



Testing the validity of the International Atomic Energy Agency (IAEA) safety culture model[☆]



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ABSTRACT

This paper takes the first steps to empirically validate the widely used model of safety culture of the International Atomic Energy Agency (IAEA), composed of five dimensions, further specified by 37 attributes. To do so, three independent and complementary studies are presented. First, 290 students serve to collect evidence about the face validity of the model. Second, 48 experts in organizational behavior judge its content validity. And third, 468 workers in a Spanish nuclear power plant help to reveal how closely the theoretical five-dimensional model can be replicated. Our findings suggest that several attributes of the model may not be related to their corresponding dimensions. According to our results, a one-dimensional structure fits the data better than the five dimensions proposed by the IAEA. Moreover, the IAEA model, as it stands, seems to have rather moderate content validity and low face validity. Practical implications for researchers and practitioners are included.

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1. Introduction

In 1986 the Chernobyl catastrophe led to the emergence of 'safety culture' as a new concept in high reliability organizations (HRO) in general and in the nuclear industry in particular. Experts at the International Atomic Energy Agency (IAEA) analyzed the disaster and came to the conclusion that the occurrences could not just be attributed to human error, the technology, or even the socio-technical system. The identified cause was a group of organizational and management factors which they labeled as safety

culture. The report was published by the IAEA (1986) as Safety Series No. 75-INSAG-1. Since the appearance of this term, all of the hazard industries have adopted it as their banner in the efforts to promote safety in their installations and operations (Wilpert and Schöbel, 2007).

During the last 25 years, the IAEA has continuously worked toward the conceptualization and theoretical development of safety culture and the creation of specific methodologies and tools for the assessment and development of strong safety cultures. One of the most remarkable contributions of the IAEA has been its five-dimensional model of safety culture. This model has clearly influenced a sector – largely composed of technical professionals, such as engineers, physicists and chemists – eager to know exactly what that important concept called safety culture was, what they should do to assess it, and how they could build strong safety cultures capable of avoiding future catastrophes. As a result, the IAEA model has become widely used in the nuclear industry as the main guide to safety culture.

Despite the relevance of the IAEA model to nuclear safety outcomes, its validity has never been empirically tested. This will be the aim of the present study and our main contribution to the advancement of safety in the nuclear industry. In order to achieve this goal, three studies are presented. The first study tests the face validity of the model on the basis of the opinions of a sample of non-experts in organizational behavior with no previous experience in the nuclear industry. In the second study, a sample of experts in organizational

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behavior is used to test the content validity of the model. Finally, the third study examines the factorial structure of a questionnaire based on the model in a sample of workers in a Spanish nuclear power plant (NPP).

1.1. Conceptualization of safety culture

Safety culture presents a great diversity of meanings and connotations due to the broad dimensionality of the concept. It has sometimes been explained in the form of intuitive slogans (e.g. “do the right thing even when nobody is watching” or “the way we do things around here”). Nevertheless, the understanding, assessment and improvement of the safety culture have typically been based on the way it has been formally defined.

Safety culture has been defined by the IAEA (1991) as “that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance” (p. 1). This was the first definition of safety culture and one of the most influential in the field. The IAEA definition “was carefully composed to emphasize that safety culture is attitudinal as well as structural, relates both to organizations and individuals” (IAEA, 1991, p. 1). Therefore, the IAEA (1991) highlights two general components of safety culture: “the first is the necessary framework within an organization and is the responsibility of the management hierarchy. The second is the attitude of staff at all levels in responding to and benefiting from the framework” (p. 5).

The definition of safety culture of the IAEA has stimulated researchers’ interest in the topic, but it is not exempt from criticism. Wilpert (1991) referred to the ‘characteristics’ term in the definition as being rather vague. On the other hand, he warned that this definition leaves out safety-related behavior, which is important because, as he reminds us, attitudes and actions do not always correlate strongly. In our view, another critical issue is that cultures are ‘shared’ by individuals and groups pertaining to the same country, society, organization, etc.

