ORIGINAL ARTICLE

Proposing a Customized Model of Safety Culture and Behavior in a Car Manufacturing Company

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This paper is available on-line at *http://ijoh.tums.ac.ir*

ABSTRACT

Work-related accidents and illnesses are a great concern in developed countries. Numerous researches have been performed to find an appropriate approach to decrease occupational accidents. This descriptive-analytical study was designed based on the retrospective and field studies to develop a customized model of the safety culture and identify the effective factors of safety culture in a car manufacturing company. In order to present a new customized model of safety culture questionnaire, the study was designed in three phases: 1) Proposing a customized model, 2) Constructing a validated questionnaire, and 3) Conducting a field study. A total number of 619 cases completed the questionnaire (321 injured and 298 uninjured people). Cronbach's alpha of the questionnaire was 0.855. The injured population noticeably acquired more points than the uninjured workers in all items of the questionnaire except for "safety rules and regulations"; though, this difference was statistically significant (P<0.05) only in the 7 items. The correlation between almost all of the safety culture components in the injured and uninjured workers was positive (P<0.05 P <0.001). Developing a customized model and questionnaire for a car manufacturing industry is an important finding of the present study. The results showed that the safety culture of the injured subjects was higher than those uninjured. Therefore, it can be stated that the occupational accident is the milestone for the evaluation of the safety culture.

KEYWORDS: *Customized model, Safety culture questionnaire, Car manufacturing, Occupational accident*

INTRODUCTION

Work-related accidents and illnesses, known as a concern in developed countries, lead to the inappropriate design of work systems [1]. Human beings are suffering from accidents in manufacturing and industrial companies. Occupational accidents are considered as the third reason of fatality in the world and second in Iran. They are also one of the most important socio-economic and health-related risk factors in both developed and developing countries [2]. In recent years, the automotive industries have grown considerably and according to statistics, production of 100,000 cars in 1994 reached to 1,000,000 cars in 2004. This dramatic increase was also about 100%

from 2011 to 2012 [3]. In addition, with the extensive progress in the Iranian automotive industry since the early 1990s, large funds were invested in the automotive spare parts industry [4]. Automotive industries have always been among the groups involving occupational accidents due to the use of heavy machines, task variety, pace of work, organizational climate, and policies [5-6]. The preceding studies showed that unsafe behavior, with a share of more than 70%, is the most important reason for occupational accidents [7]. Cullen et al. showed that 80-90% of workplace accidents and near-misses were related to unsafe behavior [8]. A practical approach to review and organize the causes of occupational accidents is the use of a safety culture model. The safety culture

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model provides an overview of the factors that cause the incident [9]. It would not be sufficient to assess the main causes of accidents, unless considering them in a comprehensive qualitative or quantitative model. In most of the safety culture models, the accident causes are classified into several main attributes, including but not limited to the environmental, individual, and behavioral factors [10-12]. According to some researchers and safety professionals, safety culture can be proposed using the internal and external factors [13].

Controlling the rate of accidents is highly important and the different models and studies have been conducted to find the main causes of such accidents. Therefore, this study was performed to provide a distinct customized model of the safety culture for an Iranian car manufacturing company.

MATERIALS AND METHODS

This descriptive-analytical field study was carried out retrospectively in 3 phases, including 1) Proposing a customized safety culture model, 2) Constructing a questionnaire for the assessment of safety culture, and 3) Conducting a field study using safety the prepared questionnaire (Fig. 1).

Phase 1: Proposing a customized model: A customized model of the occupational accident was presented in the first phase. In order to propose the model, the following steps were taken:

1) Reviewing the existing models related to safety culture and behavior and analyzing their items to provide a customized model of the safety culture: The models presented in the previous studies were compared with each other to identify their common components or attributes.

2) Determining the model variables: the details and/or common components of all models were identified and listed according to the experts' opinion using the focused group method.

