

Assessing Safety Culture and its Relationship with Mental Load and Job Stress in the National Gas Company

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ABSTRACT

Background: Accidents may occur for varying reasons, including unsafe behaviors, which originate from the safety culture of the organization. Job stress and mental load may also be contributory to accidents. This study aimed to assess safety culture and its relationship with mental load and job stress in a national gas company in Iran. **Methods:** This is a cross-sectional study conducted over a period of one year. This study used the NASA-TLX task load index, a standard questionnaire approved by the American National Institute of Mental Health to measure job stress, and the standard Health and Safety Executive safety culture questionnaire. All personnel was counted, and the total number of employees was 122. Statistical methods of t-test, correlation coefficient, and averaging have been used. Data were collected and analyzed in SPSS software and Microsoft Excel software. **Results:** The average mental load of employees was 61.51, i.e., moderate level. The average job stress and employee safety culture were 180.43, i.e., high level, and 331.34, i.e., desired level. The mental load was assessed as moderate, safety culture was optimal, and job stress was high. A significant relation was found between safety culture and mental load (correlation coefficient: -0.278; $p = 0.03$). Besides, the mental load was significantly related to job stress (correlation coefficient=0.293; $p = 0.2$). **Conclusion:** Controlling stress and reducing the mental load in sensitive work environments is important and can lead to a higher level of safety culture in the organization.

Keywords: Safety culture; Mental load; Job stress; Gas

Introduction

Industrial accidents account for nearly one-third of work-related mortality. Considering the loss of workforce, materials, equipment, and time, the global cost of these accidents is estimated to be approximately \$5million annually.¹

Inquiry into accidents has shown that the majority of accidents are linked with process industries. In Iran, a substantial number of accidents occur in process industries.² One hazardous process industry is the gas

site, where there are many dangers such as explosions. Every part of the oil and gas industry is associated with several perils due to the properties of materials, including flammability, toxicity, and reactivity.

An accident takes place when the danger turns into an unintended and damaging event.³ According to a June 2014 report by the United States Chemical Safety and Hazard Investigation Board (CSB), inadequate management systems and poor safety

Citation: Sepehr P, Jabbari M, Erfani Fard M, Rezapour SH, Samimi K. Assessing Safety Culture and its Relationship with Mental Load and Job Stress in the National Gas Company. Archives of Occupational Health. 2021; 5(4): 1139-46.

Article History: Received: 21 June 2021; Revised: 20 August 2021; Accepted: 15 September 2021

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culture contribute to accidents in oil and gas industries.

⁴ One of the principles of safety in the workplace is the bio-hardware perspective. It is essential to observe the safety culture in the organization and conceive strategies that can promote it. ⁵ Research has shown that developing an appropriate safety culture in the workplace is a critical strategy to prevent and reduce occupational accidents. ⁶

Safety culture is an organizational concept that aims to minimize accidents in dangerous working settings. ³ Many researchers have found that safety culture has a direct or indirect impact on safety management, and the safety management system directly affects individuals' safety knowledge and awareness. ¹ There are many definitions of safety culture, most of which surround human behaviors, beliefs, and attitudes to safety issues within the organization. ⁷ The majority of definitions for safety culture have been published and reported by the Health and Safety Commission. ⁴ Rahmati et al. evaluated safety culture among South Pars Gas Complex personnel and described it as a key priority in oil and gas organizations. ⁸

While people develop science and technology to benefit, new industries have brought many risks and problems. These risks increase stress, illness, and work accidents for people. ⁹ In fact, among the factors that lead to accidents in the organization is job stress. Job stress is one of the most important psychological problems and has been considered the disease of the twentieth century. Studies have shown that 30% of the workforce in developing countries suffer from job stress. ^{10,11} Job stress is an individual's harmful physical and emotional response and occurs when working conditions do not match the workforce's capabilities, available facilities, or needs. ¹² It can lead to decreased concentration, reduced decision-making power, anxiety, decreased efficiency and productivity, incorrect work, and memory impairment for accuracy in work, all of which contribute to accidents. ¹³

Psychosocial factors in the work environment affect the body and mind of individuals and cause

occupational accidents. Job stress is regarded as a psychosocial factor in the workplace. ¹⁴ Accordingly, it is essential to look for ways to reduce job stress in the workplace and, hence, help reduce accidents. A study conducted by Lailun Nahar et al. to examine the relationship between job stress and mental load showed that mental load was a predictor of job stress. ¹⁵ Li CY's study showed that job stress could lead to accidents, and this means that people with work accidents may have high levels of job stress. ¹⁶ Moreover, Zamanian et al.'s study revealed that increased safety culture reduces job stress. ¹³