Later, the IAEA (1998) adds that the ‘characteristics’ and ‘attitudes’ referred to in its definition should be commonly held (addressing the shared issue) and relatively stable. Furthermore, in an effort to extend its own definition to other contents, the IAEA (1998) clarifies that “safety culture is also an amalgamation of values, standards, morals and norms of acceptable behavior. Therefore, safety culture has to be inherent in the thoughts and actions of all the individuals at every level in an organization” (p. 4).

The theoretical and practical development of safety culture has been closely related to the development of the term “safety climate”. In this context, it is important to mention the theoretical distinction between these two constructs. While safety culture is believed to encompass stable shared basic assumptions, beliefs, values and norms regarding safety at work, safety climate is presented as shared perceptions of safety at a given point in time. Specifically, safety climate generally includes day-to-day perceptions towards the working environment, working practices, organizational policies, and management (Yule, 2003). Safety climate is viewed as a manifestation or “snapshot” of safety culture (Flin et al., 2000); it is more transient and less stable, and reflects somewhat the current-state of the underlying safety culture (Mearns et al., 2001, 2003). Because of this, many authors rely on climate studies to capture the state of HRO’s safety cultures, and these terms have been often used interchangeably (Cox and Flin, 1998; Rollenhagen, 2010) although it is important to define each construct precisely and use them accordingly.

1.2. Dimensions of safety culture

Safety culture comprises a variety of contents that are indistinctively called indicators, principles, traits, characteristics, components, dimensions, attributes or a combination of these (e.g., the Institute of Nuclear Power Operations [INPO] and the World Association of Nuclear Operators [WANO] refer to principles; the Health and Safety Executive [HSE], to indicators; the Nuclear Regulatory Commission [NRC], to components; and the IAEA, to characteristics). Following the psychometric terminology and reflecting the assumed multidimensional nature of safety culture, we will use the term *dimension* when referring to each of these contents. When a dimension is composed of smaller sub-contents, these will be referred as *attributes* of that specific dimension.

The existing conceptualizations, models and assessment tools for safety culture reflect a lack of consensus on the dimensions that comprise the safety culture construct. There is an overlap between the identified dimensions as well as a lack of conceptual clarity. The dimensionality of safety culture, as reported by Guldenmund (2000), ranges from 2 to 19 dimensions, with little coincidence in their labels. The labels given to these dimensions vary considerably from author to author, even when they try to refer to the same safety culture contents. Several reasons lie behind the existing multitude of safety culture dimensions and the lack agreement between them, for instance:

- The numerous definitions of safety culture, which show little consensus about the operationalization of the construct.
- The variety in authors’ professional and academic backgrounds (e.g. psychology, sociology, engineering, economics, etc.), their idiosyncratic writing styles, and the paradigms their work is influenced by (e.g. constructivism, positivism, relativism, etc.).
- The use of empirical atheoretical approaches to identify the dimensions of safety culture (e.g. factor analysis [FA], principal components analysis [PCA], etc.) without the guidance of solid theoretical models, leaves researchers considerable freedom to label their dimensions. For a detailed explanation of this point, the reader is directed to Guldenmund (2000).
- Different industries (e.g. nuclear, petrochemical, aviation, mining, construction, etc.) often address distinct organizational and management aspects having an impact on safety outcomes.

The labeling of dimensions requires special caution, as quite often labels have a life of their own beyond what the items making up these dimensions operationally measure. This is especially true when assessment tools are used by practitioners. If a label does not adequately capture and summarize the content of its corresponding attributes, it can be confusing and misleading in practice.

A number of safety culture reviews have attempted to identify the commonly accepted dimensions of safety culture (see Table 1). According to Sorensen (2002), most investigators agree that the dimensions of safety culture are: good organizational communication; good organizational learning; senior management commitment to safety; and a working environment that rewards identifying safety issues. He also noted that some investigations have included a dimension related to management and organizational factors, such as a participative management leadership style. Wiegmann et al. (2004) concluded in their review that safety culture includes five dimensions: organizational commitment; management involvement; employee empowerment; reward systems; and reporting systems. The Health and Safety Executive (HSE, 2005), after reviewing the literature surrounding safety culture, identified the following five dimensions: safety leadership; two-way communication; employee involvement; learning culture; and attitudes towards blame (a just culture). Meanwhile, Choudhry et al. (2007) take the view that safety culture comprises

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