personal Priorities and Need for Safety*, had three items which accounted for about 3.333% of the variance.

Table 2: Factor loadings for a seven-factor safety climate model

Factors	α	Load factor
Factor 1: Management Commitment to Safety and Personnel Collaboration	**0.954**	
1. My company values in the workers the correct observation of safety rules and procedures		0.753
2. I believe that safety issues are not assigned a high priority		0.711
3. Management acts decisively when a safety concern is raised		0.693
4. Management and the workforce work together to tackle safety-related issues		0.677
5. In my workplace managers/supervisors show interest in my safety		0.664
6. In my workplace management turns a blind eye to safety issues		0.651
7. Management clearly considers the safety of employees of great importance		0.608
8. In my company, the results of incident and accident investigation are used to develop changes in work procedures according to solutions given by workers with the aim of improving safety		0.607
9. My company values the sincerity and participation of all workers in information collection about incidents and accidents		0.601
10. Management readily acts upon safety suggestions from staff		0.579
11. Managers and supervisors express concern if safety procedures are not adhered to		0.565
12. Safety is not a priority for my supervisor		0.563
13. Management acts only after accidents have occurred		0.549
14. I am supported in my work by my immediate supervisor		0.549
15. My company values the collaboration of all workers in the solution of problems related to work goal achievement		0.528
16. The company I work for does not learn from its incidents/accidents		0.526
17. In my company, the results of incident and accident investigation are used for the revision of previously set work goals to adapt these to specific situations		0.518
18. In my company, the results of incident and accident investigation are used for providing information to workers about non-observation of safety rules and procedures and for developing disciplinary procedures		0.518
19. I am strongly encouraged to report unsafe conditions		0.500
20. Accidents that happen here are always fully investigated		0.506
21. Frontline staff are involved in making safety-related decisions		0.478
22. My immediate superior shows me the safe way to do the task when I carry out an unsafe behavior.		0.453
23. In my company, the results of incident and accident investigation are used for the detection of training needs and training program development		0.435
Factor 2: Safety communication	**0.830**	
1. In my company, workers contribute with information about incidents and accidents from their experience in the work context		0.683
2. I am aware of the safe system of work before I start a job		0.590
3. Individuals receive sufficient training to enable them to work safely		0.584
4. Safety information is always brought to my attention by my line manager/supervisor		0.543
5. I have received sufficient training to understand the procedures/instructions/rules associated with my job.		0.531
Factor 3: Supportive environment	**0.793**	
1. I do not receive praise for working safely		0.668
2. Employees are not encouraged to raise safety concerns		0.657
3. Senior managers are rarely seen by the workforce.		0.610
4. There is a low level of trust between management and frontline staff		0.486
5. My line manager/supervisor does not always inform me of current concerns and issues		0.431
Factor 4: Work Environment	**0 .803**	
1. There are always enough people available to get the job done safely		0.694
2. Management operates an open door policy on safety issues		0.531
3. Safety procedures are carefully followed		0.471
4. This is a safer place to work than other companies I have worked for		0.462
5. The company puts sufficient resources into safety		0.461
6. My department cares about their workers' satisfaction with performance criteria, for example: clarity of job tasks, work rules and procedures		0.407
Factor 5: Formal Training	**0.774**	
1. There are frequent safeties training/briefing sessions that are useful/relevant to me		0.685
2. Discussions about safety at the briefings/meetings I attend are frank and open		0.638
3. The training I received covered the safety risks associated with my work		0.495
4. I have received training in the emergency procedures for my workplace		0.486
Factor 6: Priority of Safety	**0.740**	
1. Sometimes it is necessary to depart from safety requirements for production's sake		0.764
2. Some health and safety rules and procedures are not really practical		0.688
3. Sometimes conditions here hinder my ability to work safely		0.569
4. Sometimes I am not given enough time to get the job done safely		0.532
5. Operational targets often conflict with safety measures		0.477
Factor 7: Personal Priorities and Need for Safety	**0.547**	
1. I understand the safety rules for my job		0.663
2. It is important that there is a continuing emphasis on safety		0.640
3. I am clear about what my responsibilities are for health and safety		0.586

Discussion

The goal of the study was to develop a safety climate questionnaire in refinery context in Iran and to evaluate the dimensions depending on adequate levels of reliability. To develop a questionnaire we used the items introduced by Cox & Cheyne [10] and D´ıaz-Cabrera et al [11] and more items were added based on our experience. Then, a 61-item questionnaire was tested. Doing exploratory factor analysis on data resulted in removing 10 items. Remained items formed seven dimensions factor, as dominant constructs in the research filed, which demonstrated an acceptable internal consistency and were labeled as management commitment to safety and personnel collaboration, safety communication, supportive environment, work environment, formal training, priority of safety, personal priorities and need for safety.

Factor 1: Management Commitment to Safety and Personnel Collaboration

This factor alone consists of 23 items 8 by Cox et al, 8 by D´ıaz et al, and 7 by expert panel and explains more than 17% of the total variation in this factor analysis. Collectively, this group of items indicates the management manifestation of safety, mostly recognized via management reacting to accidents /incidents.