Another factor that can affect the occurrence of an accident is the workload, which can include part of the time a person spends performing a task. ¹³ Mental workload is defined as the cognitive and intellectual needs of the worker while performing physical and mental tasks. When a person's mental load overrides his/her capacity, it leads to a decline in personal performance, which increases the likelihood of an accident and is a key contributor to fatigue. The workload is directly related to individual performance and affects health and safety. ¹⁷ It is a multidimensional and complex construct that is influenced by external requirements of the task, environment, organizational and psychological factors, and administrative and cognitive abilities of the individual. Therefore, in recent decades, the issue of workload and its effects in organizations has become one of the major issues of organizational behavior. ¹⁸ With its effect on individuals, the mental load can cause stress and fatigue and, most importantly, lead to error. Most accidents occur due to human error. Therefore, managing the mental load can contribute substantially to controlling accidents. ¹⁹ Rezai et al. have studied the average mental workload in a tuna fish factory, showing a significant relationship between mental workload and the frequency of accidents, hence introducing mental workload as an underlying cause of accidents. ²⁰ Considering the importance of the subject and the explanations

provided, this study aims to measure, analyze, and study the correlations between safety culture, job stress, and mental load in a gas industry company.

Methods

This cross-sectional was conducted in 2019 among all the North Khorasan Gas Company personnel of Iran to review and evaluate safety culture, mental load, and job stress. The aim was to analyze these variables and help plan and implement targeted programs that can enhance the maturity of safety culture. In this study, the participants were selected by the census method. The total number of participants was 143. NASA (National Aeronautics and Space Administration Task Load Index) task load index (22-21) and a standard questionnaire approved by the American National Institute of Mental Health with a reliability coefficient of 0.92 were used to measure job stress (23). Also, the Persian version of the HSE standard questionnaire with a reliability coefficient of 0.89 was used (24). A demographics form was completed along with the questionnaires. The form included age (year), marital status (single/married), tenure (year), and type of employment. While completing the questionnaires, respondents were asked to read the items carefully. They were asked to select "completely agree" if an item was found totally in line with their working conditions and opinions and to select "completely disagree" if they disagreed with an item. They needed to select "agree," "no idea," or "disagree" if they held tentative attitudes toward items. Besides, the research colleague checked any and every questionnaire to ensure that they were answered completely when collecting the questionnaires. If they were not, they were returned to the respondent to complete so that complete and correct information would be collected.

A standard questionnaire with items organized on a five-point Likert scale was used to assess safety culture. This questionnaire describes the status of safety culture in ten sections. They include the status of training and competence; production-safety priority

ratio; communication; status of employee participation; accidents and quasi-accidents; organizational commitment and commitment management; status of supervisors, managers, and production line managers; safety and health laws and regulations; status of ignoring safety and health laws and regulations; and general attitude of employees towards safety culture. The questionnaire consists of 87 items in two parts: background questions and research questions. Items are answered on a five-point Likert scale (strongly agree, agree, no opinion, disagree, strongly disagree). Some of the items are scored inversely. According to this scale, the total score of a respondent is compared with the total average score of all respondents. If the individual's score is higher than the average, s/he has a positive safety culture; if it is lower, s/he has a negative safety culture. Given the number of items in this study, if a respondent's score was higher than 261, their safety culture was evaluated as positive; otherwise, it was assessed as negative.

The workload was assessed using the NASA task load index. The index entails a mental scale that ranges from 1 to 100 degrees and 6 subscales, including mental demand, physical demand, temporal demand, performance, effort, and frustration level. The average score of the subscales is reported as the total workload score. After completing their personal information, the respondent rates each subscale. Accordingly, if a person's mental load is between 0 and 25, the person's mental load is low. A score between 26 and 50 denotes moderate mental load, and scores between 51 and 70 describe high mental load. Lastly, a score from 71 to 100 denotes an extremely high mental load.

A standard questionnaire was used to estimate the level of job stress. The questionnaire is approved by the American National Institute of Mental Health and has a reliability coefficient of 0.92. This questionnaire contains 60 items distributed along the three sections of interpersonal relationships, physical condition, and

interest in work. The items are completed on a 5-point Likert scale (never, rarely, sometimes, often, and most of the time/always). The answers to all items are summed up to indicate the stress score of each occupational group on one of the three categories of low stress (≤ 116), moderate stress (117-140), and high stress (≥ 141).

