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Safety Culture Assurance and Improvement
Methods in Complex Projects –
Intermediate Report from
the NKS-R SC_AIM

Kaupo Viitanen¹
Nadezhda Gotcheva¹
Carl Rollenhagen²

¹VTT Technical Research Centre of Finland Ltd.
²KTH Royal Institute of Technology, Vattenfall AB, Sweden

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Abstract

A good safety culture is an essential ingredient for ensuring safety in the nuclear industry. The predominant approaches for safety culture are based on the assumption of stable and relatively homogeneous organizations, which often does not apply to contemporary project-oriented and turbulent environments. This study aims to identify and specify safety culture assurance and improvement methods for project environments.

A variety of approaches and practical methods for safety culture improvement was identified in the literature. Based on their apparent objectives, the methods were classified into the following groups: organizational structures, direct behavioural modification, interaction and communication, commitment and participation, training, promotion and selection. The literature review did not reveal methods intended specifically for project environments or guidelines for tailoring the existing ones to suit project environment. Further review of the literature concerning project environments revealed a multitude of project-specific challenges and boundary conditions in the domains of time, team, task and context that can potentially influence safety culture assurance and improvement.

Three empirical case studies in Nordic nuclear industry organizations were conducted. In the first case study, which focused on the use of safety culture ambassador group, it was found that this method can influence safety culture through multiple mechanisms and that the flexibility of this method can potentially rectify some of the challenges posed by project environment, or even benefit from them. Another case study focused on a safety-oriented project management seminar and showed the potential of this method in influencing safety culture through providing a forum for dialogue between different stakeholders. Finally, information exchange with experts provided additional insight into the current challenges and opportunities of safety culture work in projects. As a result of the theoretical and empirical work, a preliminary framework for evaluating the applicability of safety culture assurance and improvement methods was developed.

Key words

Safety culture, project management, organizational change

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NKS Secretariat
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DK - 4000 Roskilde, Denmark
Phone +45 4677 4041
www.nks.org
e-mail nks@nks.org

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(Contract: AFT/NKS-R(16)121/9)**

Kaupo Viitanen¹
Nadezhda Gotcheva¹
Carl Rollenhagen²

¹VTT Technical Research Centre of Finland Ltd.
²KTH Royal Institute of Technology, Vattenfall AB

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1. Introduction

The concept of safety culture was first introduced three decades ago in the aftermath of Chernobyl power plant disaster (see e.g. IAEA, 1992). The purpose of the concept was to shed light on the cultural and organizational factors that contributed to the disaster – implying that the mere technological or individual human factors were not sufficient in explaining it. This resulted in a change – or rather expansion – of emphasis in accident investigation practices: since the 1980s, organizational and cultural factors were discovered as the underlying factors in many accidents in different safety-critical domains. Examples of the accidents identified as resulting from cultural or organizational factors are the Challenger Space Shuttle launch (Vaughan, 1997), Piper Alpha oil drilling platform explosion (Cullen, 1990), sinking of the Herald of Free Enterprise (Department of Transport, 1987) and Clapham Junction train crash (Clarke, 1998). As a result, a need for a more profound understanding of safety culture emerged, which initiated research into defining and modelling the concept. One of the earliest and still often cited definitions of safety culture was developed by the International Nuclear Safety Group:

“Safety culture is 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.” (IAEA, 1991, p. 1)

This definition resulted in one of the earliest attempts to define the components of a good safety culture. The resulting model describes a variety of principles for policies, managers and individual staff (IAEA, 1991). The currently predominant safety culture model in the nuclear industry was developed by the IAEA (for a detailed description see IAEA, 2008), which proposes five characteristics of a good safety culture accompanied by descriptions of attributes of each of the characteristics. Another widely used approach to safety culture in the nuclear industry is the model of Traits of a Healthy Safety Culture (INPO, 2012b), which describes eight principles for a strong safety culture. Furthermore, in the nuclear industry there are safety culture related requirements (e.g. IAEA, 2016a; for Finnish legislation see STUK, 2014a, 2014b) that elaborate the characteristic traits of a good safety culture. Other definitions and models have been proposed in other domains by institutions such as UK Health and Safety Executive (Health & Safety Commission, 1993) and in scientific literature (for a review see Choudhry et al., 2007).