Workers' perception of management safety commitment is the strongest and prime factor in safety culture [4, 17, 18, 19]. Akiner and Tijhuis (2008) investigated cultural variables and managerial characteristics in construction industry and concluded that a successful changing of safety culture requires clear management commitment throughout the organizations [20].

In the present study, however, it seems personnel collaboration could affect workers' perception as a dominant impression about management safety commitment. It could be explained on the social character of the human being. In workplace, this characteristic may be expressed by personnel need to collaborate in decision making on safety. At CSIRO Minerals, Vecchio-Sadus & Griffiths (2004) found that employees are more likely to demonstrate commitment to safety culture if they are actively involved in making decisions [21]. In a Norwegian petroleum company Høivik, Moen, Mearns and Haukelid (2009) pointed that many informants frequently mentioned collaboration [22]. Besides, Bock, Zumud, Kim & Lee (2005) argued that one of the dimensions which can affect employee's subjective norm is human relationship [23].

Factor 2: Safety Communication

Safety communication consists of five items 1 by Cox et al, 1 by D´ıaz et al, and 3 by expert panel; and reflects workers' perceptions about aspects related to safety information exchange, provided for workers by managers/supervisors. This group of items demonstrated the workers' perception of mutual exchange of information about safety in their workplace.

There are authors that showed the importance of safety communication, too. For example, Vecchio-Sadus & Griffiths (2004) raised the issue that the best and most persuasive risk communication involves a combination of emotional and rational considerations [21]. Because, communication could result in a feeling that employee's contributions are recognized [24]. Törner (2011) expresses that social interaction and communication could be considered as main process tools for attaining and sustaining high-quality social relations at the workplace [25].

Factor 3: Supportive Environment

This factor has included five items 3 by Cox et al., and 2 by expert panel. The factor demonstrates the respondents' need to be seen by the higher authority within the organization.In elderly homes, Yeung & Chan (2012) revealed that supervisor and co-worker safety support as one factor in the structure of the dimensions [26]. Bayesian network analysis in a nuclear power plant [27] illustrated that a humanistic-encouraging culture distinguishes a participative and person-centered way in the organization.

Factor 4: Work Environment

This factor consists of six items 4 by Cox et al, 1 by D´ıaz et al, and 1 by expert panel and indicates the workers perception of the amount of available resources people, procedures and etc. that facilitate working safely. Cox & Cheyne (2000) introduced such a factor to specify the workers' perception of conflict of operational targets, availability of time, people and equipment related to safety and whole work environment safety [10]. In this study the same concept conveyed via the same term and included resources availability, policy, procedures related to safety and whole work environment safety, as well as, workers' satisfaction with performance criteria.

Factor 5: Safety Training

This factor consists of four items all by expert panel and explains workers perception of adequacy of safety training in format of formal briefings, meetings and so on within the company. This factor indicates workers' perception of all courses which are presented by the organization.

Krause & Hidley (1989) suggested that safety training can significantly improve an employee's safety related behavior [28]. Zohar (1980) emphasized on safety training as a main dimension of safety climate [29]. A number of studies, including Flin et al (2000) and Grote (2012) have mentioned this concept, too [18, 30].

Factor 6: Priority of Safety

This factor consists of five items all by Cox et al and tells about what workers feel about considering safety against operational goals, and indicates workers' perception about management priority of safety versus production goals in terms of allowed departure from safety requirements, ignoring rules in a condition of time pressure for production. This factor was one of the themes identified by Zohar (1980) [31]. Furthermore, Rundmo (2000) believes that this factor is the most significant predictor of acceptability of rule violations[31].

Factor 7: Personal Priorities and Need for Safety

This factor consists of three items all by Cox et al and indicates workers' concerns about safety. This factor indicates workers' perception of role in safety. We borrowed the name of this factor from Cox & Cheyne (2000) and accepted the same concept [10].

As mentioned before, no more safety climate questionnaires in refinery field were available. If so, it would not be unexpected to get more factors.

Conclusions

This study was conducted in a developing country. Considering the acceptable levels of reliability and validity measures of the safety climate scale developed, the results look encouraging and promising. Achievement of a valid and reliable safety climate tool may bring enormous benefits to the organization. Furthermore, the generic nature of the safety climate scale grants its use for other workplaces. It is, however recommended that its reliability and validity be reexamined.

Altogether, the concepts of these factors were in line with other safety culture studies. Thus, it would be inferred that the factors are mainly similar in different fields. For example, as mentioned before, nearly all safety climate/culture questionnaires refer to *Management Commitment to Safety* as the first factor. However, the number of questions may vary. In the present study, *Management Commitment to Safety* accompanied with *Personnel Collaboration* included almost half of the questions. It would be same for other factors. However, the importance of each factor possibly will differ from field to field.

As the questions which presented by expert team considerably manifested in this tool 17 out of 51 questions, we recommend qualitative researches in this area.

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Conflict of interest statement

The authors have no conflicts of interest in the research.