Data analysis

The frequency was used to describe the qualitative variables, and Mean and Standard deviation were employed for quantitative variables. The data are additionally presented in diagrams. Besides, demographic characteristics and sub-scales were examined to achieve the overall mental load score and measure the relationship between it and the demographic variables affecting it. In this study, a correlation test and independent t-test were used to examine the relationship between safety culture and job stress, the relationship between mental load and safety culture, and the link between mental load and job stress. Data were analyzed using SPSS-19 statistical software, and graphs were prepared using the Microsoft Excel software(version 2013).

Results

Examination of demographic characteristics showed that the mean age of individuals was 36.11 ± 7.55 years. Moreover, the tenure of individuals was 8.126 ± 11.8 years. Of the respondents, 27% were long-term contractual workers, 36% worked under temporary contracts, and 37% were the permanent staff. Most of the participants (93.5%) were married, and 6.5% were single.

The results showed that the highest level of safety culture was related to employees with temporary contracts (346.94 ± 63.039) and the lowest to long-term contractual workers (312.81 ± 28.407). The score of safety culture according to the type of employment type is presented in Table 1.

The job stress results showed that the highest amount of job stress was related to permanent employees (183.60) and the lowest to long-term contractual staff (168.00). According to the type of employment type, the job stress score is presented in Table 2. The results of the relationship between job stress and demographic characteristics are shown in Table 4.

Table 1. Mean and standard deviation of safety culture scores by employment type.

		Mean \pm Standard deviation	Minimum	Maximum	Interpretation
Safety culture	Contractual employees	312.81 \pm 28.407	242.00	355.00	Positive
	Temporary employees	346.94 \pm 63.039	269.00	447.00	Positive
	Permanent employees	329.73 \pm 47.445	255.00	433.00	Positive
	Total	331.34 \pm 49.894	242.00	447.00	Positive

Table 2. Mean and standard deviation of job stress scores by employment type.

		Mean & Standard deviation	Minimum	Maximum	Interpretation
Job stress	Contractual employees	168.00 \pm (23.82)	131.00	168.00	High
	Temporary employees	171.55 \pm (22.71)	128.00	199.00	High
	Permanent employees	183.60 \pm (16.74)	137.00	211.00	Very high
	Total	180.43 \pm (21.19)	128.00	218.00	Very high

Table 3. Mean and standard deviation of mental load scores by employment type.

		Mean & Standard deviation	Minimum	Maximum	Interpretation
Mental load	Contractual employees	64.65 \pm (13.486)	38.67	93.83	Moderate
	Temporary employees	56.60 \pm (12.179)	36.67	86.67	Moderate
	Permanent employees	62.52 \pm (8.675)	48.33	77.33	Moderate
	Total	58.46 \pm (11.62)	36.67	93.83	Positive

The results showed that the highest mental load was related to the long-term contractual staff $64.65 \pm (13.486)$ and the lowest to the employees under temporary contracts $56.60 \pm (12.179)$. The mental load score according to the type of work contract is presented in Table 3. Besides, the relationship results between the amount of mental load and demographic characteristics are summarized in Table 4.

Statistical correlation test revealed that mental workload is significantly related to age ($r = 0.762$; $p = 0.04$).

Statistical correlation test showed a statistically significant relationship between safety culture and mental load ($r = 0.278$; $p = 0.030$).

correlation test showed a statistically significant relationship between mental load and job stress ($r = 0.293$; $p = 0.022$)

Discussion

In the present study, the average score of safety culture (331.3448) was evaluated as positive. The overall job stress in employees was 180.43, which indicates high job stress. Also, the overall mental workload in all employees was 58.46%, which reflects a moderate mental load. Safety culture and job stress were not significantly linked with demographic characteristics. Statistical correlation test showed a statistically significant relationship between safety culture and mental load. A statistically significant association was found between mental load and job stress, and there was a significant association between workload and age.

In a study conducted by Fernández et al. in a Spanish company, the average safety culture was positive. They introduced the safety management system, management commitments, and worker participation as key contributors to its safety culture. Fernández et al. argue that if managers have commitments to safety issues, the staff will be more interested in safety issues.²⁵ Rahmati's study found that safety and the safety culture among the staff of a

gas complex were in good condition.⁸ This finding corresponds with the results of our study. Since our study was conducted in the National Gas Company, where safety principles, culture, and training are prioritized, a positive safety culture score is predictable. In this study, safety culture was not significantly correlated with age and tenure.