Safety culture is usually seen as having its roots in organisational culture theories. Most of the safety culture theories are inspired by Schein’s theory of organizational culture, which sees culture as an integrated and multi-level phenomenon. The very essence of culture according to Schein is at the level of shared *basic assumptions* (Schein, 2010). Basic assumptions are unconscious, taken-for-granted and non-negotiable beliefs and values of the group that have developed as a result of successful problem solving (Schein, 2010). Basic assumptions describe *“the correct way to perceive, think, and feel in relation to those problems”* (Schein, 2010, p. 18). Examples of safety-related basic assumptions are: What is safety and how can it be improved? What are the main hazards our organization should be concerned about? What causes accidents? What are the reasons why people make errors? These types of basic assumptions can be interpreted as the essence of safety culture.

In Schein’s approach, the tangible manifestations of culture are called *artifacts*. These can include the products of culture such as its physical environment, the behaviour of its

members, language, technology, jargon, myths and stories, rituals and ceremonies (Schein, 2010). The level of artifacts is easily observable, however, because the mechanisms that have led to the production of the artifacts are covert, it might be difficult to understand the meaning of the artifacts as symbols of the culture (e.g. Schein, 2010). This can be a challenge especially in the context of culture change or assessment because due to its visibility, the level of artifacts is the level of culture that is perhaps most readily approachable with intervention or measurement tools. Examples of safety-related artifacts can be technologies used by the organization, organizational structures, safety-related behaviours and visible safety promotion materials (Guldenmund, 2000; Nielsen, 2014).

The third level of culture – *espoused beliefs and values* – is conceptually situated between the basic assumptions and artifacts in terms of its accessibility. This level consists of elements such as ideals, goals, values and attitudes (Schein, 2010). As opposed to basic assumptions which are subconscious and tacit, members can be conscious about espoused values, which means that they can be assessed using methods such as document analysis, questionnaires or interviews (Nielsen, 2014; Schein, 2010). In the context of safety culture, espoused beliefs and values can include organization's or industry's safety-related goals, statements or policies, or attitudes towards safety (Guldenmund, 2000; Nielsen, 2014; Packer, 2002).

The majority of the established safety culture literature can be characterized as perceiving culture as normative (Edwards et al., 2013) and integrative (Haukelid, 2008; Richter & Koch, 2004) phenomenon. This means that safety culture on the one hand represents the correct means of achieving a good safety performance, and on the other hand emphasizes shared understanding and cohesion within a group. However, phenomena such as power relations, cultural ambiguity (e.g. a culture that does not provide clarity or consensus throughout the organization) or the cultural differentiation (e.g. resulting from the existence of multiple subcultures), might get neglected (Edwards et al., 2013; Haukelid, 2008; Richter & Koch, 2004). The weaknesses of the predominant approaches to safety culture become apparent in contemporary organizational forms and operating environments that are characterized by project-orientation, organizational fragmentation, and turbulence. The implications of these special organizational conditions to safety culture assurance have not been extensively discussed in the safety culture literature (see however Oedewald & Gotcheva, 2015a, 2015b).

An example of a situation in which project environment has been associated with safety culture issues is the Olkiluoto 3 nuclear power plant construction project. Two safety culture events have been identified and analysed by the Finnish Radiation and Nuclear Safety Authority (STUK, 2006, 2011). The first case involved work process and quality assurance problems during the construction of Olkiluoto 3 concrete base slab. The deficiencies at the tendering stage included not explicating nuclear-specific requirements to the tenderers and choosing a supplier with little experience in nuclear. During the preparation and execution of the project the deficiencies related to lack of coordination between the organizations and various other issues that eventually resulted in a change of the concrete composition in violation to regulations. The safety culture related issues contributing to the quality deficiencies, as identified by the Finnish regulator, included lack of understanding nuclear-specific requirements due to main actors being inexperienced in the nuclear industry and its expectations regarding safety culture, lack of efficient and open communication and coordination between the organizations involved, and lack of timely measures to make corrective actions (STUK, 2006). The second case was also related to the management of subcontractors: as a result of audits of the supplier of emergency diesel generators, it was found that the supplier was not provided up-to-date design criteria or quality management policy documents, and that the quality assurance requirements imposed by the plant vendor

were not properly communicated to the manufacturers (STUK, 2011). In its analysis of the case, the Finnish regulator found safety culture related deficiencies that included insufficient focus on safety when organizing the quality control and manufacturing process, lack of communication and understanding in the supply chain, and lack of clearly allocated responsibilities (STUK, 2011).

