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Relationship between safety climate and workplace indices and accidents: a case study in a petrochemical industry

Behzad Fouladi Dehaghi[1,2], Davood Rahmani[3], Zinab Mosavian[2], Leila Ibrahimi Ghavamabadi[3*]

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[1]Environmental Technologies Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran; [2]Department of Occupational Health, Health Faculty, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran; [3]Department of Environmental management-HSE, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.

Correspondence:
Leila Ibrahimi Gavamabadi. Department of Environmental management-HSE, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.
Email: leilaebrahimy@yahoo.com

ABSTRACT

Introduction: Safety climate is one of the most important indicators for evaluating the performance of safety management and occupational health in the workplace. The aim of this study was to evaluate the influencing indicators of workplace on safety climate and the incidence of accidents in a petrochemical industry.

Methods: This cross-sectional study was conducted in one of the petrochemical industries in Khuzestan Province, Iran in 2017. All operational staff of the petrochemical industry (N=354) were included in the study based on census sampling. Safety climate was evaluated using the Petroleum Safety Authorities (PSA) 2006.

Results: All participants were male. Work experience was 2-5 years in 27.4% of the participants. No significant relationship was observed between safety climate and accidents in workplace ($P > 0.05$). There was a significant relationship between disease symptom, physical workplace, psychological factors, safety climate and accidents and occupation group ($P < 0.001$), education and work experience ($P < 0.01$). No significant relationship was found between age and safety climate ($P > 0.05$).

Conclusion: The findings of this study showed that "workers' negative attitude toward management commitment", "workplace physical factors" and "occupational disease" influenced the incidence of work related accidents. These factors indicate that industrial management commitment to provide a safe climate is necessary to prevent work related accidents and diseases in petrochemical industry.

Introduction

The rapid pace of industrialization and neglecting industrial safety principles result in the increased rate of work-related accidents in developing countries (1). Despite the importance of health and the expansion of health and safety improvement programs, work related hazards and accidents are increasing in the process of industrialization and inclusion of new technologies. Regarding the importance of this issue, many programs have been suggested by safety and occupational health associations and various industries in order to improve safety and occupational health and preventing accidents (2). So far, industry managers have found out that one of the most important factors in the improvement of productivity and technology transfer and development is occupational safety. Based on the point of view of many managers in developed countries, occupational safety is considered as an investment with high return of profits both in economic and humanitarian aspects (3). Therefore, management system has always tried to reduce accidents, injuries and diseases as well as their indirect costs (4). Safety and occupational health are the vital tools that help managers reach important goals, including production increase, cost reduction and improving organizational image, through prevention and reduction of work-related accidents (5). Recent studies have determined the role of organization factors, including workplace factors and management commitment, in the incidence of work-related accidents (6). Similar to other psychological and social and humanity indicators, safety culture and the resultant safety climate in the workplace have a strong tie with workers behaviors (7). Safety climate is a transient indicator of safety culture and is considered as a common impression of the individuals in the organization. Safety climate is time and location dependent and is defined as the perceived condition of safety in a specific location and time. Safety climate is proportionally unstable and changes in relation to the new environment or dominant conditions (8). The concept of safety climate was first described in 1980 as a multidimensional factor that has an important role in workplace safety. Thereafter, especially

after the Chernobyl event, many studies were performed on the evaluation of safety climate and its influencing factors. Careful assessment of safety climate can be effective in the detecting and assessment of potential work-related issues and increasing workers' productivity and reducing accidents (9, 10). The importance of research and evaluation of workers' perception about safety can be assessed from various literature. The reasons for the importance of workers' perception towards safety include; 1) It is an important indicator of safety performance and an antecedent for work-related accidents. Identifying and assessing the influencing factors on safety climate can be helpful in reducing work-related accidents. 2) It provides useful information on identifying safety issues prior to accidents event. 3) Compared to other accident preventing techniques, evaluation and analysis of workers perception in terms of safety is less costly. 4) Safety climate can provide useful information regarding workers' perception about safety management (11). On the other hand, identifying the level of safety climate, as an important cause of work-related accidents, can have an important effect on the management of accidents' risk and workplace hazards. Studies have shown that workers' perception about "Safety climate" affects the reoccurrence of accidents (12, 13). The findings of the previous studies have shown a significant relationship between safety climate and safety behaviors of the employee's and the rate of work-related accidents (14). Evaluation of safety climate can be effective in identification of the weakness of organizational safety and health programs in reducing work-related accidents. Therefore, the aim of this study was to assess the relationship between safety climate and work-related accidents in one of the petrochemical industries in Khuzestan Province, Iran in 2017.

