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Evaluation of Safety Culture and Work-Related Accidents in Oil Depots of Tehran

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ABSTRACT

Safety culture is a set of beliefs, norms, incentives, social and technical roles and functions that make the core of the safety management system. The aim of this study was to examine factors affecting safety culture and its relationship to accidents in the oil depots. This cross- sectional study was conducted in 2016. Overall, 300 employees of 3 oil depots in Tehran Province were selected. About 150 of selected people had not accident in the last 3 yr and 150 of them were injured in the last 3 yr. A questionnaire consisting of 61 questions was used to evaluate the safety culture and effective factors on it. The collected data were analyzed using SPSS software ver. 19. The mean of the age, work experience, and safety culture scores were 32.07 yr, 7 yr and 185.8, respectively. There was a significant relationship between safety culture and accidents so that the percentage of positive safety culture among people with a history of accidents (72.6%) was more than percentage of individuals without a history of accidents (39.3%). The age, work experience, education and marital status variables had no significant relationship with safety culture. Among the aspects of safety culture, the management commitment had the highest score and the safety priorities had the lowest score. The percentage of people with negative safety culture in the oil depots and safety culture had a significant positive correlation with the accidents.

KEYWORDS: *Safety culture, Accident, Oil depot, Safety*

INTRODUCTION

Accidents can cause many financial, physical and environmental losses. In addition, to the direct and visible damage of accidents including damage to equipment and property, other costs such as lowering the credit of organizations, as non-obvious costs, are imposed on organizations [1]. Moreover, many accidents such as the destruction of the environment and maim cannot be compensated. According to official statistics, 2.34 million people in 2008 have died from work-related accidents and diseases.

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Therefore, on average, more than 6300 deaths in the world happen due to work every day [1-2]. According to the statistical center of Iran in 2013, 29000 and 231 people had an accident. However, an average of the death in this year was 5 people [3-4].In recent years; notice to the importance of the cultural and behavioral aspects of safety management in organizations has largely increased. Because of the performed investigation on accidents such as Piper Alpha and Chernobyl show that despite the use of all engineering factors and high protection, there is still the potential of great accident for high-risk

industries [5]. The important point is that these errors do not appear solely as an individual error, but often in the form of an incomplete behavioral culture is created. Creating a strong occupational safety and health culture is equally useful and necessary for all of the work levels in workplace including workers, supervisors, and managers. Performing the occupational health and safety prevention methods is effective in the prevention of occupational accidents and diseases [6].

One of the effective ways for reducing of occupational safety accidents among workers is promotion of safety culture. Safety culture is an overall definition of the organization level that its members have the common values about occupational health and safety, the effective and useful attitude about occupational health and safety, the application of the rules, systems and management methods and participation for creating a health and safety workplace [7].

If safety based on the culture and behaviors was established in organizations, it can be continuous and durable. An organization can claim that its efforts are effective for organizing and institutionalizing the safety when pressure and force are not imposed on people for the implementation of safety instructions. In organizations that safety is stable and durable; People are not encouraged to perform safe work and are not penalized for performing unsafe work. In these organizations, implementation of safety is obviously a part of their culture, belief and inherent behavior [8-9]. The existence of a positive safety culture in the organization makes employees aware of the risks and continuously protects against them and avoids unsafe behaviors. Therefore, by creating a positive and effective safety culture is that people can be aware of the risks and reduce accidents in the workplace [10]. Oil depots are one of the most important industrial installations. The prevalence and incidence of occupational injuries and accidents are consistent as one of the important problems in these environments. There is the risk of the diffusion of toxic substances, fires, and explosions in fuel storage tanks of oil depots. According to available statistics, the economic damage of accidents in the energy sector of the oil industry was about $ 10 billion since 1907 to 2007 that is equivalent to 25% of the total economic losses. The monitoring, evaluation, and control are essential stages in every project including safety climate project [11-12]. Due to the importance of high risk in process industries, and because, study on the safety culture in oil depots has been not performed, so the necessity of doing such researches seems vital.

The aim of this study was to investigate safety culture, effective factors on it and its relationship with occupational accidents in oil depots of Tehran province.

MATERIALS AND METHODS

This study is a cross-sectional study conducted in 2016. Totally, 450 workers work at three oil depots in Tehran Province. At least one-year work experience was inclusion criteria. After performing inclusion criteria, 300 employees of three oil depots in Tehran Province were selected. Totally, 150 of selected people had not accident in the last 3 yr and 150 of them were injured in the last 3 yr based on reports, documents, and medical records. There are three oil depots in the North West, the South and the North East region of Tehran province that people were selected from three oil depots in this study. The sampling method was probabilistic.