Another related analysis focused on quality assurance issues in nuclear new-builds during the 1970s and 1980s in the USA (Altman et al., 1984), which describes rather similar organizational deficiencies as the abovementioned two events that occurred during the Olkiluoto 3 construction (see also NRC, 2007). The reoccurrence of similar organizational issues 30 years later in a modern new-build project suggests that the issue of assuring safety culture in complex project environment is a major challenge that has not been sufficiently addressed. Such experiences further imply the need for a better understanding of how to assure and improve safety culture in complex projects.

Two apparent research gaps in the domain of safety culture inform this study: there is a relative lack of insight into the assumptions underlying practical safety culture improvement and how safety culture improvement is affected by contemporary organizational environments. A lot of the work done to date on safety culture is focused on understanding the nature of the concept, i.e. developing definitions and models describing the elements of safety culture, that are then utilized in organizational assessments or accident investigations. Conversely, empirical studies of safety culture improvement appear to be scarce (e.g. DeJoy, 2005; Hale et al., 2010). Also, the previous literature predominantly assumes the existence of a stable organizational environment, which suggests that the current approaches might not be directly applicable for safety culture assurance in organizations that are characterized by temporariness and change. Respectively, this may mean that the existing practical tools and methods to assure and improve safety culture need to be tailored to meet the requirements of the changed organizational context. For example, the “traditional” methods developed for safety culture improvement in stable organizations promoted by institutions such as IAEA and WANO might not be effective in project organizations.

This study aims to provide guidance for safety practitioners operating in temporary and dynamic organizational contexts in their effort to assure and improve safety culture. These can include modernization projects and nuclear new-builds. Within the scope of this research project we do not intend to address the process of safety culture improvement in its entirety, but rather focus on the challenges of project environment and the practical methods that nuclear industry practitioners can utilize in improving safety culture.

The objectives of this study are twofold:

1. To identify and specify methods to improve and facilitate safety culture in complex projects
2. To identify and specify methods to assure safety culture in complex projects

This two-year study is ongoing and is planned to continue in 2017. In 2016 the focus has been on the identification and analysis of currently used safety culture improvement methods, reviewing the characteristics of project organizations and developing a framework for evaluating safety culture improvement methods in project environment. In addition, empirical case studies have been conducted and there has been information exchange with experts from nuclear organizations regarding their safety culture activities in projects. The following chapters present the theoretical and empirical work done to date in this project.

2. Theoretical Foundations

2.1 Safety Culture Improvement Methods

In this chapter we review the more generic work done in the field of organizational (culture) change and identify the currently used approaches and methods for safety culture improvement from the literature. The assumption guiding our work was that to identify and evaluate safety culture improvement methods, it is useful to first identify the principles of culture change. Literature reviews were conducted to identify the most essential approaches to safety culture and organizational change, and to identify concrete safety culture improvement practices and methods.

2.1.1 *Implementing safety culture change*

By (2005) conducted a literature review to identify the different approaches to organizational change. As a result, three distinct groups were found: organizational change can be distinguished either through by distinguishing the originator of the change (i.e. how the change comes about), its rate of occurrence or the scale of change. Below we describe the implementation of safety culture change from the perspective of these three types of organizational change.

How change comes about

The most common types of organizational change are planned (i.e. top-down) and emergent (i.e. bottom-up). *Planned change* emphasizes the idea of full control over the organization and a clear understanding of the phases the organization goes through as it changes (By, 2005). These characteristics create certain inherent limitations: the success of change is dependent on factors such as the competences of the planners (usually senior management), validity of the plans and willingness of the stakeholders (By, 2005). A well-known theoretical model of planned change is Lewin's three-stage model of organizational change, which proposes that the organization must be made amenable to change (i.e. *unfreeze*) before the actual *change*, and after change, means must be provided to internalize or institutionalize the change (i.e. *refreeze*) (Lewin, 1947). This model of change is also adopted by some safety culture literature to break down the phases of safety culture change (e.g. IAEA, 2002), implying a planned and top-down approach to safety culture change.