3) Presenting a primary new model for behavior and safety culture by brainstorming sessions: The safety culture components were customized at the studied company by several brainstorming sessions with the participation of the expert members, and some items were added to the early components selected in the first phase from the literature reviews.
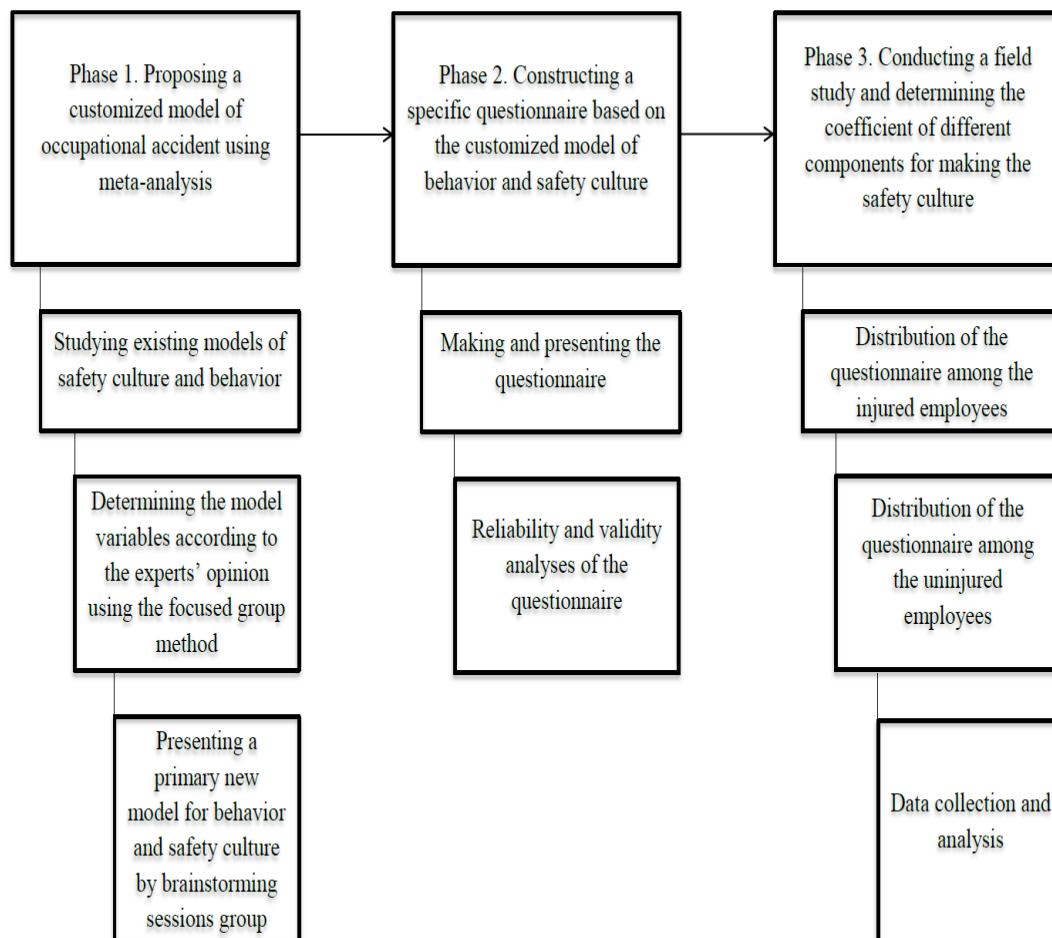

Fig. 1. Flowchart of the study procedures and steps

Phase 2: Constructing a distinct questionnaire: A specific questionnaire was prepared based on the proposed model of behavior and safety culture in the second phase including the following two steps:

1) Constructing and presenting the questionnaire: After identifying and customizing the safety culture components at the studied company, a specific questionnaire was provided by studying the existing questionnaires. According to the experts' opinions and based on the highest correlation between the selected components and questions, a total number of 2-3 questions were selected and customized for each safety culture component. After preparing the initial draft of the questionnaire, all of the proposed questions were analyzed and finalized in the expert panel meetings. To determine the relationship between the demographic characteristics and safety culture in the studied group, some necessary information, including age, marital status, education, birthplace, job tenure, job type, and workplace, were collected through a separate questionnaire.

2) Reliability and validity analyses of the questionnaire: For each question, the participants were required to choose their answer from the five options of Likert format as 1) completely disagree, 2) disagree, 3) no idea, 4) agree, and 5) completely agree.

Phase 3: Field study: In the final phase, a field study was conducted to determine the correlation between the different components of the constructed safety culture questionnaire. Two groups of injured and uninjured subjects were selected to determine the correlation between the different safety culture components at the company under study. The safety culture was compared between these groups. The adopted model could be a framework to improve the safety culture level at the company and prevent the occurrence of occupational accidents. The procedures of this phase are described as follows:

Distribution of the questionnaire among the injured employees: Accident statistics for the past six months due to unsafe actions were extracted and listed separately by the participants' place of work. Then, the HSE expert of the company placed the questionnaires at the disposal of the injured subjects to fill out and return.