Methods

This cross-sectional study was conducted on the workers of a petrochemical industry in Iran in 2017. Assessment of the safety climate was performed using the Petroleum Safety Authorities (PSA) 2006 (16). The Cronbach's alpha for the questionnaire was 0.85. All the petrochemical workers (N=354) were included in the study based on census sampling. The study aims were declared to the workers prior to the study and workers were free to participate in the study or leave it. All questionnaires were filled anonymously. The study questionnaire included 72 items in three indicators, including disease symptom indicators, safety climate and workplace characteristics. The questionnaires were filled in a semi-supervised manner. The three mentioned indicators cover 12 dimensions all together. Disease symptom indicator comprised 3 dimensions, safety climate comprised 5 dimensions and workplace characteristics comprised 4 dimensions. In this study, 4-, 5- and 6-point scales were used for the assessment of the questionnaire items (16). Safety climate was categorized based on the cutoff score of 144.5 in a way that negative safety climate was defined as scores less than 144.5, while positive safety climate was defined as scores higher than 144.5. The finally collected questionnaires from 354 workers were entered in the statistical package for social sciences (SPSS) software version 19 in order to be analyzed. Data was analyzed using descriptive statistics, including percentage, and mean, and analytical statistics, including multiple analysis of variance (MANOVA) and t-test.

Results

All participants were male and the education level of more than 32% of the participants was under graduate. Table 1 shows the demographic characteristics of the participants (Table 1). The mean safety climate score for the workers regarding accident and employment status is shown in Table 2. The mean safety climate score among workers with a history of accident was 164.41, while it was 161.72 among workers without previous history of accidents. Regarding the employment status, workers who had fixed job had higher safety climate scores compared to the contract workers 166.21 and 159.97 respectively (Table 2).

Table 1. Demographic characteristics of the research participants

Demographic characteristics	Subgroup	Percentage of workers in each group
Employment status	Fixed job	38.7
	Temporary job	61.3
Education	Illiterate	26
	High school	32.7
	Associate Degree	9.3
	Bachelor's degree and higher	32
Work Experience	Under 1 year	2.7
	2-5 year	24.7
	6-10 year	3.37
	11-20 year	32
	More than 21 year	3.3
Accident History	With accident history	24.7
	Without accident history	75.3
Age	20-30 year	7
	30-40 year	35
	40-50 year	55
	50-60 year	3

Table 2. Average safety climate score by type of employment and accident history

Factors	With accident		Without accident		P-value
	Mean	SD	Mean	SD	
Musculoskeletal Pains	11.08	2.84	11.88	2.61	0.11
Allergic reactions	6.19	1.54	6.61	1.53	0.15
Hearing impairment	6.95	1.98	6.43	1.66	0.14
Physical factors	15.14	5.06	18.43	5.77	0.001*
Work Environment Support	15.73	4.97	15.72	4.81	0.98
Job controls	11.03	3.00	10.73	2.69	0.56
Positive changes in work	6.22	1.70	5.76	2.12	0.23
Management commitment	20.57	5.24	22.22	4.42	0.04*
Safety system	39.27	6.665	39.01	6.224	0.828
Level of risk	33.54	7.57	29.87	10.609	0.053
Work pressure	29.43	4.004	29.81	3.644	0.59
Work Competency	41.59	4.646	40.81	4.989	0.397

*significant at $P < 0.05$

There was a significant positive relationship between safety climate subscales, including management commitment (P=0.04) and workload (P=0.59) and accidents. Based on the data presented in Table 3, there was a significant difference between workers with and without history of accidents only in the workplace characteristics subscale (Table 3).

Table 3. T-test results for people with an accident and without an accident

Factors	With accident		Without accident		P-value
	Mean	SD	Mean	SD	
Musculoskeletal Pains	11.08	2.84	11.88	2.61	0.11
Allergic reactions	6.19	1.54	6.61	1.53	0.15
Hearing impairment	6.95	1.98	6.43	1.66	0.14
Physical factors	15.14	5.06	18.43	5.77	0.001*
Work Environment Support	15.73	4.97	15.72	4.81	0.98
Job controls	11.03	3.00	10.73	2.69	0.56
Positive changes in work	6.22	1.70	5.76	2.12	0.23
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*significant at P < 0.05

Table 4. MANOVA analysis about the effects of occupational groups, education, age and work experience on health, safety, work and accident variables

Dependent variable	λ-calculus	F-tests	Degrees of freedom	P
Working Groups	0.376	2.962	50	0.001*
Symptoms of diseases		2.208	10	0.021*
Workplace Physical Factor		11.193	10	0.001*
Workplace psychological factor		0.092	10	0.373
Safety Climate of workplace		0.576	10	0.831
Accident		2.154	10	0.024*
Education	0.803	2.17	15	0.007*
Symptoms of diseases		0.465	3	
Workplace Physical Factor		4.421	3	0.005*
Workplace psychological factor		2.305	3	0.079*
Safety Climate of workplace		0.51	3	0.676
Accident		1.574	3	0.198
Work experience	0.788	2.358	15	0.003*
Symptoms of diseases		1.201	3	0.312
Workplace Physical Factor		2.849	3	0.04*
Workplace psychological factor		1.727	3	0.164
Safety Climate of workplace		0.85	3	0.468
Accident		0.887	3	0.45
Age	0.888	1.15	15	0.309
Symptoms of diseases		1.638	3	0.183
Workplace Physical Factor		1.064	3	0.366
Workplace psychological factor		0.905	3	0.44
Safety Climate of workplace		1.336	3	0.265
Accident		0.223	3	0.88

