

Investigation of Relationship between Level of Awareness around Health, Safety and Environment Management System and Its Effects on Safety Climate and Risk Perception by Employees in an Iran Oil Refinery, 2015

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ABSTRACT

Special attention of and oil, gas and petrochemical large corporation in the world to the HSE management system is due to its importance in the designing and development of products, services and processes by considering its health, safety and environment requirements. Staff's perception of the existing job risks has a significant impact on their safe behavior at work. This study was conducted to determine the relationship between safety climate and staff's perception of risk with an awareness level among employees of the HSE management system in an oil refinery in Kermanshah.

The study population was employees in one of the oil refineries in Iran. After designing and questionnaire psychometric assessment of staff knowledge of HSE management system (Cronbach's alpha was 0.9 and its validity was assessed by certified professionals), Loughborough safety climate questionnaire and Flin risk perception questionnaire were used. Data analysis was performed using SPSS V22 software.

Results showed that the relationship between safety climate and awareness level of the HSE management system; also the relationship between safety climate and perception of risk was also getting significant. However, the relationship between perception of risk and awareness level of the HSE management system was not significant.

The results of this study showed a moderate awareness of HSE Management System in refinery workers. In this regard, appropriate and proper management policy should be committed to improving the situation. The results of this study is a profile the situation of safety climate in the refinery, which can be used as an indicator for the development of preventive policies and evaluate the performance of the organization's safety and the results of the safety improvement organization.

Key words: Awareness, Safety Climate, Risk Perception, Health, Safety and Environment Management System, Oil Refinery.

INTRODUCTION

Human resources are the backbone of sustainable development [1]. In order to achieve sustained and developed global industry level, various ways are considered. But regardless human resources, progress towards optimal consequences and designing system appropriately doom to fail [2]. Advanced organizations in the competitive world, in order to improve the level of customer's satisfaction, should pay special attention to the employees' health and safety and protection of environment [3]. One of the most important issues which encourage companies toward establishing and improving the health, safety and environmental systems is out breaking of the basic expectations of stakeholders in the field of HSE [4]. Surveying the workplace accidents in the United

States show that accidents imposed approximately 142.2 billion dollars per year in financial losses to its economy and about 4 million non-fatal injuries and 5734 deaths in 2005 occurred in this country [5, 6]. As a result, these injuries were caused 80 million days of work absence [6]. Similarly, in 2003, 4664 work-related deaths and an accident in every 5 seconds and one death in every 2 hours were recorded in European Union [7]. Also annually, 1891 deaths have occurred due to work-related accidents [8].

Today, health, safety and environment (HSE) factors are an important issue for customers, employees and shareholders [9]. The main goal of implementing the HSE management systems, ensuring the establishment of these elements in the strategies and

policy of the organization [10]. Special attention of and oil, gas and petrochemical large corporation in the world of the HSE management system is due to its importance in the designing and development of products, services and processes by considering its health, safety and environmental requirements [11]. Considering the HSE needs to assess the number of accidents, severity of accidents, safety trainings, safety requirements, having a safety system, and so on [12]. Special attention of organizations and large oil and gas and petrochemical industries in the world is due to its importance in designing and developing of products, services and processes with regard to health, safety and environmental considerations [11]. The ultimate goal of the HSE management system is people, property and environmental protection [13]. HSE is a system which is integrated and by its convergence and arrangement and synergism of human resources and facilities and equipment tries to make a healthy, pleasant and joyful environment, away from the accident, damage and waste [14]. Safety climate is a term which is used to describe a staff's common vision of how to manage safety in the workplace [15]. It means which refers to the perceived level of safety in a particular time and place, relatively unstable and is subject to current environmental components change or current circumstances [16]. Safety climate importance is concerned with its ability in predicting the safe behavior [17]. Based on this capability, safety climate has shown its ability in important safety results such as the perception of risk, accidents and injuries [18]. Perception of risk is a subjective assessment of the likelihood of experiencing a hazardous event and the severity of the consequences of an accident if it is taking place [19]. Individual perception of risks is related to the sensory evaluation of the likelihood or magnitude of damage [20]. In a workplace, employees' risk judgments related to safety climate and other social and organizational factors that are important for safety must be considered [21]. In the study by Tuaha *et al.* (2006) showed that workers' intentional behaviors have an integrated association with accountability and safety management as well as the perception of workers, safety attitudes and behavior has a significant relationship with management performance in the field of safety [22]. The study of Jafari *et al.* (2014) also showed a strong correlation between awareness and recognition of safety regulations and safety climate score [23]. The study of Adl *et al.* (2012) showed that the safety climate can be used as an indicator of occupational health and safety management system performance. The advantages of safety climate using than audit tools used, it is done in a shorter time [8]. Many studies have confirmed the relationship between