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References

1. Advisory Group of the International Atomic Energy Agency (IAEA). Safety culture. Report 75-INSAG-4. Vienna: International Nuclear Safety; 1991.
2. Itoh K, Andersen HB, Seki M. Track maintenance train operators? Attitudes to job, organization and management, and their correlation with accident/incident Rate. *Cogn Tech Work*. 2004;62:63-78.
3. Saari J. On strategies and methods in company safety work: from information to motivational strategies. *J Occup Acc.* 1990;12:107-118.
4. Guldenmund FW. The nature of safety culture: a review of theory and research. *Saf Sci*. 2000;34(1-3):215-257.
5. Yule S, O'Connor P, Flin R. Testing the structure of a generic safety climate survey instrument. The 5th Australian Industrial/Organisational Conference; June 26-June 29; Melbourne 2003.
6. Hudson P. Implementing a safety culture in a major multinational. *Saf Sci*. 2007;45:697-722.
7. Wang CH, Liu YJ. Omnidirectional safety culture analysis and discussion for railway industry. *Saf Sci.* 2012;50:1196-1204.
8. Vinodkumar MN, Bhasi M. Safety climate factors and its relationship with accidents and personal attributes in the chemical industry. *Saf Sci*. 2009;47:659-667.
9. Guldenmund FW. The use of questionnaires in safety culture research – an evaluation. *Saf Sci*. 2007;45:723-743.
10. Cox SJ, Cheyne AJT. Assessing safety culture in offshore environments. *Saf Sci*. 2000;34:111-129.
11. D´ıaz-Cabrera D, Hern´andez-Fernaud E, Isla-D´az R. An Evaluation of a new instrument to measure organizational safety culture values and practices. *Accid Anal Prev*, 2007;39:1202-1211.
12. Guillemin F, Bombardier C, Beaton D. Cross-cultural adaptation of health related quality of life measures: literature review and proposed guidelines. *J Clin Epidemiol.* 1993;43:1417-1432.
13. Brislin R.W. Back-translation for cross-cultural research. *J Cross-Cul. Psychol*. 1970;1:185-216.
14. Tabachnick B, Fidell L. *Using Multivariate Statistics*. 4th ed. New York: Harper Collins; 2001.
15. Hair JF, Black WC, Babin BJ, Tatham RL, Anderson RE. *Multivariate data analysis*. 6th ed. New Jersey: Prentice Hall, Upper Saddle River; 2006.
16. Bland J, Altman D. Statistics Notes: Cronbach's alpha. *BMJ*. 1997;314:570-572.
17. Mark BA, Hughes LC, Belyea M, Chang Y, Hofmann D, Jones CB, et al. Does safety climate moderate the influence of staffing adequacy and work conditions on nurse injuries? *J Saf Res*. 2007;384:431-446.
18. Flin R, Mearns K, O'Connor P, Bryden R. Measuring safety climate: identifying the common features. *Saf Sci*. 2000;34(1-3):177-192.
19. Kines P, Lappalainen J, Mikkelsen KL, Olsen E, Pousette A, Tharaldsen J, et al. Nordic safety climate questionnaire NOSACQ-50): A new tool for diagnosing occupational safety climate. *Int J Ind Ergon*. 2011;41:634-646.
20. Akiner I, Tijhuis W. Cultural variables and the link between managerial characteristics in construction industry: reflections from Turkish and Dutch examples. International Conference on Multi-National Construction Projects. Securing High Performance through Cultural Awareness and Dispute Avoidance; November 21- November 23; Shanghai 2008.
21. Vecchio-Sadus AM, Griffiths S. Marketing strategies for enhancing safety culture. *Saf sci*. 2004;42:601-619.
22. Høivik D, Moen BE, Mearns K, Haukelid K. An explorative study of health, safety and environment culture in a Norwegian petroleum company. *Saf Sci*. 2009;47:992-1001.
23. Bock GW, Zmud RW, Kim YG, Lee JN. Behavioral intention formation in knowledge sharing: examining the roles of extrinsic motivators, social-psychological forces, and organizational climate. *MIS*. 2005;29:87-111.
24. Summerill C, Pollard SJT, Smith JA. The role of organizational culture and leadership in water safety plan implementation for improved risk management. *Sci Total Environ*. 2010;408(20):4319-4327.
25. Törner M. The ''social-physiology'' of safety. An integrative approach to understanding organisational psychological mechanisms behind safety performance. *Saf Sci*. 2011;49:1262-1269.

26. Yeung K Ch, Chan Ch C. Measuring safety climate in elderly homes. *J Saf Res*. 2012;43:9-20.

27. Garcia-Herrero S, Mariscal MA, Gutiérrez JM, Bayesian network analysis of safety culture and organizational culture in a nuclear power plant. *Saf Sci*. 2013;53:82-95.

28. Krause TR., Hidley JH. Behaviorally based safety management: parallels with the quality improvement process. *Professional Safety*. 1989;3410:20-25.

29. Zohar D. Safety climate in industrial organizations: Theoretical and applied implications. *J Appl Psychol*. 1980;651:96-102.

30. Grote G. Safety management in different high-risk domains – All the same? *Saf Sci*. 2012;50:1983-1992.

31. Rundmo T. Safety climate, attitudes and risk perception in Norsk Hydro. *Saf Sci*. 2000;34:47-59.