Safety Culture: Analysis and Intervention

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Abstract

The paper deals with issues of safety culture in three steps. The first step will refer to the origins and central connotation of culture and of safety culture. The second step will touch on the difficulties of analysing and measuring safety culture with reference to some recent research programs. The concluding third step will propose some approaches on how to introduce and sustain an effective safety culture in high hazard systems.

1 Introduction

It is surprising that a a novel concept suddenly catches the attention in safety thinking: "Safety Culture". Coined in the aftermath of Tchernobyl catastrophe (1986) as an explanatory concept for the accident, it has now caught the imagination virtually of all hazard industries: chemical process industries, civil and military aviation or space research, railway systems, petrochemical and pharmaceutical industries, medicine. Nevertheless, will the concept amount to a surplus value of safety? After almost 50 years of civil nuclear power generation one of the first systematic international comparative study of nuclear power plants unequivocally comes to the conclusion that world-wide nuclear industry condones the principles of safety culture, a flag which may today be considered a characteristic of the industry (Rochlin & von Meier, 1994).

Culture has been called an omnibus term. Everyone uses it, alas most likely everyone in a different way. However, the vagueness and ubiquitous use of terms set barriers to their clarification (Büttner, Fahlbruch & Wilpert, 1999). This is not to blame practitioners, after all, social science has its particular problems with the term culture as well. Therefore, it seems timely to start yet a new attempt to clarify "culture" in relation to "safety culture".

2 Scientific Backgrounds of Culture and Safety Culture

Anglo-saxon social and cultural anthropology have given the first meanings to the term culture in social sciences although two major camps claim property rights to the correct and appropriate use of its understanding: "culture as patterns of behavior" and "culture as pattern for behavior" (Keesing, 1974).

In the 1980s organization science appropriated the term culture by using the concept of *organization culture* as a promising theoretical concept and profitable research paradigm. However, one dominant model emerged due to the fact that it

achieved something of an integration of the two camps mentioned before: the approach developed by the American social and organizational psychologist Schein (1985). Schein proposes a three-layered conceptualization of culture. The fundamental basis, the essence of organization culture are the unquestioned, unaware and pre-conscious deep layers of basic orientations and assumptions which operate unconsciously and define the ways organization members view themselves, their organization and its environment (Schein, 1985:6). Thus, this deep level provides meaning and identification to the members of an organization. The second layer above represents the shared values and norms of the organization. They are more easily accessed by the consciousness, but their analysis usually implies conjectures from the observable artifacts and actual behaviors of organization members. In its upper most layer of Schein's conceptualization of organizational culture will be found the directly observable actual behavior patterns of an organization's members, its technology and artifacts. The three layers indeed encompass the different approaches of received culture theories, offering a very comprehensive, holistic conceptualization of organization culture.

However, it is a result from the shock of the Chernobyl catastrophe when the International Safety Advisory Group (INSAG) of the International Atomic Energy Agency (IAEA) tried to comprehend the Chernobyl events. Much more complex systemic dynamics seemed to play a crucial role in bringing about the catastrophe than usually assumed. After several meetings INSAG agreed to the following definition (INSAG, 1991):

"Safety culture is that assembly of characteristics and attitudes in organization and individuals that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance"

Features and attitudes of organizations and of individuals are used to define safety culture here, therefore, the definition remains too much in the mental-cognitive domain. There exists lots of research evidence in social psychology that attitudes and action do not always correlate highly. Already in 1991, the original INSAG definition was criticized because it leaves out what is of primordial importance: *safety related behavior* (Wilpert, 1991).

The "working definition" of the British Advisory Committee on the Safety of Nuclear Installations (ACSNI, 1993) gives a somewhat more precise definition which comprises elements that refer also to the deeper defining dimensions of organization culture as described by Schein:

"The safety culture of an organization is the product of individual and group values, attitudes perceptions, competencies, and *patterns of behavior* that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (ACSNI, 1993:23, our emphasis).