A study conducted by Si-Hao Lin on the relationship between the safety climate in China reported no significant differences between age groups in terms of safety climate.²⁶ The reason can be attributed to the presence of peer groups in the workplace. In Eshaghi et al.'s study, age and tenure were significantly linked with the culture score, i.e., more experienced staff scored higher due to their more realistic view of safety issues.²⁷ Examining various aspects of safety culture and its influencing factors in a power plant, Reiman et al. found that age and job position resulted in significant differences in safety culture scores.²⁸ Zamanian's study showed that safety culture was not significantly associated with marital status,¹³ according to our findings. Safety culture entails ten dimensions, which are contributory and influential factors in the culture. They can be indirectly affected by other factors. Older people observe more safety culture due to greater experience, further education, and higher awareness. Thus, age is an indirect factor in the dimensions of safety culture. Nonetheless, marital status does not have an indirect effect on any dimension of safety culture. Najmabadi et al. have similarly pointed out that safety culture and marital status are not significantly associated.²⁹

The job stress results showed that the average job stress score of the company's employees was high, indicating high job stress in the staff. Mohammadfam's research in the automotive industry also showed that 88% of employees have high job stress.³⁰ which is consistent with our findings. It can be said, of course, that the National Gas Company is, by nature, a stressful industry for

employees because of the existing risks and high workload. A study of workers at the Norwegian Shelf oil and gas company found high job stress and a significant correlation between job stress and job accidents.²³ Rafieyan et al.'s study, which measured job stress among employees of the gas company, showed that many employees suffer from job stress.³¹ This agrees with the results of the present study. The reason can be the difficult working climate and great care required in this industry, as the slightest mistake may cause irreparable damage.

Evaluation of mental load among oil refinery employees using the NASA TLX shows that the total score of NASA-TLX among employees of different units is 83.56%, suggesting that the mental load in some working groups is large,³² which is compatible with the results of the study mentioned above. In Hoboubi et al.'s study in the context of a metal industry, the average total score of the mental load index was 71.22. The mental load score in both studies was in a moderate status.³³ The study of Rezai et al. in a tuna fish factory reports that the average mental load is 66, above the desired level, meaning that employees have a high mental load in their jobs.²⁰ In the present study, the mental load was 58.46, which indicates a moderate mental load.

A study examining the relationship between job stress and mental load by Lailun Nahar et al. found a significant job stress level among non-governmental employees because they felt less job security and a high workload.¹⁵ In this study, the job stress of permanent staff was high because they were entrusted with managerial positions and jobs with responsibilities, and managerial work is stressful by nature. A study examining the associations between safety culture and job stress among employees of telecommunication factories showed that about 80% of employees had high job stress.¹³ The study reports the relationship between safety culture and job stress as significantly negative.¹³ In the present study, the correlation test showed no significant relationship

between safety culture and job stress. However, there was a significant relationship between mental load and safety culture. Mental load leads to job stress, and the relationship between mental load and safety culture was negative. In our study, there was a statistically significant relationship between mental load and job stress. Cai-Feng's study indicates that high workload leads to job stress and has adverse effects on functioning.³⁴ In his study, Nasrudin states that heavy workload is the main cause of mental load and job stress, with a significant relationship held between them. The physical environment may exacerbate this factor.³⁵

By examining the safety culture, job stress, mental load, and the associated dimensions, we can identify the weaknesses in an organization. Upon the elimination of the weaknesses, we can reduce accidents. Since there is a significant relationship between safety culture and mental load and between job stress and mental load, it is worthwhile to perform interventions that can promote safety culture and job stress and study the effect of these interventions on mental load.

Conclusion

The employees of an organization are part of the organization's assets, and therefore, maintaining their mental and physical health can have a significant impact on the organization's productivity. The present study shows that job stress should be controlled in work environments where sensitive activities are performed. Therefore, people's work responsibilities should be reduced to help control people's mental load. Reduced job stress, peer support, and adequate management understanding of job stress and mental load can be important factors in reducing accidents in workers, improving the safety culture level, and increasing the organization's productivity.

Limitations

It will take time to obtain permission to distribute the questionnaires and not return some of the

questionnaires by the staff and re-filling the limitations of the plan.

Ethical considerations

The authors fully respect ethical issues (including plagiarism, data fabrication and/or information falsification, duplication and/or posting, etc.). The questionnaires used were without personal details, and all participants in the study were given sufficient information about the objectives and process of the study.

Acknowledgments

The management and all the petrochemical staff who helped us implement this project are warmly appreciated. Besides, this article was approved by the research committee of North Khorasan University of Medical Sciences (NKUMS) with the research code 970174 and the ethics code IR.NKUMS.REC.1397.124. We hereby express our gratitude and appreciation to the research vice-chancellery of NKUMS.

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