

Role of Human Factors in Awareness Enhancing in Workplaces

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Abstract

Aims: Ability of employees to maintain awareness of the work situation, understand the information it holds, and predict how situations will develop are important factors in prevention of industrial accidents. The aim of current research was to investigate the relationship of safety climate and work overload with work situation awareness.

Instrument & Methods: This cross sectional study was administrated between October and November 2015 in the National Petrochemical Company (NPC). 190 persons were selected by stratified random sampling method. Validated instruments were used for data collection on work situation awareness, safety climate and work overload. Data was analyzed by SPSS 15 software using Pearson correlation coefficient and stepwise regression analysis.

Findings: Safety climate (68.67 ± 7.13) had significant ($p < 0.01$) correlations with work overload (16.17 ± 3.21 ; $r = 0.26$) and work situation awareness (65.55 ± 6.22 ; $r = 0.5$). Also, work overload and work situation awareness had a significant negative correlation ($r = -0.39$; $p < 0.01$). Safety climate and work overload both predicted 33% of work situation awareness. Individually, safety climate predicted 21% ($t = 6.81$; $\beta = 0.43$) and work overload predicted 10% ($t = -4.43$; $\beta = -0.28$) of the work situation awareness.

Conclusion: Safety climate and work overload affect the work situation awareness among workers.

Keywords

Cliamte [<https://www.ncbi.nlm.nih.gov/mesh/68002980>];

Safety [<https://www.ncbi.nlm.nih.gov/mesh/68012449>];

Workload [<https://www.ncbi.nlm.nih.gov/mesh/68016526>];

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Introduction

After a number of catastrophic events (most remarkably the Piper Alpha catastrophe in 1988 in which 167 workers died [1]), oil and gas companies are making every endeavor to warrant that their job-related accident rates are kept as low as feasible [2]. In most job-related accidents, there is a causal sequence of organizational conditions and person errors [3], in a way that human factors can be ascribed to 70–80% of job-related accidents in high-jeopardy industries [4]. One critical element in predicting job-related accidents is the ability of employees to sustain an adequate understanding of their work situation. This means having a high level of awareness of job duties and workplace conditions, and judging how these may change in the near future to predict how the situation will develop [5].

Cognitive psychologists have long been interested in attention [6], and the role of cognitive skills in safety is well-recorded [7]. In industries, the necessary attention skills are referred to as 'situation awareness' (SA). SA is defined [8] as "... the perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status in the near future". SA has been further studied in aviation industry [9], in the fields such as aircraft maintenance [10], the military [11], driving [12], anaesthesia [13], the maritime industry [14], and nuclear power plants [15].

Cognitive skills, such as work situation awareness, are known to be sensitive to the elements of work-related conditions, e.g. safety climate and work overload [16, 17], which are prevalent in many high-hazard industries and organizations, for example oil and gas exploration, where employees work on remote installations, often in high time-pressured, dangerous conditions [18]. Ongoing research of the causal events shows failures in situation awareness and risk assessment [19]. Therefore, it is important to identify factors reducing work situation awareness.

Employees' perceptions on safety climate have been regarded as an essential guide to safety performance and situation awareness, as measuring the precursors of job-related accidents diagnosed in a safety climate analysis has been prepared compelling proactive accident management tools. studies report

along this line have shown that workers with negative perceptions of safety climate in organization (e.g., high workload and work pressure) tend to engage in unsafe acts, which in turn increases their susceptibility to accidents and injuries [20, 21]. Safety climate is defined as "employees' perceptions pertaining to safety policies, procedures, and practices" [22]. Policies and procedures are the guidelines established to certify safe behavior, and practices are the process of the implementation of the policies and procedures as well as workers' perceptions of the relative importance of safe behavior at workplace [23]. As some researchers have indicated that a positive safety climate is a critical part of a safe workplace, safety climate is a theoretical term concentrating more on the perception of behaviors than on the behaviors themselves [24]. Safety climate reflect the extent to which workers believe that their individuals' safety and health are valued within the organization and reflect the relative emphasis that employees believe is placed on safety versus productivity [22, 25].

In addition, unusual high workloads can affect individuals' performance [26]. Work overload was defined [27] as "a hypothetical construct that represents the cost incurred by a human operator to achieve a particular level of performance". If workload is high or the tasks are very complicated, it can mean that workers are involved by attending to particular tasks, or are distracted by other pressing issues to tackle, and so do not apportion adequate time to monitor their work situation. In doing so, their situation awareness will be damaged, as they may be unaware of situational changes, and may make improper decisions based on incomplete or incorrect data [28]. Consequently, they may be unable to react as quickly as they should on unforeseen incidents [2].