3 External Assessment vs Self-Assessment

The hitherto most encompassing description and discussion of different models and analytic instruments to study safety culture has been collated by Wilpert et al., (2003) which covers altogether 20 different approaches. They differ in terms of

depth of analysis, psychometric quality criteria such as reliability, objectivity and validity as well as in terms of economy of use and manageability. However, one difference may be seen in the general conduct of the analysis, namely whether it is conducted by external experts from outside the studied organization or whether the analysis is pursued as a self-assessment by staff members of the organization itself.

External investigations usually utilize competent outsiders who conduct a safety audit, use questionnaires and interview guidelines, study the safety related features through observation and document analysis. The advantage of outsider investigations lies mainly in their characteristic of introducing perspectives into the analysis which are guided by experience from other contexts than those of the focal organization. However, keeping in mind Schein's model of organizational culture suggests that the approach will mainly be confined to the study of artifacts and, at best, to some degree to conjectures about underlying norms and values. In short, such analyses are likely to remain in the realm of attitudes, climate and directly observable phenomena. Deeper layers of the organizational culture will be less approachable.

Self-assessments, in contrast, are conducted by internal qualified staff members who are thoroughly familiar with their own organization. Self-assessments can easily and economically be carried out and have an immediate educational effect in the sense that once problems of safety culture are identified they may be discussed and intervention solutions can be developed and implemented. On the other hand, a disadvantage of self-assessment may be the danger of analysts remaining focused on aspects in the organization which have no taboo, are acceptable to management and staff, and are easily optimized. In consequence, self-assessment and external assessment are techniques which are not mutually exclusive but complementary. The research of the Berlin based Research Center System Safety has so far mainly focused on self-assessments in developing a screening technique for safety culture which will be presented below.

4 Towards an Integrative Model

The guiding theoretical framework for the screening technique and conceptualizations for interventions to introduce and improve safety culture in high hazard organizations to be reported below has been the somewhat further differentiated socio-technical systems approach (Fahlbruch & Wilpert, 1999). The differentiations refer to the postulation of a functional and a structural part of organizations. Functional aspects are considered all those features of high hazard organizations which need to be present in the organization in order to make it viable such as leadership, group norms, control, rules, procedures. Structural parts are elements of the organizational build-up such as organizational level, including the most important links to external institutions and organizations such as regulators or other reference organizations.

The next step required an operationalization of the socio-technical systems approach for the nuclear industry. This was achieved partly through theoretical integration of the socio-technical systems approach (Wilpert et al., 1997) and partly by pragmatically distinguishing five relevant system levels: *technology* (e.g.

hardware); *individual* (e.g. personal behavior, cognitive competence); *group level* (e.g. group dynamics); *organization* (e.g. leadership/control); *environment* (e.g. media/public).

Based on prototypical organizational features of nuclear plants the following structural elements were identified: regulation, utility, plant management, managers, plant personnel categories (operational staff, maintenance, systems technology, supervision, accounting, logistics, general staff), external staff.

The allocation of functional factors resulted in a clustering on the following levels: *individual level, group level, organizational level and technology.*

These structural and functional dimensions provided the basis for the development of a self-assessment screening methodology of safety culture and suggested conceptualizations for the introduction and maintenance of a sustained safety culture in nuclear plants.

4.1 Development of a screening instrument

workshop to identify weak points or domains in organization

According to Schein (1985) the underlying beliefs are for the analysis of safety culture of special importance. Thus, we suggest to use a stepwise procedure for assessments of safety culture. A first step could be to use a screening instrument to identify weak points or domains in an organization's safety culture. A second step could be a participative approach including moderated workshops etc. to increase the understanding of identified weaknesses. Otherwise, the assessment might become too complex, too time and resource consuming for an investigation.