*significant at P < 0.05

The Wilk's Lambda for occupation grouping factor was 0.376 with the probability of P < 0.001. The linear combination for dependent variables for various occupation categories were significantly different. This indicates a significant difference in disease symptoms, workplace characteristics and accidents between occupation categories with the F value of 2.208, 11.193 and 2.154 respectively. The MANOVA test results for the evaluation of a significant difference between education level in the perception of disease symptoms, with workplace physical and psychological characteristics, safety climate and accidents as dependent variables and education level as fixed variable, are presented in Table 4. The findings revealed a significant difference in workplace characteristics between different education levels (F=4.421). The results of MANOVA test for the assessment of a significant difference in perception of disease symptoms, workplace physical and psychological characteristics, safety climate, and accidents are presented in Table 4. The findings indicated a significant difference in workplace physical characteristics between work experience groups (F=2.849). The MANOVA test revealed no significant difference in terms of perception of disease symptoms, workplace physical and psychological characteristics, safety climate and accidents between age groups (Table 4).

Discussion

Safety climate in the workplace is the result of attitudes and personal and group benefits, credibility and behavioral patterns. The identification of the weak points of safety climate can be used to implement interventions (17). As previously indicated, the aim of this study was to assess the relationship between safety climate and workplace indicators and the incidence rate of work-related accidents. The results of the analysis of different dimensions of safety climate, hazardous workplace factors and occupational diseases indicated that the workplace physical dimension was significantly different between workers with and without history of accidents. The mean score for workplace physical characteristic was lower in workers with the history of accidents compared to those without the history of accidents. Furthermore, workers with the history of accident had higher dissatisfaction from workplace physical characteristics. Regarding the existence of hazardous physical and chemical factors in workplace and the climate condition of the study location, the score of the workplace physical characteristics was very low in this study. This finding indicates workers' dissatisfaction about physical characteristics of the workplace. The findings of the study by Bjerkan supports the results of this study (16). Data analysis revealed that perception of the disease symptoms was different among workers with the history of accidents compared to workers without history of accidents. The disease symptoms scores, including musculoskeletal pain,

allergic reactions and acoustic injury was higher in workers with the history of accidents. In other words, workers with the history of accidents reported higher rates of work-related diseases. Other studies have also shown that different dimensions of work and perception regarding the workplace can have a negative effect on workers' health and wellbeing (18, 19). The mean score for safety climate questionnaire was 144.5 in this study. This finding indicated a positive safety climate in the organization. Among the dimensions of safety climate, management commitment had the lowest score. Workers' perspective regarding management commitment was different between workers with the history of accidents and those without the history of accidents in the past three years. Workers with the history of accidents had a more negative perspective towards management commitment. In the study by Jafari et al. management commitment toward safety was found to be an important factor that can affect other safety climate factors and improve the mean score for safety climate (20). The findings of the current study were in line with the findings of other studies that focused on the idea that management commitment is effective in the management commitment towards safety (11, 21-23). Regarding the risk perception, differences between workers with and without history of accident were close to statistical significance. This indicates that workers with the history of accidents considered their workplace hazards to be more negligible and with less consequences compared to those without the history of accidents. Therefore, this finding indicates that workers with the history of accidents are still vulnerable to work-related accidents due to neglecting workplace hazards. Similar findings were reported by Lee, and Williamson et al. (24, 25). Regarding workload or production, competency, safety system, positive changes in work, controls other than the occupation, and supportive environment, no significant relationship was found between these factors and the probability and mean scores among workers with or without history of accidents. Furthermore, there was no significant different in the subscales between workers with and without history of accidents (26). This deduction was also supported by the findings of the study by Chin et al (27). In the study by Hoffman et al. workload was related to reduce safety level at workplace (28). Clarke et al. also reported that stressful factors in workplace, including the working pace, were related to increased work-related accidents (29). The findings of this study revealed that the linear combination for disease symptoms, workplace physical and psychological characteristics, safety climate and accident were significantly related to education level and work experience but these factors were not significantly related to age. Different studies have reported the important role of personal characteristics, including skills, and workplace factors in the incidence of work-related accidents (12, 30-32). On the other hand, Adl et al. reported that occupation type, work experience, education, and age did not have a significant effect on safety climate and psychological environment and that other variables including workplace management, affect organization climate and in turn affect the safety climate of the workplace (3).

Conclusion

The findings of this study revealed that the safety climate in a petrochemical industry was positive while the safety climate was negative among workers who had a history of accident. Therefore, in workplaces that had been characterized to insist on adherence to safety principles and workers cooperation in the implementation of safety and health programs, the workers perspective and the organizational safety climate were positive. Therefore, the causes of work-related accidents should be sought in other factors that influence work-place accidents including workplace physical condition, psychological factors, occupational diseases and other causes that influence these accidents.

Ethical disclosure

Before performing this study, it was explained to the patients and an informed consent was obtained from all patients.

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Author contributions

Study concept and design: B F and LIG. Acquisition of data, analysis and interpretation of data: D M. Drafting of the manuscript, critical revision of the manuscript for important intellectual content: L IG and Z M. Administrative, technical and material supports: L IG.

Conflict of interest

There is no conflict of interest in this study.

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