Although oil and gas industries try to maintain the correct balance between production pressures and safety [29], in today's energy market, changing demand is an intrinsic characteristic of the oil working environment and therefore work does not always occur at a constant rate. Low workload phases do occur (e.g. waiting on weather), but more typical are periods when workload sharply increases (e.g. due to production pressures, or when the

number of workers on workplace is low). Studies indicate that increased workload has a detrimental effect on workers' psychological wellbeing [30-32].

In attention to above materials, the aim of current research was to investigate the relationship of safety climate and work overload with work situation awareness.

Instrument & Methods

This cross sectional study was administrated between October and November 2015 in the National Petrochemical Company (NPC). Regarding to the extent and distribution of the employees in different parts of the company stratified random sampling was used. The sample size was calculated by the procedure recommended by Fritz & MacKinnon [33] as 180. Given the likelihood of failure to complete or return questionnaire, almost 190 employees were selected. Those who lack the interest in participating in current research were excluded and new samples were added.

6 demographic factors (age, gender, marital status, education, years of working experience and shift) were recorded for each sample. Validated instruments were used for data collection on work situation awareness, safety climate and work overload. At first, all questionnaires were translated from English into Persian and independently back-translated into English by a second translator. The few discrepancies between the original English and the back-translated version resulted in adjustment in the Persian translation based on direct discussion between the translators. At next step, psychometric characteristics of instruments were examined. Linguistic validation was performed by 3 experts of psychology department and 5 experts of safety and health departments. Thus, the questionnaires were piloted and finalized with an advisory group of workers to ensure that the scales items were comprehensible and appropriate to the context. Moreover, conceptual analysis was confirmed the content validity of all instrument. The questionnaires were distributed to workers with the help of union steward. Participants were assured of confidentiality and informed consent in written format was acquired from each them.

Situation Awareness Questionnaire (SA): had 20 items (5 positive and 15 negative) [34]

and the respondents indicated the extent of agreement with each statement on a 5-point Likert scale from "very often" (1 point) to "never" (5 points). The reliability of the questionnaire was measured by the Cronbach's alpha coefficient as 0.86 [34]. Evidence of reliability of this scale, as administered to Iranian relevant populations was 0.79 by Cronbach's alpha coefficient and 0.75 by Split-half method.

Workplace Safety Scale (WSS): Workers' perceptions of safety climate were measured with the 50-item workplace safety scale (WSS) developed by Hayes *et al.* [35]. This instrument assesses the employees' perceptions of work safety in 5 distinct constructs of safety climate (each had 10 items); job safety perception, coworker safety perception, supervisor safety perception, safety management perception, and safety programs and policies perception. All items were answered in a 5-point Likert scale ranging from "strongly disagree" (1 point) to "strongly agree" (5 points). The scores of participants were obtained by adding their responses to a 50 items. Higher scores indicate that employees perceive better safety climate in their work environment. The reliability of the scale was measured as 0.91 by Cronbach's alpha coefficient and it was calculated in our research as 0.87 Cronbach's alpha coefficient and 0.77 by Split-half method.

Work Overload Scale: had 4 items and was developed by Beehr *et al.* [37]. The scale refer to general perceptions about whether there was work density (eg, hours of work) in the job or not. Participants showed the extent of agreement with each statement on a 5-point Likert scale from "strongly disagree" (1 point) to "strongly agree" (5 points). Mantineau [38] has reported the internal reliability of this scale using Cronbach's alpha as 0.83 and we calculated it as 0.79.

In order to control the confounding factors, questionnaires were completed by the selected samples in a quiet environment and away from the noise. Employees writing stated their satisfaction on participating in this research and in order to avoid bias in answering questions in the questionnaire. In addition, a covering letter explained the purpose of study, and that participation in the study was confidentially was guaranteed.

They were given to ensure that their responses would be confidential and responses by managers and supervisors will not see any way and the results will be evaluated collectively, not individually. Respondents were asked to return completed questionnaires inside the sealed envelopes either to the person who had distributed them or directly to the research team.

Data was analyzed by SPSS 15 software using Pearson correlation coefficient and stepwise regression analysis (to assess the safety climate and work overload to predict work situation awareness).

Findings

All participants were men and 162 (90.0%) were married (Figure 1).

Figure 1) Demographic characteristics of the samples (N=180)

Parameter	Number	Percentage
Age		
18 to 29 years	49	27.5
30 to 41 years	122	67.5
42 to 53 years	9	5
Sex		
Male	180	100
Woman	-	-
Marital status		
Married	162	90
Single	18	10
Education		
MSc (MA) degree or higher	58	32.5
BSc (BA) degree	49	27.5
High school	73	40
Primary school and lower	-	-
Work experience		
5 years and lower	63	35
6 to 15 years	43	24
16 to 25 years	43	24
26 years and higher	31	17
Shift status		
Shift	130	72.5
Not shift	50	27.5

Safety climate (68.67±7.13) had significant (p<0.01) correlations with work overload (16.17±3.21; r=0.26) and work situation awareness (65.55±6.22; r=0.5). Also, work overload and work situation awareness had a significant negative correlation (r=-0.39; p<0.01).