This study was conducted in two stages. In the first stage, the safety culture of subjects was evaluated. At this stage, two-part questionnaire was used for collecting data. First part of questionnaire was including demographical and occupational questions such as age, work experience, education level, marital status and accident history. Second part was the standardized safety culture questionnaire in the oil industry. This questionnaire had 61 questions scaled based on the Likert scoring method. Therefore, the answers were including strongly agree, agree, no comment, disagree, and completely disagree with every question. Safety culture dimensions in this questionnaire were including the management commitment (24 questions), the training and information exchange (13 questions), the supportive environment (12 questions), the barriers (7 questions), priority to safety (5 questions). The validity and reliability of this questionnaire previously were determined by researchers and the alpha Cronbach coefficient been reported 0.96 [13]. The research method was semi-supervised administration. In this method, the questionnaire was given to participants and after completion by person, the questionnaires were collected. Researchers responded to their questions during research. The scores of all questions were summed to obtain an overall score for safety culture. The following equation was used to assess safety culture [14]:

(Equation 1): $$\mu = \frac{5k + k}{2}$$

In this formula, k is the number of questions and μ is the mean of the safety culture score. Since the number of questions in the questionnaire was 61, the score more than 183 was related to the positive safety culture and the score

less than 183 was related to the negative safety culture. In the second stage to determine the relationship between safety culture and accidents, since 2013 to 2015, the demographic characteristics such as age, sex, education, work experience was gathered and compared to the safety culture. All participants complete the questionnaires, 300 questionnaires were coded, and SPSS software ver. 19 (Chicago, IL, USA) was used for analyzing data. The relationship between age, marital status, education, occupation, work experience, history of accidents and accidents with safety culture were analyzed using chi-square and t tests.

RESULTS

The mean and standard deviation of age and safety culture were 32.07 ± 5 yr and 185.8 ± 15.2, respectively. Of all participants, 58% had a negative safety culture and 42% had a positive safety culture. 54.8% of single people and 68.9% of married people had a positive safety but this difference was not statistically significant (P=0.145). In addition, the accident rate in single people and married people were 61.8% and 48.5%, respectively. In this study, the percentage of negative safety culture in the age groups below 30 yr and above 40 yr old was more. The examination of accidents based on the age groups showed that the accident rate in the age group above 40 yr was more than another age group. The frequency of accidents based on demographic variables has been shown in Table 1. The age range of 30 to 40 yr had the highest frequency of the positive safety culture. In general, except for the age group above 40 yr old that showed a downtrend of the positive safety culture, the positive safety culture had an uptrend in all age groups. As shown in Table 1, the independent t-test showed that there is no significant relationship between a negative and positive safety culture with age group (P=0.913).

However, the statistical analysis showed that the mean and standard deviation of the work experience in people with negative safety culture and positive safety culture were 5.07 ± 3.18 and 5.57 ± 7.35 yr, respectively and with increasing work experience, their negative safety culture have been reduced (Table 2). However, the result of independent t-test showed no significant relationship between safety culture and work experience (P=0.543). Moreover, the accident rate in people with work experience below 5 yr was more than others people.

Based on statistical analysis, the negative safety culture among people with degrees of elementary and under diploma was more than another group. In addition, percent of accident in people with degrees of elementary was higher than other groups. Statistical analysis using Chi-square test showed that there is a significant relationship between the positive and negative safety culture and degrees of education (P=0.0001). The frequency of people with the negative and positive safety culture in different occupational groups of the oil depots and the prevalence of the recorded accidents in different occupational groups have been presented in Table 3 and Table 4, respectively. Based on the data of Table 4, the percent of people with negative safety culture and the prevalence of accidents in people employed in fuel platform loading section were more than other groups. In addition, the percent of people with negative safety culture with a history of accidents was higher than the percent of people without the history of accidents. There is a significant relationship between safety culture and the history of accidents (P=0.0001). Investigation of the recorded accidents based on causes and consequences showed that the most common cause of the accident was the carelessness and unsafe behaviors (68%). Among the dimension of the safety culture, the management commitment had the highest score and the safety priority had the lowest score (Table 5). Finally, statistical analysis using independent t-test showed that there is a significant relationship between the safety culture score and the percent of the recorded accidents according to the demographic characteristics such as age, sex, education, work experience and occupational group (P=0.028).

Table 1. Frequency of accidents among people based on the demographic variables

History of accidents		**With the history of accidents**		**Without the history of accidents**		**Total**	
	Demographic Variables (Year)	Frequency	Percent	Frequency	Percent	Frequency	Percent
Age group (yr)	Below 30	54	43.5	70	56.5	124	100
	30-40	77	51.0	74	49.0	151	100
	Above 40	19	76.0	6	24.0	25	100
Work experience	Below 5	27	40.3	40	59.7	67	100
	5-15	93	48.4	99	51.6	192	100
	15-30	30	73.2	11	26.8	41	100
Education	Elementary	61	56.5	47	43.5	108	100
	Elementary -high school	55	53.4	48	46.6	103	100
	Diploma-university degree	34	38.2	55	61.8	89	100

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Table 2. Frequency of the people with different safety culture based on the demographic variables