safety climate and safety behavior [24, 25]. This study was conducted to determine the relationship between safety climate and perception of risk at an awareness level among employees and staff of the HSE management system one of the oil refineries in Iran.

MATERIALS AND METHODS

This was a cross-sectional study. The statistical population of this study is all Kermanshah Oil Refinery employees (Headquarters and staff). The sample size was determined in 95% confidence interval equal to 255 people, which were extracted by simple random sampling. After selecting sample and by their consent to the inclusion, demographic characteristic, safety climate, perception of risk and awareness of the HSE management system questionnaire was completed by them. Data collection tools consisted of three questionnaires: safety climate, perception of risk and awareness of the HSE management system. For assessing the perception of risk, Flin perception of risk questionnaire that was used in the oil industries in 1996 [26]. In this method, a list of industry's risks is in the issue. This questionnaire contains 14 questions, and by averaging of questions scores from 1 to 5 (if the score acquires 0 to 1, the perception of risk is very low, between 1.1 to 2 is low, 2.1 to 3 is moderate, 3.1 to 4 is high and 4.1 to 5 is too much) the final score is obtained. To examine the safety climate, safety climate questionnaire of Loughborough University (LSCAT) used [27]. This questionnaire contains 43 questions with 5 degrees Likert scale. If statistical scores are equal to or higher than the average (129?) for the subject of the climate is positive and if it is lower than the average (129>) for the issue, the climate is negative. Employee's awareness level of the HSE management system questionnaire includes 7 items and the researcher designed this questionnaire inspired by the health, safety and environment self-assessment system of Safety and Health Administration in Victoria, Australia.

In order to determine the content validity of the questionnaire, it was given to 10 experts, which after its questionnaire survey, the awareness level of the HSE management system is evaluated acceptable. At this point the examined questions, in terms of being simple, relevant and understandable were evaluated. The majority of questions for each of the criteria were allocated 100 percent. According to the obtained percentages, it was representing a very high content validity of the questionnaire. The calculated correlation coefficient for a number of factors in the test and retest obtained 0.98. This rate indicates a very high correlation between the two test measures

[28]. Internal reliability is a correlation between questions of a test that is often to calculate it; the Cronbach's alpha coefficient is calculated. Results showed that the Cronbach's alpha coefficient was obtained 0.9; this number indicates that the measuring instrument has a very good internal reliability [29].

Respond to the questionnaire to each question score gives one to five scores (very low-low-medium - high - very high), and by summing the scores for each question, final score obtained. If the score obtained 29 to 35 the awareness level is very high, between 22 and 28 is high, 15 to 21 are medium, 14 to 8 are low and 1 to 7 is very low. In order to analyze data and test the hypotheses and respond to research questions, SPSS 22 statistical software and ANOVA were used.

RESULTS

Totally, 255 people participated to complete the questionnaire. The average age of employees and their job experience in the refinery was 36.9 and 9.63 years, respectively, and 68.8 percent were married. 56.1 percent of respondents had a bachelor's degree. Average hours of safety HSE and training at the begging time of hiring were 49.05 hours. The most surveyed persons (17.6 percent) were firefighters. The highest type of employment was officially (43.1%). Also in the past year, 19 accidents occurred to workers.