Distribution of the questionnaire among the uninjured employees: In order to determine the role of personnel safety culture in accidents, the questionnaire was completed by the uninjured workers and the results were compared to that of those injured. Some personal characteristics of the injured subjects were adopted as the criteria for choosing the uninjured individuals. These characteristics were age, marital status, job experience, job type, and workplace.

Data collection and analysis: The data was analyzed using SPSS 21 software. The statistical tests were used to determine the influential factors of the safety culture and behavior at the car-manufacturing factory and to present a customized model for the safety culture.

RESULT

The components of the customized safety culture model at the studied company were divided into three categories of individual, management, and organizational factors. The components of each category are the components of the management system including participation, safety mind, communications and information exchange, leadership, safety education, safety laws, and regulations. The individual attributes included knowledge, motivation, attitude, lifestyle, competence, responsibility, expert knowledge, and skill. The attributes of the organizational factors were time and speed of production, equipment, technology, and sources.

According to the model, a 37-item questionnaire was designed using the data of 30 employees and distributed in the company. Cronbach's Alpha for the internal reliability of the questionnaire was estimated at 0.855. The validity of the questionnaire content was acceptable in terms of simplicity, comprehensibility, and necessity. It was analyzed using expert panel data as the HSE experts and as well as the research team members. Most of the participants were between 20 to 30 years old, with less than 6 years of job experience. They were mostly workers, non-Persian, married, non-smokers, with an active lifestyle and no illness history. Most of them had a high-school diploma. They were from Tehran City and its suburbs, but living in Karaj City and its suburbs. The participants were workers of the body making plant (i.e. welder and steelworks) at Pars Khodro (PK) Company.

Except for the above-mentioned demographic variables, some other variables were also considered, including job experience, workplace, sports, birthplace and living place. The number of participants was significantly different in the injured and uninjured groups. The linear regression was applied to compare the components of the safety culture in both groups. The results are shown in Table 1. The correlation between the safety culture components in the injured and uninjured groups was examined by Biuret and Partial Correlation tests. According to the finding, the injured group earned a higher score in all components of the safety culture except for the "safety laws and regulations" and there was a significant difference only in 7 components (P <0.05). The correlation between the safety culture components over the injured and uninjured subjects

and a combination of both groups confirmed a significant positive correlation between most of the components (<0.05 P <0.001). The lowest correlation (0.26) was found between the safety laws, regulations, and managerial factors and the highest correlation (0.94) was reported between the individual factors and the safety culture.

DISCUSSION

A safety culture model was assessed by the participation of HSE specialists as the expert panel. Then, the related attributes were developed in three main categories and finally, a 37-item questionnaire was developed. The Cronbach's Alpha coefficient of the questionnaire was obtained 0.855. In the study conducted by Mohammadi Zeidi entitled "the composition, validity, and reliability of the safety atmosphere", a 30-item questionnaire was designed, which was related to the seven components and the Cronbach's Alpha coefficient of the questionnaire was estimated at 0.77 [14]. In a study, Zeidi et al prepared a questionnaire of 37 questions, which was extracted from a questionnaire of 43 questions, to investigate the validity and reliability of the safety atmosphere questionnaire. It included 8 effective factors in safety culture with a Cronbach's Alpha of 0.82 and 0.87 for the two separate parts of the questionnaire, respectively [15]. In a study by Noori et al., the reliability of the safety culture was studied and 12 components were identified through 75 questions. After factor analysis, the questionnaire was

changed into a 70-item and the components were changed into 12 (the Cronbach's Alpha coefficient was 0.96) [16]. According to Coel, safety attitudes are the prelude to an accident. Attitudes have the most determining effects on behavior [17]. In the present study, the attitude had a significant relationship with all other components and was correlated to safety culture with a correlation coefficient of 0.65. As stated by Williamson et al., one of the necessary components to create programs for promoting safety behavior is the awareness of the safe atmosphere, which includes attitudes, perceptions, and knowledge on the employee's safety [18]. By evaluating this information in any workplace, it is possible to design a practical safety program. In addition, if people's attitudes, perceptions, and knowledge of safety are changed, useful information about the effectiveness of safety programs will be obtained [18]. In the present study, knowledge was also positively correlated with all components of culture with a correlation coefficient of was 0.71.