Safety climate and work overload both predicted 33% of work situation awareness. Individually, safety climate predicted 21% (t=6.81; β=0.43) and work overload predicted

10% (t=-4.43; β=-0.28) of the work situation awareness.

Discussion

Previous studies have demonstrated that work situation awareness is related to workplace safety behavior and accident occurrence [2, 34], and this research aimed to discover how safety climate and work overload can affect work situation awareness. The results showed safety climate significantly predicted work situation awareness among workers. This is consistent with the findings of the previous studies [39-44] and can be interpreted based on the following possibilities:

First, the studies showed that safety climate is related to perceived helplessness and uncontrollability. The perception of uncontrollability usually occurs when a person has previously failed to achieve their career goals. If people think that they are unable to control events and attribute them to internal/stable/global causes, would perceive helplessness; Helpless individuals perceive future events uncontrollable and therefore, decrease the attention to work situation [39]. The weak safety climate in work situations often suggested a sense of helplessness and uncontrollability. They felt that they had no control over accidents occurrence which, to them, seemed to be unavoidable and uncontrollable and therefore, maintaining the awareness of their work situation can't help them to prevention of accident [40].

Second, workers' positive perspectives regarding safety climate cause they perceive that their organizations are supportive, concerned, and interested in their general well-being and safety, as a result, they are more likely to perceive that their organizations value their safety rather than more production [41, 42]. Therefore, they show more attention to the surrounding environment to be less injured by the negligence and carelessness due to low situation awareness [42, 43].

Third, workers with positive safety climate perceptions expressed more job satisfaction and were more compliant with safety procedures and rules in workplaces. Therefore, they are doing their tasks with more awareness and satisfaction [44]. This is in

accordance with the norms of reciprocity and the social exchange theory.

Compliance with safety procedures and rules seemed to be an avenue for high organizational support and positive perceptions concerning management's concern and support, the high levels of job satisfaction is resulted of the perception of positive safety climate. This finding corroborates suggestions that have regarded the Social Exchange Theory and the Norms of Reciprocity as a basis of workers' safety-related behaviors and actions [44,45].

Safety climate has been related with decreases in accident frequency, where task and informational support from organization have reduced the incidence of injuries [46]. It is worth noting that efforts to increase the awareness of workers and thus motivate them to engage in safe work behaviors may fail if safety climate is weak [47]. In addition, the results showed work overload significantly predicted work situation awareness among workers. Several researches indicated how the concepts of workload, situation awareness, and safety performance relate to each other for individual operators [48].

These models generally indicate that work overload has a negative impact on work situation awareness, which in turn has a positive correlation with incidents among workers. That is, as workload increases, situation awareness decrease and subsequently safety performance worsens. A Structural Equation Model (SEM) indicate that the theoretical constructs of SA, workload, and safety performance are related and affect each other, so that the workload negatively affects the SA, a low SA enables disturb safety performance. In addition, work overload can result in increasing stress levels among workers that can cause to reduced working memory capacity and diminished attention. Work overload can result in poor concentration/alertness due to an overload on the personnel's cognitive resources, and this can interfere with the primary perception of the situation and conditions, causing inattention to the available information [2]. Sawaragi & Murasawa [49] concluded that the high workload of the task demands can affect much the decision maker's internal reasoning tasks, and the internal states of the cognitive processing within a decision maker and

interaction complexity can affect his/her ability of work situation awareness.

Safety intervention needs to focus on these variables, as well as on the prevention methods coping against them, and these concepts influence the increase of work situation awareness directly or indirectly. It is recommended that the future research examine the effects of safety interventions on increasing situation awareness. Further, with designing these interventions and with more attention to them, we can affect one of the most important influential variables in incidence of occupational accidents. The present study needs to be replicated in different populations and needs support that is more empirical. Until then, the findings of the study should be interpreted with caution. Further, the cross-sectional design of the study and participants (i.e., a group of employee) exert some limitations on the generalization of the findings. Finally, the problems and limitations on the use of self-reporting instruments should not be overlooked.

Conclusion

Safety climate and work overload affect the work situation awareness among workers.

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Ethical Permission: All participants have agreed with participation in this study. Informed consent was obtained from each participant and was approved the research by the appropriately constituted ethics committees where the work was done.

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