In our case a screening instrument was developed for this first step. The development was based on the theoretical model stated above as well as on a comprehensive collection and analysis of published questionnaires and indicators. (Wilpert et al., 2003). The collection of the questionnaire items and indicators resulted in a first pool containing 3250 indicators which was reduced stepwise. The first reduction was based on origin of the indicator, only those indicators remained in the pool which originated from a complete published instrument or approach. The remaining 2650 items were further reduced by a weighting procedure based on empirical support, theoretical background, methodological soundness and relevant domain. The subsequent selection step was based on an inter-rater agreement according to the classification with the categories of functions described above. Items with an agreement of four raters were selected as well as those to which three raters agreed and to which the rater who originally had a different judgment did not object to the rating of the others. By this procedure the items could be reduced to 600. The next selection step was based on precision of meaning as well as on the content, i.e. similar items were used only once. The remaining 300 items were reduced to 98 by expert discussions within the Research Center System Safety and with experts from nuclear power plants. These 98 items were combined in a questionnaire and tested in a pilot study in a German nuclear power plant. The questionnaire was then sent to a random representative sample of the plant personnel according to different roles and functions. Participation was voluntary and anonymous. Altogether 151 questionnaires were distributed, 79 were returned (return

rate: 52,3%). Based on the returned questionnaires reliability and variance were computed and used for a further reduction to 58 items for the 13 categories of function: training, treatment of risks, safety related attitudes, underlying belief of the organization, communication, information and documentation, leadership, control, resources, rules and procedures, learning from experience, technology, relation with the extra-organizational environment.

The resulting questionnaire is a self-assessment screening instrument which can easily be used by qualified plant personnel. It identifies certain domains in which safety culture may need to be improved compared to other domains. Once the domains for necessary improvement have been identified, in a second step additional participative intervention methods will have to be developed as discussed above.

4.2 Safety culture interventions

In nearly all safety culture conceptualizations leadership and questioning attitude are seen as key elements. Therefore a training course for managers and supervisors of the nuclear industry was developed in interaction with the top-level management of one large German utility. Altogether more than 300 participants from different nuclear plants and from central administration units joined the three day seminars which were run 24 times over a period of 40 months.

The theoretical background for the development of these interventions was again the socio-technical systems approach adopted for the nuclear industry (Becker et al., 1995) as well as Schein's approach for analyzing organizational culture (Schein, 1985). A framework was developed based on the five subsystems of the nuclear industry – individual, team, organization, extra-organizational environment and technology – for factors identified to be crucial for the safety culture of an organization.

A workshop with the top-level management identified factors to be included in the training course. Based on these factors a first concept for the training and a training guide-line were developed and a pilot-training was run. The following four objectives were identified for the training in an overall sense:

- Improvement of a questioning attitude
- Improvement of systemic thinking
- Increasing sensibility of managers and supervisors for their function as a model for adequate safety oriented performance.
- Reflection of the professional identity of participants

The training had five modules: (1) Goals and visions of the organization, (2) main issues of safety and reliability – understanding of culture and safety culture, (3) measuring safety culture and organizational experience with safety culture, (4) influencing safety culture within the organization and in interaction with the public, (5) leadership as a driver of change.

The didactic concept of the training was a successive phase model, starting with an input phase, followed by an interaction phase and a reflection phase at the end.

Each of the five topics was planned according to these didactical principles, except the first, goals and vision of the organization, which was always presented by a top-level manager of the utility as kind of a "pep-talk" to underline top management's commitment to improving safety culture. The training ended with an overall reflection phase taking into account the goals and vision as well as the participants' expectations of the first part.

For the evaluation 14 of 24 training sessions with 196 participants were used. The evaluation was conducted in several steps: (1) An overall evaluation of the three days by participants. (2)A more detailed questionnaire filled in by participants. (3) A workshop with the top-level management rating the training. (4)A second questionnaire distributed to the participants 15 to 24 months after the training. (5) A second workshop with top-level management feedback on the evaluation. Altogether the evaluation showed that the training was successful, implemented changes were judged as exceeding expectations, safety culture is seen now as a relevant theme within the organization, the information exchange increased, and a new understanding of leadership developed. Last not least, the objectives of the training seem to have been reached for the majority of participants.