Safety culture	Demographic Variables(Year)	People with positive culture		People with negative culture		Total	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Age group (yr)	Below 30	73	58.9	51	41.1	124	100
	30-40	84	55.6	67	44.4	151	100
	Above 40	17	68.0	8	32.0	25	100
Work experience	Below 5	30	44.8	37	55.2	67	100
	5-15	80	41.7	112	58.3	192	100
	15-30	16	39.0	25	61.0	41	100
Education	Elementary	14	13.0	94	87.0	108	100
	Elementary -high school	43	41.7	60	58.3	103	100
	Diploma-university degree	69	77.5	20	22.5	89	100

Table 3. Frequency of the people with different safety culture based on occupation type

Safety culture	**People with positive culture**		**People with negative culture**		**Total**	
Job Group	Frequency	Percent	Frequency	Percent	Frequency	Percent
Fuel platform loading worker	34	67.0	14	33.0	48	100
Tanker driver	58	58.3	50	41.7	108	100
Quality Control	8	32.5	20	67.5	28	100
Mechanic	20	55.7	15	44.3	35	100
Electrician	10	42.3	17	57.7	27	100
Sealing	8	47.1	9	52.9	17	100
Administrative, security and services	8	42.1	11	57.9	19	100
Fire and safety officers	0	0	18	100	18	100

Table 4. Frequency of the people with different safety culture based on accidents

Safety culture History of accidents	**With the history of accidents**		**Without the history of accidents**		**Total**	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Positive culture	48	32	78	52	126	42
Negative culture	102	68	72	48	174	58
Total	150	100	150	100	150	100

Table 5. The obtained scores in the dimensions of the safety culture

Dimensions	**Total score** Mean± SD	**Score out of 5** Mean± SD
Management commitment	81.87± 16.61	3.23± 0.81241
Training and exchange of information	73.12± 17.73	± 0.785042 3.36
Supportive environment	43.65± 8.35	2.98± 0.74323
Inhibiting factors	30.92± 8.78	2.47± 0.75382
Priority to safety	± 2.71 21.23	4.12± 0.76463

DISCUSSION

The safety culture is an essential element in the organization to prevent the workplace accidents. People with a negative safety culture were more in oil depots that can be a huge barrier against the control measures for reducing the work-related accidents. Because the poor safety culture affects the safety behavior of employees so that the results of this study showed that, the most common cause of the accident at the oil depot was carelessness and unsafe acts. The positive safety culture among married people was more than single people. Perhaps, because married people have family commitments, they are less risky. Of course, these finding is different from other findings [13, 15]. The percent of the negative safety culture among people below 30 and above 40 yr old and the incidence of accidents in people above 40 yr was more than other people but the difference was not significant. These results have compatibility with the results of the textile industry and in the steel industry [16-17]. With increasing the work experience, safety culture increases but the difference was not significant. Unlike the safety culture, the incidence of accidents was higher among subjects with work experience under 5 yr. These findings are consistent with the findings of studies that stated with increasing work experience, safety culture will be increased [13, 18]. People with the higher work experience participated in

more education courses and they have more experiences on the irreparable results of the unsafe acts. On the other hand, these people think to have high skills and they have less attention to the safety instructions that can be effective in accidents. In addition, the negative safety culture and the prevalence of accidents among people with degrees of elementary and under diploma were more than other people and the difference was significant. With increasing the education level, the knowledge of people has been increased and they are more ready to accept the considerable responsibility [14]. The results of the present study have contrasted with another result [19]. The percentage of the negative safety culture and the prevalence of accidents among people employed in fuel platform loading section were more than other groups. These findings indicate differences in the occupational safety culture of different groups of employees due to differences in the dimensions of the safety culture in these groups. These findings are consistent with the findings on the employees of the ports. Besides, findings are consistent with other findings [17, 20].

Moreover, the results of the present study showed that the safety culture score among people with the history of accidents was less than among people without the history of accidents [21]. People with a poor safety culture are more vulnerable and have unsafe behaviors. Finally, there is significantly a positive correlation between the safety culture score and the percent of the recorded accidents. This means that the occupational accident rate decreases with the increase of the safety culture. In addition, the management commitment has the highest score among the aspects of the safety culture. The management commitment can be effective to create a positive and strong safety culture among workers. The management commitment is a determinant factor in the behavior of employees. Based on the results, the safety priority dimension has the lowest score. The priority to safety means that how much managers and supervisors prioritize and emphasize on the safety. If the safety priority is high, the employees have a more confidence to organization and perform their tasks better [22]. The results of this study are compatible with the results of another study [23-25]. There is a positive correlation among the entire dimension of the safety culture [13]. This means that the dimensions of safety culture have a close relationship and a change in one of those will affect the other dimensions. The perception of employees about the workplace and the behavior of managers are a predictor factor for unsafe behavior and accidents. Hence, all parts of an organization, from the highest to the lowest member, must try to make a positive cultural environment in order to reduce accidents. In addition, managers must always think that why the workers do the unsafe behavior.

CONCLUSION

Marital status, education degree, occupational group and the history of accidents have effects on the safety culture. Therefore, the safety culture should be promoted, especially the safety priority, to prevent accidents. In order to create a positive safety culture, it should be focused on a variety of factors such as safety training and analysis of the events.

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