Findings related to awareness level of HSE Management System

The awareness level average rate of health, safety and environmental management systems, (HSE) for the study population was 20.85 with a standard deviation equal to 4.82. According to the scoring of awareness level questionnaire of HSE Management System, 1 staff (0.4%) were in very low class, 19 staff (7.5%) in the lower class, 121 staff (47.5%) in the middle class, 99 staff (38.8%) in the high class and 15 staff (5.9%) were classified a very high class. Average rating of

Findings related to safety climate

Average score of safety climate in surveying population was 157.04 with a standard deviation of 22.415. According to the scoring of the safety climate questionnaire assessment, 229 cases (89.9%) of surveyed employees were at positive safety class and 26 cases (10.2%) were in negative safety climate class.

The relationship between awareness of HSE management system, safety climate and employees' perception of risk in terms of scoring

The relationship between various classes of awareness to the HSE Management System in refinery employees was significantly with average

different awareness areas of the HSE management system is presented in Table 1.

Table 1: Average participant's response in seven surveyed areas of HSE Management System awareness

Surveyed areas in HSE Management System awareness level	Mean Standard deviation
Leadership and commitment	3.31 ± 0.835
Policy and strategic objectives	3.48 ± 0.934
Organization, resources and documentation	2.9 ± 0.866
Risk assessment and management	2.79 ± 0.86
Designing	2.82 ± 0.879
Implementation and monitoring	2.76 ± 0.884
Audit and review	2.79 ± 0.949

Findings related to the perception of risk

The awareness level average rate of perception of risk for the studied population was 3.45 with a standard deviation equal to 0.835. According to the scoring and the perception of a risk assessment questionnaire, 0 staff (0.0%) was in very low class, 6 staff (2.4%) in the low class, 85 staff (33.3%) in the middle class, 95 staff (37.3%) in the high class and 69 staff (27.1%) were classified as a very high class. Average rating of different perceptions of risk areas is presented in Table 2.

Table 2: Average participants response in 14 surveyed areas of perception of risk assessment

The surveyed areas scope in perception of risk assessment	Mean Standard deviation
Falling from height	2.96 ± 1.18
Lack of using personal protective equipment	3.23 ± 1.262
Skin contact with chemicals	3.42 ± 1.098
Inhalation of chemical vapors	3.48 ± 1.064
Electrocution	3.47 ± 1.108
Firing	3.52 ± 1.072
Explosion	3.51 ± 1.079
trapping organs between devices	3.43 ± 1.106
Contacting with the hot surface	3.51 ± 1.049
Falling pieces on foot	3.43 ± 1.08
Damage to the eye	3.5 ± 1.019
tripping on the floor of the working site	3.34 ± 1.075
exceeded volume	3.38 ± 1.101
Back pain and repetitive movements	4.16 ± 0.833

safety climate scores (P-value <0.05). In order to investigate the relationship between awareness of HSE management system, safety climate, the Pearson correlation test was used. The result of this test showed that there is a positive relationship between these two variables and this relationship is statistically significant at the 5% level ($r = 0.219$, $P - \text{value} = 0.001$).

The relationship between various classes of awareness to the HSE Management System in refinery employees hadn't been significantly with the average perception of risk score (P-value >0.05). In order to investigate the relationship between awareness scores of HSE management system and the perception of risk, Pearson correlation test was

used. The result of this test showed that there is a positive relationship between these two variables and this relationship is statistically significant at the 5% level ($r = 0.137$, P -value = 0.028).

The relationship between various classes of perception of risk in refinery employees became significant with an average safety climate score (P -value <0.001). In order to investigate the relationship between perception of risk and climate score, the Pearson correlation test was used. The result of this test showed that there is a positive relationship between these two variables and this relationship is statistically significant at the 5% level ($r = 0.651$, P -value = 0.001).

