Original Article

Ergonomic Behavioral and Workers' Safety Perception in a Khuzestan Petrochemical Company

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Objectives: An effective safety management requires paying attention to human factors. One of the most important methods for achievement to accident prevention is using safety climate or safety culture. Moreover, some studies suggest that in most organizations behavior contributes to 86-96% of all injuries. This cross-sectional study was performed on the functional units' workers of Khuzestan Petrochemical Company, in 2010.

Methods: Data collection tools were safety climate questionnaire that has been presented by Kumar et al. (2009), Ergonomic Behavior Sampling and collected data was analyzed by SPSS 16.

Results: With reference to the results of a pilot study, a sample of 1147 was determined for Behavior Sampling. The numbers of returned valid questionnaires were 134 out of 151 and response rate was %88.74. Questionnaire reliability assessed by Cronbach's Alpha, was 0.928. Results indicated, management commitment and actions for safety, workers' knowledge and compliance to safety, and workers' attitudes towards safety, are those safety climate factors which have obtained the highest correlation coefficient with ergonomic behaviors and as predictors on multi-variants linear regression model for ergonomic behavior forecasting.

Discussion: Results showed the importance of decreasing number of workers with negative safety climate. Also, results obligate paying attention to workers' ergonomic behaviors in the workplace and their promotion.

Keywords: Safety Climate, Ergonomic Behavior, Petrochemical Company

Introduction

An effective safety management requires attention to human factors as well as system components which makes risky or safe situations at technical components. Paying attention to human factors, organizations with high reliability can recognize hazards before occurrence. One of the most important methods for achievement this purpose is using leading criteria such as safety climate or safety culture. Human factors include procedures comprising (1): 1) facilities, equipment and environment, 2) management systems and 3) people. Considering these elements in management process may lead to control of accidents and their costs. Safety culture has been used for the first time in an initial report about the Chernobyl accident (2). In the viewpoint of Advisory committee on the safety of nuclear installation (3) safety culture has been defined as "the produce of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to safety, and the life style and proficiency of an organization's health and safety management''. There is a considerable point in literature that shows safety culture is a sub-facet of organizational culture (4). As safety culture is a subset of overall organizational culture and subset of organizational factors, it denotes the extent to which upper level management demonstrates positive and supportive safety values, attitudes and behaviors. It is one of the

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most stable and substantial forces within organizations, shaping the way members think, behave, and approach their work (5).

We can adopt safety behavior definition presented in "a practical guide for behavioral change in the UK oil and gas industry" (6) for ergonomic behavior. This definition is: "A behavior that is directly related to Ergonomics, such as correct manual handling, having correct posture or talking to colleagues about ergonomics. From the perspective of behavioral psychology, behavior is a function of the environment in which it occurs. Unsafe work behavior is taught be the result of (1) the physical environment, (2) the social environment, and (3) workers' experience (7).

The expenses of the musculoskeletal disorders are estimated to be 1/13% of the governmental budget in 2000 in Iran (8). Therefore, paying attention to ergonomic behavior is obviously important.

Our object behaviors are known as behavior in the literature (1, 7-15).

Advisory committee on the safety of nuclear installation (3) has defined safety culture in a comprehensive manner. In their view " safety culture is the produce of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determines the commitment to safety, and the life style and proficiency of an organization's health and safety management.'' More specifically, safety culture is seen as a sub-facet of organizational culture (4). The concept of safety culture has its origin in the social and behavioral psychology of the 1950's and 1960's that came to the fore in the organizational psychology, organizational behavior, and management literature of the 1980's (2). This study has been conducted in the functional departments of a Petrochemical Company, which is located in the south of Iran, in 2010.

Methods

The study was a cross-sectional study and was conducted by using Ergonomic Behavior Sampling (EBS) technique based on Safety Behavior Sampling (SBS), and safety climate questionnaire (SCQ). Collected data was analyzed by Pearson correlation and linear multi-variants regression.

