



## Original Article

# Safety Culture Assessment in Petrochemical Industry: A Comparative Study of Two Algerian Plants



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## ARTICLE INFO

## Article history:

Received 26 November 2013

Received in revised form

11 March 2014

Accepted 25 March 2014

Available online 3 April 2014

## Keywords:

safety behavior

safety culture

safety management

safety performance

## ABSTRACT

**Background:** To elucidate the relationship between safety culture maturity and safety performance of a particular company.

**Methods:** To identify the factors that contribute to a safety culture, a survey questionnaire was created based mainly on the studies of Fernández-Muñiz et al. The survey was randomly distributed to 1000 employees of two oil companies and realized a rate of valid answer of 51%. Minitab 16 software was used and diverse tests, including the descriptive statistical analysis, factor analysis, reliability analysis, mean analysis, and correlation, were used for the analysis of data. Ten factors were extracted using the analysis of factor to represent safety culture and safety performance.

**Results:** The results of this study showed that the managers' commitment, training, incentives, communication, and employee involvement are the priority domains on which it is necessary to stress the effort of improvement, where they had all the descriptive average values lower than 3.0 at the level of Company B. Furthermore, the results also showed that the safety culture influences the safety performance of the company. Therefore, Company A with a good safety culture (the descriptive average values more than 4.0), is more successful than Company B in terms of accident rates.

**Conclusion:** The comparison between the two petrochemical plants of the group Sonatrach confirms these results in which Company A, the managers of which are English and Norwegian, distinguishes itself by the maturity of their safety culture has significantly higher evaluations than the company B, who is constituted of Algerian staff, in terms of safety management practices and safety performance.

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## 1. Introduction

The term “safety culture” appears to have been first used after the Chernobyl disaster in 1986. The investigation report by the International Nuclear Safety Advisory Group (INSAG) of the International Atomic Energy Agency (IAEA) pinpointed “poor safety culture” as one of the contributing factors to this worst nuclear

power plant accident in history. Although the concept of safety culture has been used more often in safety research, particularly in high-risk industries such as nuclear power, oil, gas, chemical, construction, etc. [1], not much research has examined the relationship between safety culture and safety performance. Recently, many industries showed a growing interest in safety culture concept as a means of potential accident reduction associated with

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unforeseen working situations and as in the ordinary tasks [2]. Safety culture is the main indicator of safety performance [3].

The safety culture is a polemical and complex concept which requires the theoretical and empirical clarification [4]. Several definitions have been attributed to the safety culture concept [2,5–9]. Nevertheless, most of them are wide ranging and implicit. The safety culture has been defined as the product of interactions between people (psychological factors), jobs (behavioral factors), and the organization (situational factors) [10]. It recognizes explicitly that this tripartite interaction is also represented in the definition given by Advisory Committee on the Safety of Nuclear Installations [11].

Cooper [2] considers those attitudes, perceptions, and faiths of individuals, their behavior, and the safety management systems as well as the situational objective characteristics as the constituents of the safety culture of the organization.

Fernández-Muñiz et al [12] consider the culture of safety as a component of the organizational culture that refers to the individuals, to the work, and to the organizational characteristics that can affect their health and safety. The purpose of a positive safety culture is to create an atmosphere in which the employees know the risks to which they are exposed in their workplace and the means of protection.

The culture of safety is an important management tool in checking the faiths, the attitudes, and behavior of the employees regarding safety.

According to Lefranc et al [13], safety culture is based on three main components: behavioral, organizational, and psychological. There seems to be a consensus suggesting that the organizational and contextual factors are important in the safety culture definition. The psychological component aims to analyze the attitudes and perceptions of the individual and the group. The behavioral component evaluates external factors (wearing Personal protective equipment (PPE), following operating procedures, etc.) applicable to individuals in the field and observable behavior. Finally, the organizational component corresponds to an analysis of business operations through its policies, procedures, and structures.

In summary, although a lot of different factors have been found to underlie safety culture, the most commonly measured factors are regarded as safety policies, safety rules and procedures, incentives, training, communication, workers' involvement, safety managers' commitment, and employees' safety behavior. Likewise, the dependence relations among these dimensions constitute the hypotheses of the study.

