

Visualizing team characteristics from the HRA perspective – its feasibility

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1. Introduction

The safe operation of complicated socio-technical systems, such as NPPs (Nuclear Power Plants) is the most critical factor determining their sustainability. This means that it is indispensable to precisely evaluate the safety of NPPs in a logical and consistent manner. For this reason, traditionally, the safety of NPPs has been evaluated by a PRA (Probabilistic Risk Assessment) or PSA (Probabilistic Safety Assessment) technique that provides a holistic result incorporating the probabilities of hardware failures with HEPs (Human Error Probabilities) quantified by various kinds of HRA (Human Reliability Analysis) techniques. Accordingly, the provision of sufficient data pertaining to PIFs (Performance Influence Factors) or PSFs (Performance Shaping Factors) that are helpful for understanding why human operators show a degraded performance is very important in conducting the HRA. Unfortunately, due to a lack of consistent framework, it is not easy to secure necessary data representing team characteristics (or team dynamics). In this study, as a method to visualize the nature of the team characteristics, the applicability of Hofstede's culture model is investigated.

2. Team characteristics

From the viewpoint of the HRA, although there could be a plenty of significant PIFs, it is possible to consider several PIF groups that are applied to the context of most tasks. They are: (1) the features of an object system that will produce desired outcomes (e.g., NPPs or commercial airplanes), (2) the required tasks that have to be properly carried out to safely and effectively control the object system, (3) the characteristics of human operators who have to accomplish the required tasks, (4) all kinds of aids including HMIS (Human Machine Interface System) to accomplish the required tasks, (5) the working environment in which human operators have to accomplish the required tasks, (6) the organizational structure that confines the role or function of the object system, human operators and their aids, and (7) the management and social aspects that add pressures and constraint to be satisfied in the course of producing the desired outcomes [1]. One of the typical PIFs included in the sixth group is team characteristics. According to Ref. [2], team characteristics (or team dynamics) refer to “degree of independence among individuals, operator attitudes/biases/rules, use of status checks, approach for implementing procedures, (e.g., aggressive vs. slow and

methodical).” (p. 5-12) For example, let us consider Fig. 1, which depicts a hypothetical component configuration with the behaviors of two teams for a given task such as “Confirm the pump is running.”

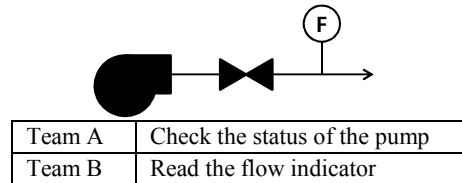


Fig. 1. A hypothetical component configuration with different team responses

In the case of Team A, there is no problem because the required task is properly conducted. In contrast, the behavior of Team B could be somewhat risky because there is a possibility for a wrong situation awareness (i.e., what if the flow indicator has failed?). In this regard, USNRC articulated that: “Investigations of actual incidents and simulator exercises from nuclear and other industries have demonstrated the importance of *intended violations (circumventions)* of procedures by plant personnel. ... the operators did what they felt was the optimal response to the evolving accident” [3]. This strongly implies that the team characteristics should be adequately considered in conducting the HRA because they are able to directly affect the team performance. Unfortunately, most of HRA techniques do not explicitly include the effect of the team characteristics on the team performance because it is not easy to systematically visualize their variability (i.e., how we can express the team characteristics?). In order to unravel this problem, Hofstede's model, which has been used to measure the cultural characteristics of a certain group, is considered [4].

3. Hofstede's culture model

3.1 Theoretical basis

According to Hofstede's culture model, two kinds of cultural profiles of a given group are crucial for understanding the values and norms of group members. One is the national culture and the other is the organizational culture. The profiles of each culture can be represented by five and six distinctive dimensions, respectively. Tables I and II briefly summarize distinctive dimensions belonging to the national and organizational culture with the associated meanings. With these dimensions, Hofstede suggested specific

formulae that are able to quantify the value of all the 11 dimensions. More detailed information on quantifying the value of each dimension can be found from Ref. [4].

Table I. Five dimensions pertaining to the national culture

Dimension	Meaning
PDI (Power Distance Index)	The extent to which the less powerful members of institutions and organizations within a society expect and accept that power is distributed unequally
IDV (Individualism Index)	Collectivism stands for a society in which people from birth onwards are integrated into strong, cohesive in-groups, which continue to protect them throughout their lifetime in exchange for unquestioning loyalty.
MAS (Masculinity Index)	Masculinity stands for a society in which emotional gender roles are clearly distinct; Femininity stands for a society in which emotional gender roles overlap
UAI (Uncertainty Avoidance Index)	The extent to which the members of institutions and organizations within a society feel threatened by uncertain, unknown, ambiguous, or unstructured situations
Long-term Orientation Index (LTO)	Long-term Orientation stands for a society that fosters virtues oriented towards future rewards, in particular perseverance and thrift.