Data collection tools were Safety Climate Questionnaire (SCQ) that has been presented by Vinodkumar and M. Bhasi (16) on a 1–5 Likert scale. After piloting questionnaires between 42 workers and calculating cronbach's Alpha, six factors' Alpha was valid. Used SCQ consists of 49 questions and six categories. Its categories are management commitment and actions for safety (F1), workers' knowledge and compliance to safety (F2), workers' attitudes towards safety (F3), workers' participation and commitment to safety (F4), safeness of work environment (F5), and emergency preparedness in the organization (F6).

Questionnaires were distributed between total of 151 functional workers of Khuzestan Petrochemical Company (KPCo) within 5 shift work groups (day work or no shift work, A, B, C, and D group).

Procedure of Ergonomic Behavior Sampling

Work Station Definition

This includes departments in an organization where ergonomic behavior sampling was conducted. In this study, a workstation considered as a functional unit of Khuzestan Petrochemical Company (KPCo) in Iran.

Preparing a List of unergonomic Acts

After specifying the unergonomic behaviors as any action that could have harmful consequences, a list of unergonomic acts was collected. The obtained list was adjusted based on literature review and presented conditions such as the type and nature of work, reviews of accidents' reports, and presented cultural conditions. Table (1) shows a specimen worksheet.

Table 1. Ergonomic Behavior Checklist

Behavior	Ergonomic	Unergonomic	Notices
Proper carrying Load weight			
Load closed to body while carrying			
Proper grip of load while carrying			
Carrying from appropriate path			
Symmetric carrying			
Distance of carrying (4 meters)			
Proper lifting load weight			
Move feet - don't twist while lifting			
Proper grip of load while lifting			
Load closed to body while lifting			
Use of legs while lifting			
Upper arm posture			

Behavior	Ergonomic	Unergonomic	Notices
Leg posture			
Trunk posture			
Lower arm posture			
Wrist posture			
Neck posture			

Conducting a Pilot Study

After specifying unergonomic behaviors, a number of necessary observations of workers' behaviors were carried out in order to determine the proportion of their unergonomic behaviors. The number of required observations was based on the data collected during the pilot study, the accuracy required, and the given level of confidence. Two terms were recorded during the pilot study:

1. Total number of observations (N1)
2. Number of observations in which unergonomic behavior was observed (N2)

Thus, the proportion of unsafe behavior is (7, 12, 17):

$$p=\frac{N_2}{N_1} \qquad \text{(Eq. 1)}$$

If: e = desired accuracy

N = Total number of observations required $Z_{0.99}$= the value obtained from standardized normal tables for a given level of confidence, then the total number of required ergonomic behavior observations is derived from (7, 12, 17):

$$N=\frac{[Z^2_{1-\alpha}P(1-P)]}{e^2} \qquad \text{(Eq. 2)}$$

For 95% confidence, $Z_{0.95}$ is approximated as 2, and for 99% confidence, $Z_{0.99}$ is about 3. Accuracy may be interpreted as the tolerance limit of the observations that fall within a desired confidence level. 5% accuracy with 99% confidence level is the combination used in ergonomic behavior sampling. It means that 99% of the time within 5% accuracy limit, the conclusion drawn based on ergonomic behavior sampling will be representative of the actual population.

Calculation of Required Number of Observations

After performing the pilot study the proportion of unergonomic acts was estimated to be about 47.7%. With 5% accuracy and 95% confidence level; the total number of observations was estimated to be by 900.

Ergonomic behavior sampling needs to be done randomly. This is usually achieved when any observation period is selected randomly from all the workday time. So in the next step the observations are performed randomly. It means that both observed workers (134 workers of functional units) and frequency of observations (in the period of 8 hours from 8 a.m. to 17p.m.) were selected randomly. Since the behavior of workers might be changed from time to time, the observation duration has a critical role in accuracy of the results. This duration should be as short as possible to observe and specify the behaviors. In this study, the average time of each duration was 3 seconds. Unergonomic behaviors were carefully recorded in a time limit of 3 seconds. The researcher carried out the observations randomly while the subjects were not aware of the fact that they were being observed.

In order to recognize the relationship between the employees' demographic characteristics and unergonomic behaviors, previously mentioned variables such as age, work experience, education, working shift group and marriage status were registered through interviews and a special questionnaire.