DISCUSSION

Awareness level of HSE Management System

According to the findings in terms of awareness level of the HSE management system, the most awareness belongs to the second scope (policy and strategic objectives) and the lowest level of awareness belongs to the sixth scope (implementation and monitoring). One of the reasons that increase the awareness toward policy and strategic objectives, scope, is at the refinery, the panel of the HSE policy installed in all refinery units and in view of all employees, and notify to staff directly and indirectly about organization health, safety and environment policy. However, the staff had relatively low awareness with other HSE management system areas, because the refinery HSE unit does not involve staff in other areas. If the HSE unit, involve staff in the implementation of HSE process, also supervisors stress on the policy, annually or monthly lecture of CEOs and other executives will further increase staff awareness about different areas of the HSE management system.

Perception of risk

Most perception of risk score relates to the fourteenth scope (back pain and repetitive motion) and the lowest score relates to first score (Falling from height). One of the reasons that increase the perception of risk in terms of lower back pain and repetitive movement areas, this is because many employees have ambulatory jobs, so it can cause the employees suffer from musculoskeletal disorders and back pain. Also the training unit of the refinery will establish ergonomics short-term training for all staff. Also HSE unit refinery, provide and install repetitive movement ergonomics posters for all staff's rooms. These reasons led to increasing the perception of risk in terms of back pain and repetitive movements among employees. One of the reasons that reduce perception of risk in falling from height scope is that there are very few jobs at the refinery which is

associated with work at height. The perception of risk has been evaluated in a few studies, for example the study of Jafari *et al.* (2009) showed that implementing job safety analysis has increased the perception of risk among subjects and such perception of risk is evident in the answers given to the questions in the perception of risk questionnaire. In this study, people had the highest sense of safety, of electric shock (38.5%) and trip (42.3%) [30]. Jahangiri *et al.* study (2009) showed that 3.7% of people in the refinery had a moderate perception of risk and 96.3% had a high perception of risk associated with their workplace respiratory hazards. In this study, there was a significant relationship between perception of risk and the use of respiratory protection equipment (P -value <0.05) but the relationship between perception of risk with the proper use index of masks (PURI) was not significant (P -value >0.05) [31]. Yusefi *et al.* Study (2013) showed that the average perception of the risk score in construction workers was 6.77 ± 1.57 . In this study, perception of risk in 1% is low, and 21.4 percent were medium and 77.6 percent were high [32]. In the Rundmo study (1992) the Norway Beach workers feel less safe than contact with falling objects and slipping [33]. In the Arezes *et al.* study (2008) it was found that perceptions of risk are a predictive factor in workers' safety behavior [34]. The perception of risk in refinery workers was high class.

The highest mean scores of perception of risk are associated with areas of low back pain and repetitive movements ($M = 4.16$) and firing ($M = 3.52$) and the lowest average score in the area of falling from height ($M = 2.96$), not using of personal protective equipment ($M = 3.23$) and tripping on the floor of working site ($M = 3.34$). The study of Jafari *et al.* (2009) showed that about half of the participants in this study feel safety toward incidents such as explosions, fires and leaks of toxic gases. One reason for this sense of safety might be it's less likely to occur than everyday events such as slipping, although the consequences of such risks are severe and can impose catastrophic effects. Also, about 90% of workers feel safe about the collapse of the structures [30]. Comparing the results with the Flin *et al.* (1996) show that workers UKCS beach feels more secure than the explosion, firing and toxic gas leak. Rundmo study (1992) feels less safe toward explosion, fire and leakage of toxic gases than the study of Flynn (1996) [33, 35]. Rundmo (1996) knows the reason of less sense of security at events such as explosions, firing and leakage of toxic gases in the workers' focus in terms of the consequences of an accident than the likelihood of its occurrence [36, 37]. In the study of Mark *et al.* (1985) feel security against the risk of