Even though traditional measures of safety performance rely primarily on some form of accident or injury data, safety-related behaviors such as safety compliance and safety participation can also be considered as components of safety performance. Safety compliance represents the behavior of the employees in ways that increase their personal safety and health. Safety participation represents the behavior of employees in ways that increase the safety and health of co-workers and that support an organization's stated goals and objectives [14].

In the current study, we conceptualized employee safety performance as a bidimensional, facet-specific aspect of job performance. In accordance with Griffin and Neal [15], we suggest that employee safety performance can be operationalized as two types of safety behaviors: safety compliance and safety participation. In this study, safety compliance refers to behaviors focused on meeting minimum safety standards at work, such as following safety procedures and wearing required protective equipment. Safety participation refers to behaviors that support workplace safety, such as helping coworkers with safety-related issues or voluntarily attending safety meetings. As such, safety compliance and safety participation parallel two types of general work performance: task performance and contextual performance, respectively [16].

The Algerian petrochemical industry represented by the group Sonatrach plays an important role in the current global economic environment. Its safety performance is thus of great importance. From 2004 to 2006, this sector was the field of several accidents of which GL1k<sup>a</sup> and Nezla 19<sup>b</sup> classified among the major accidents of the world petroleum industry.

These accidents revealed grave weaknesses in the prevention plans in place. This incited business managers to introduce changes in the management system Health, Safety, and the Environment (HSE) and a new policy HSE was organized in 2006.

Recognizing the pivotal effect of safety culture on safety outcomes such as injuries, fatalities, and other incidents, the purpose of this research is to realize a comparative study of safety culture assessment in two petrochemical plants of Sonatrach (which present differences in terms of cross-cultural and accident rates), to identify main indicators for safety culture, and analyze the possible relations between them, and then to produce specific recommendations for the direction of Sonatrach as the way of realizing a sustainable improvement of successful HSE.

The two companies in question are SH/DP/HRM and SH/BP/STATOIL. SH/DP/HRM is the Company of Sonatrach DP Hassi R' Mel, is situated 525 km south of Algiers, the field spreads out over more than 3500 km<sup>2</sup>, and it is one of the biggest gas fields in the world scale. SH/BP/STATOIL is the In Amenas gas field located in the eastern central region of Algeria, operated in partnership between Algerian state oil company, Sonatrach, British Petroleum (BP), and Statoil (a Norwegian firm).

SH/BP/STATOIL (Company A) is composed of Algerian-European staff, whereas SH/DP/HRM (Company B) has a purely Algerian human component. Both companies are almost the same size, with a staff of approximately 3000 employees.

## 2. Materials and methods

The final version of the safety culture survey comprised 41 items. Responses were recorded on a 5-point scale from (5) strongly agree to (1) strongly disagree. Minitab 16 software (Pennsylvania State University) was used in this study, along with various tests including descriptive statistical analysis, correlations, factor analysis, and reliability analysis.

Based on an extensive literature review, it was hypothesized that a positive safety culture perceived by employees (i.e., a high score of management commitment, policies, rules and procedures, incentives, training, communication, workers' involvement, etc.) would result in better safety performance (i.e., a high score of employees' perceptions about their safety compliance and safety participation).

The survey was distributed to 1000 randomly selected employees of two national state oil companies in Algeria. A plain language letter accompanied the survey, highlighting the aims of the study and encouraging employees to express their true feelings. In total, 508 responses were received and valid, representing a high valid response rate of 51%. Of these responses, 300 (60%) had been employed in Company A, and 208 (42%) had been employed in Company B. The data collection was completed in approximately 12 months. The study period was from September 2011 to September 2012. Details about the two companies that were studied are presented in Table 1.

<sup>a</sup> Accident occurred on January 19th, 2004 at the level of the complex of liquefaction of the industrial park of Skikda - Algeria. It caused 27 deaths, 80 wounded persons, and three units of liquefaction.

<sup>b</sup> Accident of the well Nezla 19 Gassi Touil (Hassi Messaoud) occurred on September 15th, 2006. There were nine victims, borers of the Entreprise Nationale des Travaux aux Puits (ENTP) among whom two are reported missing and the loss of the device of drilling of a 4 million dollar cost.

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