

ORIGINAL ARTICLE

The Influence of Safety Training on Safety Climate Factors in a Construction Site

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ABSTRACT

Safety issues have always been put forward as one of the major problems and primary concerns in construction industries in many countries. This paper will focus on the impact of safety training on safety climate and its relevant factors in two sites of a construction firm. The Health and Safety Executive (HSE) guide to safety climate tool that had been validated in Iran was used to determine the impacts of safety training on safety climate and its relevant factors. For this purpose, 347 workers filled out the questionnaire before and after safety training. The relationships between demographic features of workers and safety climate factors were considered in the questionnaire. Spearman's rho test was used to determine the relationship between safety climate factors. In both sites, there were significant differences ($p < 0.05$) between safety climate factors before and after safety training while, the level of safety climate in both sites was the same before ($p = 0.416$) and after ($p = 0.547$) safety training. The results of Spearman's correlations test indicated that there has been a significant relationship ($p < 0.05$) between safety climate and its relevant factors in both sites. The results showed that some safety climate factors such as pressure for production had been influenced by demographic factors such as age and job category. Safety training can improve the level of safety climate and its relevant factors in a construction industry. Improvement of each safety climate factor can promote the level of safety climate. Demographic features affected safety climate level and its relevant factors.

Keywords: *Safety climate, Safety climate factors, Construction firm, Demographic feature*

INTRODUCTION

Construction industries had high accident rates due to the nature of the work, management system, equipment used in the process, techniques used to perform the tasks, speed of the work and other relevant

factors [1]. In spite of improvements in safety conditions at this industry, effective reduction in accident rates in some countries have not been significant [2]. Safety issues have always been put forward as one of the major problems and primary concerns in this industry in many countries [3]. The U.S. Center for Construction Research and Training in 2005 stated that construction industries had the fourth highest fatality rate after agricultural, mining and

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transportation industries [4]. The results of domestic studies in recent years indicated that 46% of fatal occupational accidents occurred in the construction industry showing that construction is a high risk industry in Iran [5]. Given the costs of occupational injuries and illnesses, the construction industry is considered as one of the most expensive industries. In 2005, 5% of the total employer costs in construction industries were paid for compensation of employees that was three times as high as the average paid by other industries [4]. Costs of accidents in these industries (classified according to insured and uninsured workers) showed that as much as 3% of the total project costs and approximately 10% of costs of labor are paid for accidents [6]. The fatal accident rates in construction industry were 11.1 accidents per 100,000 workers those approximately 3 times higher than fatal work injuries in other industries (4.2 accidents per 100,000 workers) [4].

The results of previous research showed that 85% of accidents were caused by unsafe acts in construction industries [7]. Fatal accident investigation reports indicated that safety culture or climate play an importance role in occurrence of accidents [8]. The most important issue that can be stated in accident occurrence is inadequate safety training in construction industries [9]. The results of Pinto et al study (2011) showed that lack of adequate knowledge concerning safety among senior and project managers and the poor safety culture was the main cause of poor safety performance [10]. Occupational health and safety studies revealed that the root of 85-95% of accidents is caused by unsafe acts were poor safety culture [11]. A positive safety climate is one of the most important issues at the workplaces [12]. Safety climate has an impact on workers belief and behaviors in workplaces [13]. Safety climate was composed of several factors that directly involved in the relationship with each other. According to the Health and Safety Executive, these factors include factor 1: management commitment, factor 2: safety training, factor 3: safety communications, factor 4: pressure for production, factor 5: safety improvements, factor 6: employee involvement in safety, factor 7: work permit system, factor 8: safety rules, factor 9: encouraging raising safety issues, factor 10: safety committees and factor 11: safety rule breaking [7].

The results of Cooper and Phillips study in 2004 indicated that safety training can promote workers safety behaviors. Their results also showed that safety training has a significant effect on workers safety perception and safety perception has a direct relationship with safety climate [14]. Safety climate as a key element largely affects workers' performance. Assessing the workers' performance provides a method by which organizations can examine the safety perception of their employees [15]. Accident rates and compensation costs could be suitable measures to

evaluate the safety performance [14]. Organizational climate is a multidimensional tool that helps workers to evaluate their workplaces [16].