explosion and firing is low, so they argue that this risk is one of the main concerns of the workers. In the study Jafari *et al.* (2009) people had the lowest feeling of safety toward electric shock (38.5%) and tripping (42.3%). In the Flynn study (1996) the lowest sense of security was expressed to trip (38%), contacting by falling objects (48%) and weather conditions (49%). Flynn (1996) stated the lack sense of security toward mentioned matter the lack of under controllability despite risks such as contact with moving parts of the machine. Rundmo study (1992) Norway Beach workers felt less secure than dealing with falling objects and slipping. In the study of Mark *et al.* (1985) questions didn't raise about slipping, but there was a feeling of security workers to weather conditions (70%) and falling objects (50%). So in Jafari study (2009), Flynn (1996) and Rundmo (1992) the lowest feeling of safety in perception the risk of injury to people was tripping which is consistent with present results. So the present study was confirmed which is based on differences in perception of risk on demographic and job variables on job title, education level, work experience in the refinery, the hours of safety training and HSE at the time of employment, type of employment and the number of observed events.

Safety climate

Assessing the safety climate in a number of studies have been evaluated, for example, a study by Ma *et al.* (2009) conducted in China industry has estimated the total average of safety climate and 3.6 and evaluated it as weak safety climate and they used 1-5 scale in their study to assess the safety climate [38]. In another study by Smith *et al.* (2006) in the United States' industry, 3.75 was obtained for safety climate and suggests that the safety climate in this industry is too weak [39]. In comparing with these two studies, the safety climate in the relevant oil refinery is desirable. A study by Zare *et al.* (2012) showed that total safety climate score was calculated 6.35 on a scale of 1-10, which has a relatively favorable safety climate score [40], which was consistent with the results of this study. So the safety climate of Oil Refinery staff was on a positive level.

Among the extracted factors, the infringement factor had the least relationship with other factors and has the significant relationship with safety training. This may reflect the fact that safety training and safety procedures and safety rules can reduce the infringement. Safety education factor has the highest correlation with all safety climate factors. This indicates that educating safety issues is of the most important aspects of safety climate and by improving the education system; curriculum and quality of safety climate will improve considerably. Safety rules and procedures are another important factor that is

strongly associated with other factors. To enhance the safety climate, the rules and regulations governing the refinery must comply with working standards, explained for personnel and monitor its right implementation. Also the kind of training that training units and HSE refinery unit should be reviewed to select practical training and efficient elections. Also holding the Toolbox courses is offered.

The relationship between awareness level score of HSE management systems, safety climate and perception of risk

In this study showed that there wasn't a significant relationship between the levels of awareness of HSE management system. To justify this, it should be stated, because the assessment of perceived risks is an individual estimation of surrounding risk, cannot be related to the awareness of HSE Management System. As well as those with high awareness of the HSE management system, had the highest perception of risk (0.842 ± 3.557), which seems quite logical. The study by Williams *et al.* (2007) showed that even when workers had greater awareness and understanding about workplace hazards, does not mean that apply more protective measures [41]. The results of this study were consistent with the results of the present study. In the Arezes *et al.* study (2008) it was found that perceptions of risk are a predictive factor in the safety of the workers' behavior [34]. Mohamed *et al.* (2009) also stated that attitudes affect the safety attitude of construction workers effects on their perception of risk. In this study also found people who have a higher perception of risk has a higher safety approach and safety performance [42]. Rundmo *et al.* study (1992) showed that the risk perception of an individual is associated with physical and organizational working conditions. Individual perception of risk represents the working conditions perceived by refinery personnel as well as assessment of the perception of risk [35]. A study by Greening (1996) showed that the relationship between mental simulation hypothesis and perception is very strong, which reflects the subjectivity of perception of risk are [43], while awareness of the HSE management system is theoretical. The results of all these studies had confirmed rejection the relationship between awareness of HSE management system with the perception of risk that achieved in the present study.