Results

The number of returned valid questionnaires was 134 out of 151 and response rate was %88.74. Despite, estimated behavior for observation was 900; in order to achieve more confidence 1147 observations was done.

General results

All workers were male, average of employees' age was (30.95±5.298). Based on the education, the employees with diploma or less education had the largest proportion of workers (38.8%). The employees with M.Sc. or higher education were the least proportion of about 3.7%. The results also signified that average work experience of the workers was (6.57±4.44) years. In average, every worker attended five safety training courses but the range varied from 1 to 20 courses.

After data gathering, questionnaire's reliability was assessed again by Cronbach's Alpha and it was 0.928. Comparing calculated alphas for each SCQ factor with 0.7 that known as minimum desirable alpha, (18) showed that six factors' alpha were

desirable. The results showed that mean of safety climate score was (154.64 ± 19.723) out of 245.

Checklist's reliability was assessed by comparing of six different people responses who completed ETBC for similar situations and the percentage of same responses was calculated as 87%, So its reliability was desirable (12).

The results of ergonomic behaviors indicated that 43.6% of workers behaviors were unergonomic within total number of 1147. Results didn't declare any significant relationship between ergonomic behavior percentage and demographic characteristics ($p>0.05$).

Relationship between safety climate factors and ergonomic behavior

The relationship between safety climate factors and ergonomic behavior was assessed by Pearson correlation coefficient. Results declared a significant relationship between four factors of safety climate and ergonomic behavior ($p<0.05$). As is visible in table 2, management commitment and actions for safety (F1), workers' knowledge and compliance to safety (F2), and workers' attitudes towards safety (F3), and workers' participation and commitment to safety (F4) have significant correlation with ergonomic behavior. However, Safeness of work environment (F5), and emergency preparedness in the organization (F6) have not significant correction ($p>0.05$).

Thus, F1, F2 and F3 can predict ergonomic behavior (percentage) more efficiently.

Table 2. Correlation between Safety Climate factors and Ergonomic Behavior

		F1	F2	F3	F4	F5	F6
Ergonomic Behavior	Pearson Correlation	.480*	.443*	.277*	.181**	.093	.125
	Sig. (2-tailed)	.000	.000	.001	.036	.283	.151

*. Correlation is significant at the 0.01 level (2-tailed).

**. Correlation is significant at the 0.05 level (2-tailed).

Multi variants linear regression

Multi variants regression was used in order to present forecasting model of ergonomic behavior. F1, F2 and F3 were predictor factors because they had the largest numbers of Pearson coefficients.

After applying Multi variants regression analysis following equation was achieved.

$$\%\ \text{Ergonomic Behavior} = 14.531 + 0.205(F1) + 0.535(F2) + 0.616(F3) \quad \text{(Eq.3)}$$

Conclusion

The results indicated the importance of attention to safety principles and development of a positive attitude between employees related to safety because of high severity of accidents in petrochemical industry; this protocol would result in safety climate promotion and finally safety culture improvement in KPCo. So, we can focus on these factors: Management commitment and actions for safety, workers' knowledge and compliance to safety, and workers' attitudes towards safety. These results are really compatible with the scientific structure between knowledge, attitude and behavior. This structure indicated that by promotion of knowledge we can improve the attitude of people and as a result we will achieve to better behaviors. Therefore, more sustainable improvement in safety climate of company would be achieved by more attention to those factors.

In addition, attention should be paid to preventive principles and decreasing employees' unergonomic behaviors. This action would result in reduced injuries and accidents costs of KPCo.

It is obvious that we cannot neglect external factors such as physical/ social conditions' effects on workers' behaviors (7). Management in this company should be careful about control of these factors to improve ergonomic behaviors. We should not blame workers in different situation.

By using some activators such as ergonomics meetings we can improve behaviors directly. In other hand, consequences of behavior such as self-approval or injuries can improve behaviors by motivation.

Respecting these results and previous studies indicating the influence of safety climate on workers' behavior in the workplace (19-21), we can conclude that workers' behavior would be improved by safety climate promotion and as a result work related accidents and injuries would be decreased. However, changing the culture from a negative to a positive status is a prolonged process.

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