Table II. Six dimensions related to the organizational culture

Dimension	Meaning
P1 (process vs. result oriented)	In a result oriented culture, people perceive themselves to be comfortable in unfamiliar situations, where every day brings new challenges, and a lot of effort is put into the work.
P2 (employee vs. job oriented)	An employee-oriented organization takes responsibility for people's welfare, and important decisions are often made by groups or committees.
P3 (parochial vs. professional)	With high professional scores, the employees' private lives are perceived to be their own business, where they are hired on the basis of their professional skills only.
P4 (open vs. closed system)	In an open culture, almost everyone fits into the organization, and it takes only a few days to feel at home.
P5 (loose vs. tight control)	Tight control cultures are cost-conscious, keep meeting times, and jokes about the company are rare.
P6 (normative vs. pragmatic)	Employees of normative cultures view their tasks toward the outside world as implementations of inviolable rules, correctly following organizational procedures.

3.2 Observed behaviors with respect to each dimension

Based on the values of the 11 dimensions, Hofstede tried to clarify the interrelation between their variations and the observed behaviors of people who belong to a given group. Table III compares the observed behaviors of group members who are included in two contrastive groups – those having high and low UAI values [4].

Table III. Observed behaviors with respect to UAI values

Low UAI	High UAI
<ul style="list-style-type: none"> ● Weak loyalty to employer ● Preference for smaller organizations ● Skepticism toward technological solutions ● Innovators feel independent of rules ● Top managers involved in strategy ● Power of superiors depends on position and relationships 	<ul style="list-style-type: none"> ● Strong royalty to employer ● Preference for larger organizations ● Strong appeal of technological solutions ● Innovators feel constrained by rules ● Top managers involved in operations ● Power of superiors depends on control of uncertainties

One of the most interesting behaviors in Table III is that people who belong to a high UAI group are supposed to follow rules or procedures prudently, which have been written with sound technical underpinnings (i.e., *Strong appeal of technological solutions* and *Innovators feel constrained by rules*). Conversely, it is possible to anticipate that people who are involved in a low UAI group are apt to show *circumventions* with respect to the nature of an on-going situation. Similarly, Table IV supports that the level of cohesiveness (or hierarchical structure) in a given group can be envisioned based on PDI values [4].

Table IV. Observed behaviors with respect to PDI values

Low PDI	High PDI
<ul style="list-style-type: none"> ● Decentralized decision structures; less concentration of authority ● Flat organization pyramids ● Small proportion of supervisory personnel ● Managers rely on personal experience and on subordinates ● Subordinates expect to be consulted ● Consultative leadership leads to satisfaction, performance and productivity 	<ul style="list-style-type: none"> ● Centralized decision structures; more concentration of authority ● Tall organization pyramids ● Large proportion of supervisory personnel ● Managers rely on formal rules ● Subordinates expect to be told ● Authoritative leadership and close supervision lead to satisfaction, performance and productivity

4. Discussion and Conclusion

In this study, as a promising solution for visualizing the team characteristics, the applicability of Hofstede's culture model is briefly investigated. As a result, it is expected that the use of Hofstede's culture model allows us to have another viewpoint that is helpful for understanding the relationship between the team characteristics and the associated team performance. Actually, the following excerpts advocate the importance of a cultural aspect in understanding the responses of operating personnel working in NPPs:

“However, the Fukushima Daiichi NPP accident identified significant and new human, organisational and cultural challenges that also need to be addressed. The accident revealed the importance of applying existing concepts and technical knowledge throughout the decision-making processes for design, operation and accident management [5].” (p. 54)

“Nuclear industry culture has been described as culture of control where organisations and workers emphasise that risks are in control and they do not appreciate the inherent uncertainties. This has also been recognised by some of the Fukushima accident investigations. In reality many activities in the nuclear industry, for example maintenance, design work, construction of new plants and emergency management involve dealing with unforeseen situations and performing underspecified work tasks. In order to smoothly cope with these the culture of the organisation need to support flexibility and adaptability to some degree [6].” (p. 19)

Therefore, although this study is still premature, it is reasonable to say that this study is a good starting point to scrutinize the nature of the team characteristics in a systematic manner, at least to some extent.

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