This study showed that there was a significant relationship between the level of safety awareness of HSE Management System and safety climate. In justification, it can be said, because the safety climate assessment is a theoretical estimation of surrounding risk, could have a significant relationship with the awareness of HSE Management System. As well as

those with high awareness of HSE management system had the highest safety climate (23.133 ± 161.07), which seems quite logical. Of the derived factors, infringement factor has the least association with other factors and only has a significant relationship with safety education. This may reflect the fact that education and safety procedures and safety rules can reduce the infringement. As staffs become more aware of safety issues, violate less safety rules and procedures. It can be concluded that the lack of awareness of safety is a factor in violations at the refinery. Safety education factor has the highest correlation with all safety climate factors. This indicates that safety education, including awareness of the HSE management system is the most important dimensions of safety climate and improves the education system, curriculum and will considerably improve the quality of safety climate education. On the other hand, by holding training courses involved with personnel in safety, increased and persons' reaction against the offending colleagues will be stronger. In the study by Tauha *et al.* (2006) showed that worker intentional behaviors have a severe association with accountability and safety management as well as there was a significant relationship the perception of workers, safety attitudes and behavior with a management operation in the field of safety [22]. The study of Jafari *et al.* (2014) also showed a strong correlation between awareness and knowing safety regulations and safety climate score [23]. The study of Adl *et al.* (2012) showed that we can use safety climate as an indicator for the performance of occupational health and safety management system [8]. The advantages of the safety climate than the audit used tool are performed in a shorter time. Numerous studies have confirmed the relationship between safety climate and safety behavior [24, 25], which is consistent with the results of this study. The results of a study by Muniz *et al.* (2012) showed that management commitment, especially communication effect on safety behavior and safety performance, employee satisfaction and the enterprise competition. These findings, especially when risk mitigation and improved performance in these organizations be considered are more important than [44], which was consistent with the study. Kwon *et al.* study (2013) showed, knowledge of safety, safety attitude and safe working environment were the main factors affecting the safety climate. Safety knowledge and motivation had a significant effect on safety in the workplace. The results of the South Korean government restrictions on education will show promotion programs of health and safety, and knowledge participants and transmission of system encourage [45]. The results of these studies underscore the validity of assumptions regarding the

level of awareness of HSE management system with safety climate that achieved in the present study we found.

Also in this study showed that there was a significant relationship between perception of risk and safety climate. As well as people who had a high perception of risk had the highest safety climate (175.17 ± 12.861), which totally "seems logical. Insights and attitude toward safety are influenced by their perception of risk, management, rules and safety procedures. Several studies suggest the use of safety climate score in comparison between various industries [46-48], and reviewing the literature suggests that there is a positive correlation between such insights and safe behavior of employees. The study of Jahangiri *et al.* (2012) found that perception of risk of 77.6 percent of surveyed persons was high, but only 48.5% of them had the high safety attitude. However, 93.6 percent of construction workers were having a high performance in terms of safety. Results showed by increasing in perception of risk in construction workers and can improve the attitude and safety performance [32]. The results of Tholén *et al.* (2013) showed that personal perceptions of safety climate affect safety behavior, but evidence was found that the atmosphere safe behavior affects safety. In addition, the perception of safety climate increases individual behavior is safe. It also affects the mental state of the person about the perception of safety, but do not affect the safe behavior [49]. Kouabenan *et al.* (2015) showed that first-line managers who had better safety climate were more involve safety management. The results showed that safety climate effect on safety management intervention. Encouraging of employees by supervisors is more than senior managers effects on safety issues [50]. The results of these studies with having an emphasis on health, safety climate, and perceptions of risk associated hypothesis that achieved in the present study.

CONCLUSION

Awareness of HSE Management System Toolbox Meeting with meetings and continuing education courses can be increased. Given that incorrect understanding of the risks of the workplace may lead to wrong decisions and as a result of human error and unsafe behavior, attempts to increase employees' perception of risk, through practical measures such as training, can lead to recovery safety in their attitude and performance. The results of this study are a profile of the situation of safety climate in the refinery, which can be used as an indicator for the development of preventive policies and evaluate the performance of the organization's safety and the results of the safety improvement organization. While

evaluating the safety climate can be as a way to measure the effectiveness of interventions of safety in the workplace.

ETHICAL ISSUES

Ethical issues such a plagiarism has been observed by the authors.

COMPETING OF INTERNET

The authors have declared that no competing interest exists.

AUTHORS CONTRIBUTION

All authors equally help to write this manuscript.

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