Huang, in another study, indicated that the management commitment to safety, a return to work policies, and safety training are among the important components of the safety atmosphere, which is positively effective in safety actions [19]. It was proved that the leadership and safety training were significantly related to all components, and their correlation coefficient with safety culture was about 0.06 (the safety training was not correlated with the safety regulations).

Table 1. Correlation between the injured and uninjured groups in terms of the safety culture components

| Safety culture attribute	Injured	Uninjured	P- value	Sig.
Participation	7.47(±1.45)	7.14(±1.54)	0.05<	0.002
Safety mind	9.65(±1.74)	9.52(±1.89)	0.05>	0.407
Communication and information exchange	10.78(±2.24)	10.23(±2.64)	0.05<	0.011
Leadership	7.8(±1.48)	7.47(±1.75)	0.05<	0.018
Safety education	7.73(±1.4)	7.39(±1.67)	0.05<	0.007
Safety laws and regulations	5.42(±1.43)	5.49(±1.62)	0.05>	.0698
Knowledge	11.01(±2.32)	10.42(±2.41)	0.05<	0.03
Motivation	7.23(±1.53)	7.03(±1.69)	0.05>	0.157
Attitude	12.63(±1.69)	11.85(±2.29)	0.05<	0.000
Life style	6.58(±1.94)	6.15(±1.95)	0.05<	0.012
Competence	5.31(±2.2)	5.15(±2.29)	0.05>	0.692
Responsibility	7.62(±1.45)	7(±1.75)	0.05<	0.000
Expert knowledge and skill	6.03(±1.67)	5.81(±1.74)	0.05>	0.41
Production speed and timing	5.95(±1.64)	6.06(±1.86)	0.05>	0.17
Equipment, facilities, and technology	9.73(±2.82)	9.43(±3)	0.05>	0. 416
Sources	6.67(±1.65)	6.25(±1.85)	0.05<	0.008
Management system	48.85(±5.99)	48.23(±7.23)	0.05<	0.002
Individual factors	56.41(±8.69)	53.4(±9.89)	0.05<	0.001
Organizational factors	22.35(±4.69)	21.74(±5.08)	0.05>	0.347
Safety culture	127.7(±16.86)	122.37(±19.87)	0.05<	0.002
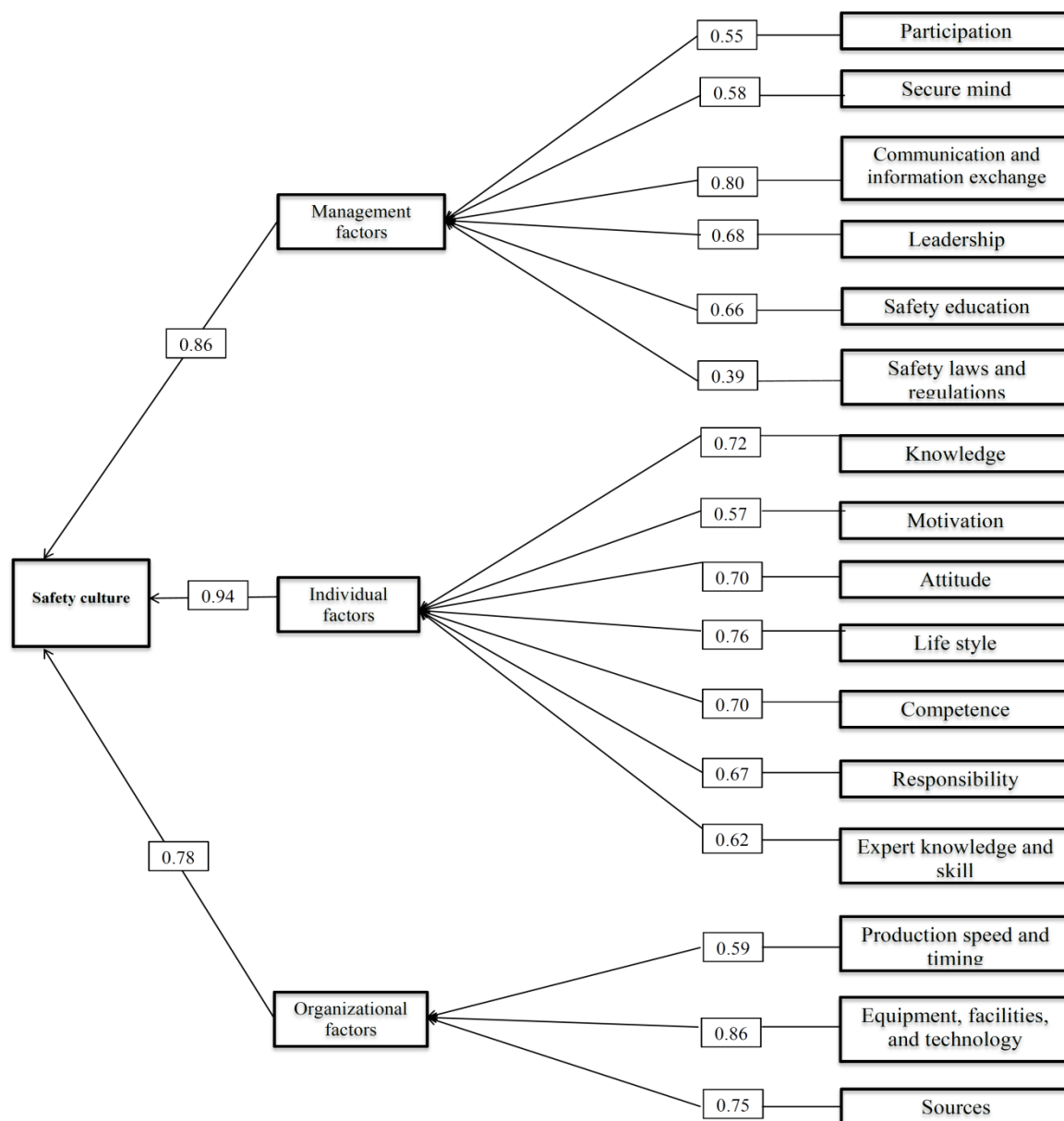
Fig. 2. Correlation between the injured and uninjured groups in terms of the safety culture components