Adequate training of personnel in the construction industry is expected to increase their perception of safety at workplaces. In recent years, there has been interest in improving the safety training in workplaces to increase employee motivation, awareness and safety performance in construction industries. The purpose of this paper is to assess the impact of safety training on safety climate factors in two sites of a construction firm.

MATERIALS AND METHODS

Study Population

This cross-sectional study was conducted in two sites of Kayson Construction Company in 2010. The main differences between site No.1 and 2 are the type of contractor companies, contract types and location of sites. The subjects were selected from 1500 workers of the executive management team, technical workers and service workers. According to Morgan table, 347 workers were selected. All selected subjects met the required entering criteria including one year work experience at the sites and consent to participation in this study. Among those selected, 168 subjects worked in site No 1 and 179 workers in site No 2.

Safety Climate Questionnaire

The guide to safety climate tool recommended by UK Health and Safety Executive (HSE) was used to assess the safety climate at the studied sites. This tool consists of 43 items, which is made up of 11 safety climate factors. The tool includes a comprehensive set of questions which are used to assess the safety climate. This tool was validated in Iran [7, 17]. Each question is scored from 1 to 5 and high scores represent high levels of safety climate. Confirmatory factor analysis was used to determine the importance of each factor as well as it was done in previous studies [7, 14]. This questionnaire was filled out before (pre-test) and after training program (post-test). Content of training courses, the number of training sessions and overall time required for training provided based on the results of risk assessment, the rate of accidents and the results of pre-test. Training courses were established based on each worksite requirements and job demands. Specific information for training was collected from relevant books and instructions before pre-test. Available training techniques (such as; lecturing, brain storming, group discussion, etc.) and equipment were reviewed and considered. Furthermore, risk assessment and the determining rate of accidents were accomplished using existent data and reports. The content of the training courses was organized and prepared after analyzing pre-test data. For this purpose, the frequency of responses to all 43 items in safety questionnaire was determined. The items with poor status were focused in educational

Table 1. Mean and standard deviation scores for safety climate factors

Factors	Before training		After training	
	Site No 1	Site No 2	Site No 1	Site No 2
Management commitment	3.598± 0.598	3.512± 0.630	3.927± 0.576	4.105± 0.525
Training	3.724± 0.708	3.348± 0.588	4.231± 0.680	3.926± 0.667
Communications	3.305±0.705	3.024± 0.739	3.856± 0.691	3.639± 0.555
Pressure for production	3.522± 0.577	3.369± 0.645	3.762± 0.565	3.386± 0.426
Safety improvements	2.922± 0.616	2.711±0.636	3.081± 0.622	2.876±0.504
Employee involvement	3.426± 0.832	3.254± 0.813	3.951±0.792	3.876± 0.790
Permit to work system	3.108± 0.851	2.827± 0.868	3.470± 0.844	3.310± 0.867
Safety rules	3.038± 0.596	2.970± 0.660	3.628± 0.602	3.482± 0.532
Encouraging to raise safety	3.217± 1.083	2.506± 1.128	3.334± 1.066	2.502± 1.230
Safety committees	3.568± 0.844	3.573± 0.859	3.799± 0.855	3.590± 0.886
Rule breaking	2.615± 0.566	2.547± 0.493	3.216± 0.577	3.150± 0.453

sessions. For example, based on pre-test data only 49 of 100 individuals were agree that “managers encourage personnel for improving safety”, thus in a session with managers this issue was highlighted and they were asked for encouraging and reinforcement of personnel. As another instance, unfortunately only 28 of 100 workers mentioned that this is not related to them that others eliminate safety rules. Thus, negative consequences of this perceptions as well as the responsibility of each individual were explained for workers at a training session. Finally, the content of the training courses was organized. Nine safety training courses each lasting from 0.5-2 hours were carried out during summer 2010. Training persistency was evaluated 45 days after the training.