On the basis of the experience with the training courses an intervention concept for the introduction and sustained intensification of safety culture was then developed based on the following assumption: Intensification of safety culture is a long-term process of organizational development. Organizational development itself aims at a planned long-term effective and sustained change (in this case safety relevant) of patterns of behavior, attitudes and skills of employees, organizational and communication structures and structural rules in a broader sense. Therefore, on all organizational levels learning processes need to be initiated which must be supported by adequate instruments and methods. Furthermore, there is a need for clear and trustworthy support of the goals by top-level management. Thus, the concept includes a close linking of various approaches and instruments for different target groups or different hierarchical levels, variable starting points and directions of procedure – top-down, bottom-up and middle-both directions. Furthermore, three successive phases were conceptualized: initiation phase, implementation phase and evaluation phase.

In line with this conceptualization an organizational development process was started in 2001 in one German nuclear power plant which will be finished in 2004. A so called systemic safety group was created in that plant which serves as a driver for the permanent improvement of safety culture within the plant. Preliminary experience with this group shows that safety culture improvements can be achieved thorough this methodology, however, its final evaluation needs to be awaited.

References

1. ACSNI - Advisory Committee on the Safety of Nuclear Installations, Study Group on Human Factors (1993). *Third Report: Organizing for safety.* London: HMSO

2. Becker, G., Hoffmann, S., Wilpert, B., Miller, R., Fahlbruch, B.,Fank, M., Freitag, M., Giesa, H., & Schleifer, L. (1995). *Analyse der Ursachen von "menschlichen Fehlverhalten" beim Betrieb von Kernkraftwerken* (BMU-1996-454). Bonn: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.
3. Büttner, T. Fahlbruch, B. & Wilpert, B. (1999). *Sicherheitskultur. Darstellung und Analyse gebräuchlicher Verfahren und Instrumente.* Heidelberg: Asanger
4. Fahlbruch, B. & Wilpert, B. (1999). System safety – an emerging field for I/O Psychology. In C.L. Cooper & I.T. Robertson (eds.). *International Review of Industrial and Organizational Psychology, Vol. 14.* 55-93
5. INSAG - International Safety Advisory Group (1991). *Safety Culture*, Safety Series No. 75-INSAG-4. Vienna: IAEA
6. Keesing, R. (1974). Theories of culture. *Annual Review of Anthropology, 3*:73-97
7. Rochlin, G.I. & von Meier, A. (1994). Nuclear power operations: A cross-cultural perspective. *Annual Review Energy Environment, 19*, 153-187
8. Schein, E.H. (1985). *Organizational culture and leadership.* San Francisco, CA: Jossey-Bass
9. Wilpert, B. (1991). System safety and safety culture. Paper prepared for the IAEA/IIASA-Meeting on "The Influence of Organization and Management on the Safety of Nuclear Power Plants and other Industrial Systems", Vienna, 18 - 20 March
10. Wilpert, B., Maimer, H., Miller, R., Fahlbruch, B., Baggen, R., Gans, A., Leiber, I., Szameitat, S., & Becker, G. (1997). *Umsetzung und Erprobung von Vorschlägen zur Einbeziehung von Human Factors (HF) bei der Meldung und Ursachenanalyse in Kernkraftwerken* (BMU-1998-505). Bonn: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.
11. Wilpert, B., Büttner, T., Otto, S., Fahlbruch, B., Schöbel, M. Niehoff, J., & Rieger, M.E. (2003). *Self-assessment and enhancement of safety culture in NPP* (Final Report Reactor Safety Research – Project No.: 1501255). Performing Organization: TU Berlin.