According to the findings of the studies by the International Nuclear Safety Group (INSAG), it was shown that motivation has an effective role as a mediator in safe behavior [6]. Similarly, in the present study, motivation and acceptance are also positively related to all components. The correlation coefficient between safety culture and motivation and also responsibility were 0.53, and 0.63, respectively. Aeal et al., in their study on the employees of an Australian hospital, proved that there is a significant relationship between safety culture and the three variables of safety attitude, awareness, and acceptance [20]. In line with that study, a significant relationship was found between safety culture and the following variables in our study: safety culture and attitude (0.65), safety culture and awareness (0.71), and safety culture

and acceptance (0.63). This finding was contrary to the study by Varonen and Mattila. The results indicated that there is no significant relationship between safety attitude and factors determining the safety level at the company, including organization safety. Safety actions of the management, safety training, and risk identification. There was not found any significant correlation between safety attitudes and the accident rate [21]. However, according to the study by Siu et al., occupational damage may be predicted from safety attitudes and control measures may be planned. They found a relationship between the safety atmosphere (i.e. safety attitudes and relationships) and spiritual stress (i.e. occupational dissatisfaction and workload) and safety action (i.e. accident rate and occupational damage). Those with a negative safety

attitude were at higher risks of the workplace accident [22]. Noori in a study (2009) on the reliability of the safety culture questionnaire showed that the management committee, level of information exchange, training, workplace, and safety prioritization are among the main components of safety culture. All of them were in a positive correlation with safety culture and the correlation between management commitment and safety culture is the strongest [16]. In our study, the variables of leadership (management), training, and information exchange were positively correlated with the safety culture; the correlation between the information exchange and safety culture was stronger (0.71) than that between information exchange and training.

One major aspect of the present study is that it is not based on any translated questionnaires from similar domestic or international studies. Instead, an original safety culture questionnaire for the automotive industry was developed and validated in this study. Items such as serial assembly lines, complex technology, and numerous management levels were the questions, which were designed specifically for this industry.

Some limitations can be mentioned in this study. The samples were small and limited to one company. A larger sample from other car manufacturing companies is recommended for future study, and it would help better generalization of the model and the tool proposed in the present study. In this case, the reliability and validity of the questionnaire should be retested.