The present study examined the relationships between the demographic characteristics of workers and the safety climate factors considered in the questionnaire. Age, marital status and education, employment, job category, contractor companies, contract types and job experience were considered in this study. One-way ANOVA, paired *t*-test and independent *t*- test were used to statistically analyze the impact of training on safety climate factors. The Spearman's rho test was used to determine the relationship between safety climate factors. To study the relationship between safety climate factors and accident rates before safety training reflected in the questionnaire items, workers based on event rates divided into two groups: workers with low accident rate and workers

Table 2. The *P* of comparing the mean scores of safety climate factors

The <i>p</i> -values of paired <i>t</i> -test	Before and after training	
	1	2
Management commitment	0.031	0.022
Training	0.024	0.016
Communications	0.003	0.001
Pressure for production	0.734	0.628
Safety improvements	0.058	0.075
Employee involvement	0.002	0.003
Permit to work system	0.046	0.042
Safety rules	0.015	0.002
Encouraging to raise safety	0.240	0.261
Safety committees	0.216	0.362
Rule breaking	0.021	0.006

Table 3. The relationship between safety climate factors and demographic features

Factors	Age group		Marital status		Job category		Contractor companies		Contract types	
	Before	After	Before	After	Before	After	Before	After	Before	After
	(p)		(p)		(p)		(p)		(p)	
Management commitment	0.443	0.446	0.359	0.537	0.091	0.005	0.505	0.278	0.138	0.028
Training	0.053	0.031	0.688	0.002	0.130	0.018	0.183	0.210	0.083	0.002
Communications			0.501	0.481	0.219	0.012	0.142	0.148	0.694	0.320
Pressure for production	0.002	0.004	0.649	0.471	0.001	0.001	0.104	0.176	0.734	0.378
Employee involvement	0.074	0.018	0.392	0.428	0.064	0.001	0.661	0.444	0.108	0.003
Permit to work system	0.287	0.606	0.258	0.211	0.786	0.412	0.063	0.029	0.209	0.008
Encouraging to raise safety	< 0.05	<0.05	0.242	0.320	< 0.05	0.002	0.827	0.894	0.124	0.137
Safety committees	0.713	0.615	0.352	0.261	0.013	0.009	0.081	0.007	0.317	0.421
Rule breaking	0.027	0.01	0.432	0.019	0.077	0.058	0.341	< 0.05	0.088	0.189

with high accident rate. Workers with low accident rate have 1 event or no event in 2010 (246 worker) and workers with high accident rates had more than 1 event in 2010 (101 worker). The Spearman's rho test was used to determine the relationship between safety climate factors and accident rates.

RESULTS

Comparison of Safety Climate Factor in Construction Firm

The mean and standard deviation scores of different safety climate factors of each studied sites before and after training are presented in Table 1. In site No 1,

safety training with 3.724±0.708 points had the highest score and safety rule breaking with 2.615±0.566 points got the least score before safety training. After training in this site, safety training with 4.231±0.680 points had the highest score and safety improvement factor with 3.081±0.622 points showed the least score. In site No.2, safety committees with 3.573±0.859 points got the highest score and encouraging raising safety issues with 2.506±1.128 points showed the least score before safety training. After training at site No 2, management commitment with 4.105±0.522 points had the highest score from the total of 5 scores and the lowest score were found for encouraging raising safety issues with

Table 4. The relationship between safety climate and its relevant factors in site No.1

Climate factors	2	3	4	5	6	7	8	9	10	11
Management commitment	**0.454	**0.403	**0.356	**0.466	**0.312	**0.237	**0.201	*0.175	**0.201	** -0.232
Training		**0.404	**0.414	*0.367	**0.477	*0.450	*0.468	0.254	**0.312	** -0.528
Communications			**0.351	**0.450	**0.563	0.040	**0.357	0.073	**0.260	** -0.390
Pressure for production				**0.227	**0.214	-0.186	0.021	**0.123	0.340	**0.259
Safety improvements					0.036	*0.368	*0.347	-0.066	0.103	0.089
Employee involvement						**0.282	**0.151	0.458	0.434	** -0.508
Permit to work system							** -0.295	0.204	**0.221	** -0.385
Safety rules								-0.244	-0.061	** -0.154
Encouraging to raise safety									0.391	** -0.226
Safety committees										* -0.331
Rule breaking										1

*Correlation is significant at the 5% level
 **Correlation is significant at the 1% level