CONCLUSION

Proposing and using a customized model and questionnaire in the car manufacturing industry is a remarkable characteristic of the present study. Based on the results, the safety culture of the injured subjects was higher than those uninjured. Therefore, occupational accidents can be considered a milestone in assessing safety culture. In addition, attention to training is essential in promoting the culture of safety.

ACKNOWLEDGMENT

REFERENCES

1. Robinson GH. Accidents and sociotechnical systems: principles for design. *Accid Anal Prev* 1982; 14(2): 121-130.
2. Bentley TA, Haslam R. A comparison of safety practices used by managers of high and low accident rate postal delivery offices. *Saf Sci* 2001; 37(1): 19-37.
3. Jacobs G, Sayer I. Road accidents in developing countries. *Accid Anal Prev* 1983; 15(5): 337-353.
4. O'Toole M. The relationship between employees' perceptions of safety and organizational culture. *J Safety Res* 2002; 33(2): 231-243.
5. Clarke S. Contrasting perceptual, attitudinal and dispositional approaches to accident involvement in the workplace. *Saf Sci* 2006; 44(6): 537-550.
6. Griffin MA, Neal A. Perceptions of safety at work: a framework for linking safety climate to safety performance, knowledge, and motivation. *J Occup Health Psychol* 2000; 5(3): 347-58.
7. Hofmann DA, Stetzer A. A cross-level investigation of factors influencing unsafe behaviors and accidents. *Pers Psychol* 1996; 49(2): 307-339.
8. Cullen WD. *The public inquiry into the Piper Alpha disaster*. Department of Energy, Her Majesty's Stationery Office (HMSO), London, UK, 1990.
9. Mazloumi, A., Aziz Pour Marzi M, Garousi E, Yaseri M, Mehrdad R. Customization and validation study of WHO surgical safety checklist as a tool to control medical error in operation rooms in Iran. *Saf Health Work* 2018; 8(2): 135-148.
10. Cox S, Flin R. *Safety culture: philosopher's stone or man of straw? Work Stress* 1998; 12(3): 189-201.
11. Geller ES. *The psychology of safety handbook*. 2nd ed., CRC press, Boca Raton, Florida, United States, 2016.
12. Cooper MD. Towards a model of safety culture. *Saf Sci* 2000; 36(2): 111-136.
13. Von Thaden TL, Wiegmann DA, Mitchell AA, Sharma G, Zhang H. *Safety culture in a regional airline: results from a commercial aviation safety survey.* 12th International Symposium on Aviation Psychology, Dayton, Ohio, USA, 2003.
14. Mohammadi ZI, Heydarnia AR, Niknami S. Safety climate measurement at workplace: development, validity and reliability. *Payesh* 201; 10(2): 157-166.
15. Mohammadi Zeidi E, Farmanbar R, Hoseyni S. Assessment of psychometric properties (validity and reliability) of Safety Climate Questionnaire: factor analysis application. *J Guil Univ Med Sci* 2012; 21(81): 12-21.
16. Nouri Parkestani H, Alimohammadi I, Arghami Sh, Ghohari MR, Farshad AA. Assessment of reliability and validity of a new safety culture questionnaire. *Iran Occup Health* 2010; **7**(1): 0-3.
17. Coyle IR, Sleeman SD, Adams N. *Safety climate. J Safe Res* 1995; 26(4): 247-254.

18. Williamson AM, Feyer A-M, Cairns D. Biancotti D, The development of a measure of safety climate: the role of safety perceptions and attitudes. *Saf Sci* 1997; 25(1-3): 15-27.
19. Yueng-hsiang H, Ho MHC, Stewart Smith G, Chen PY. Safety climate and self-reported injury: Assessing the mediating role of employee safety control. *Accid Anal Prev* 2006; 38(3): 425-433.
20. Neal A, Griffin MA, Hart PM. The impact of organizational climate on safety climate and individual behavior. *Saf Sci* 2000; 34(1-3): 99-109.
21. Varonen U, Mattila M. The safety climate and its relationship to safety practices, safety of the work environment and occupational accidents in eight wood-processing companies. *Accid Anal Prev* 2000; 32(6): 761-769.
22. Siu O-l, Phillips DR, Leung T-w. Safety climate and safety performance among construction workers in Hong Kong: The role of psychological strains as mediators. Accid Anal Prev 2004; 36(3): 359-366.