Table 5. The relationship between safety climate and its relevant factors in site No.2

Climate factors	2	3	4	5	6	7	8	9	10	11
Management commitment	**0.418	**0.413	**0.381	**0.429	**0.344	**0.237	**0.199	*0.175	**0.299	**0.238
Training		**0.412	**0.420	*0.377	**0.456	*0.444	*0.468	0.245	**0.316	**0.499
Communications			**0.371	**0.499	**0.535	0.040	**0.338	0.084	**0.289	**0.379
Pressure for production				**0.211	**0.221	-0.154	0.276	**0.111	0.331	**0.270
Safety improvements					0.103	*0.345	*0.340	-0.015	0.029	0.098
Employee involvement						**0.265	**0.144	0.058	0.133	**0.508
Permit to work system							**0.257	0.319	**0.224	**0.374
Safety rules								-0.244	-0.061	**0.161
Encouraging to raise safety									0.195	**0.199
Safety committees										*0.328
Rule breaking										1

*Correlation is significant at the 5% level

**Correlation is significant at the 1% level

2.502±1.230 points.

The comparison of mean scores for safety climate factors in site No 1 and No 2 before and after training indicated that there were significant differences between safety climate factors such as management commitment, safety training, safety communications, and employee involvement in safety, safety rules, safety rule breaking and work permit system before and after training. These differences are presented in Table 2. The level of safety climate in both site was the same before ($p = 0.416$) and after ($p = 0.547$) training and no significant differences was found.

Safety Climate Factors and Demographic Features

The results indicated that there was a significant relationship between some safety climate factors and demographic features before and after the application of safety training (Table 3). Pressure for production has been influenced by demographic factors such as age and job category.

Correlation between Safety Climate and its Relevant Factors after Safety Training

Spearman's correlations test results showed that there has been a significant relationship between safety climate and its relevant factors in site No.1 of construction firm. As can be seen from the Table 4, management commitment has positive correlation at the 1% level with other safety climate factors except rule breaking factor.

In site No.2, the results of Spearman's correlations test indicated that there was a significant relationship between the safety climate and its relevant factors. Table 5 shows that the rule breaking factor has not

positive correlation at the 1% level with management commitment.

Safety Climate Factors and Accident Rates before Safety Training

As shown in Fig.1, no significant differences were found between safety climate factors and accident rates before safety training in workers with low accident rate (246 worker) and workers with high accident rates in 2010.

DISCUSSION

In this investigation, the aim was to assess the impact of safety training on safety climate factors in two sites of a construction firm. The total score for the safety climate factors in site No.1 and 2 of the studied construction firm were 36.043 and 33.641 respectively. Safety climate levels for two sites were the same before the safety training which shows a homogeneous and no significant difference in safety climate level in two sites. After the safety training, the total value of safety climate scores of site No.1 and No.2 increased. The comparison of safety climate scores in site No.1 before and after safety training showed a significant increase in safety climate scores and safety climate promotion caused by safety training. The same result was found for site No.2. This study produced results which are compatible with the findings of a great deal of the previous work in this field. The results of this study and some previous studies revealed that safety training can improve workers safety behaviors and the effective safety training programs can change workers unsafe behaviors [14, 18].

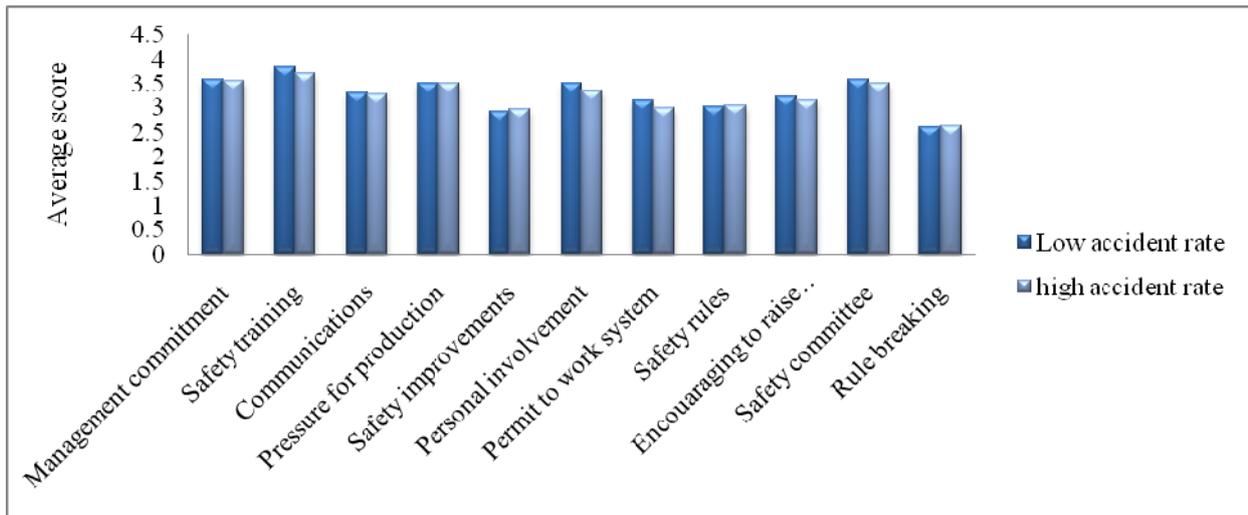


Fig 1. The relationship between safety climate factors and accident rates

A comparison of mean scores of safety climate factors in both sites showed that the scores of some safety climate factors including management commitment, safety training, and safety communications, employee involvement in safety, permit system, safety rules and rule breaking were increased remarkably after safety training. The result of Glendon et al. (2007) indicated that safety training has an impact on safety climate factors as a special feature of organizational climate and safety climate has an effect on workers' perceptions of job safety [19]. The findings of the current study are consistent with those of Kiani et al. (2012) who found that some safety climate factors such as management commitment and safety communications were improved after safety training [20].

The correlation between the safety climate factors and demographic characteristic showed that some safety climate factors such as pressure for production correlate with some demographic characteristics including age and job category before and after safety training. The results also showed that older workers believe that the organization encourage workers to promote the safety rules in work environments. Table 3 indicates that there was a relationship between age and rule breaking factor. It means that older workers have less safety rule breaking than younger workers. Investigating the relationship between age and training factors showed that experienced workers obtained more knowledge from the safety training. Previous studies reported the relationship between age and some safety climate factors [21]. The findings also indicated that there was not a significant relationship between marital statuses before safety training although a significant relationship was reported after safety training. Vosoughi (2011) and Heidari (2007) studies also did not report any significant relationship [22- 23].

There was a significant relationship between job category and some safety climate factors including pressure for production, encouraging raising safety issues and safety committees. It is encouraging to compare this figure with that found by Vinodkumar (2009) who reported a significant relationship between job categories and some safety climate factors such as management commitments and priority for safety over production [21]. The contractor company had an effect on some safety climate factors including permit system, safety committees and safety rules breaking after safety training. Contract types had an impact on training factor and employee involvement in safety after safety training. The results of the present study are consistent with those of Tharaldsen and et al. [24].

The investigation of the relationship between safety climate factors found a significant positive correlation between most safety climate factors. The observed positive correlation between safety climate factors might be explained by the fact that improvement in safety climate factors can improve the level of safety climate in site No.1 and 2. Also, improvement of one factor may be promoting the other safety climate factors [7].

Several studies in recent years have emphasized that the nature of the organizations affect safety climate factors and accident rates. Perception of safety climate and its related factors may reduce accident rates in work environments [25]. In this study no significant differences in accident rates were found between safety climate factors and the workers with low and high accident rates. The organization and workers in sites No.1 and 2 were not aware of the specific role of safety climate and its relevant factors in their workplaces. These results were not according to the results of the studies that accepted the safety climate as a subset of a safety culture in their organizations [26]. However,

these findings are limited by the use of a cross sectional design and the use of different staff members to conduct the training sessions.

CONCLUSION

Safety climate as a special subject of the safety culture focuses on safety and health issues in work environments. Safety training can improve the level of safety climate and its relevant factors in construction sites. Demographic features had effect on safety climate and its relevant factors in organizations. Improvement in safety climate factors can promote the level of safety climate in the studied sites.

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