For the purpose of organizational culture change, Schein has elaborated Lewin's model to include descriptions of the processes that can facilitate each of the three change stages (Schein, 2010). For the unfreeze stage, Schein (2010) maintains that in order for the organization to be motivated for change it is important to provide disconfirming data (i.e. any information showing that the organization is not accomplishing what it is supposed to) to cause discomfort that the current organizational state is not sufficient for future success. Schein (2010) also argues that creating psychological safety is essential in the stages of unfreeze and change: the lack of psychological safety may lead to denying or repressing the disconfirming data, or to change-related anxiety (e.g. the fear of incompetence or loss of power or group membership; Schein, 2010). Change leaders can be active in creating psychological safety by implementing activities such as articulating a compelling vision, formal and informal training, creating involvement, providing positive role models, creating support groups for open discussion and ensuring that the organizational structures are supportive of the change (Schein, 2010). With regards the refreeze stage, Schein (2010) argues that changes do not get integrated in the organization unless they are reinforced with

positive results. This suggests that the leaders of change need to design the change to match the organizational environment in such a manner that better results are archived post-change.

The common top-down means to accomplish cultural change have been summarized by Alvesson (2002) as follows: *recruitment and selection* of people that support the desired culture, *socialization and training* methods to signal the desired values and beliefs, *performance appraisal* to reward and encourage desired behaviours, *promotion of people* expressing and symbolizing the desired culture, *leadership* which communicates desired cultural values and the *use of organizational symbols* to signal the desired culture. These methods suggest an approach to culture change where the top management has first conceptualized the “desired state of culture” and then utilizes the means available to them to steer the organization’s culture towards this ideal.

The alternative approach to planned change is *emergent change*, which emphasizes bottom-up processes as drivers of change. This approach envisions change as an unpredictable, continuous and open-ended process of adaptation to contextual contingencies – essentially a process of learning (By, 2005). Such change emphasizes the role of self-organization of organizational members as leading the change, as opposed to the central control that characterizes planned change (e.g. Burnes, 2005). Complexity theories are often used in the literature to understand the effects of self-organization and emergent patterns in organizations. Burnes (2005) suggests the following implications of viewing organizations as self-organizing systems: there is a greater need for democracy to ensure that the self-organization that creates continuous improvement takes place, the organization needs to envision change as a continuous process that is initiated by the self-organization, and that because top-down control can have unpredictable effects due to self-organization, simple, non-prescriptive order-generating rules can be more appropriate means of control. For safety-critical organizations, however, the application of emergent change approaches can pose a paradoxical issue safety is a limiting boundary for all activities and thus any self-organization is not acceptable because it may result in adverse safety outcomes. This means that leaders of change in safety-critical organization need to manage the balance between limiting and facilitating self-organization (see e.g. Reiman, 2015; Reiman et al., 2015).

Culture formation can also be seen as an emergent phenomenon. For instance, Antonsen (2009) sees culture as a product of day-to-day interactions between the organizational members, which means that culture is produced bottom-up “in the shop-floor”, not by strategic decision-making. While top-down initiatives may help the conditions for steering the culture in a particular direction, this process is inherently unpredictable (Antonsen, 2009). Alvesson (2002) interprets emergent culture change as an *organic social movement*, which is characterized by change where there is no uniform will or intentional plan leading the change. Instead, the change emerges as a result of spontaneous rethinking and giving meaning – triggered by factors such as discontent with dominant practices or external influences (Alvesson, 2002). Thus, the consideration of bottom-up processes, in addition to the top-down ones, is important for implementing a successful safety culture change.

Furthermore, understanding the relations between behaviour, organizational structures and culture can help identify the leverage points for driving culture change. The question of how these phenomena are related has sparked an on-going discussion in safety culture literature (e.g. Clarke, 2000; DeJoy, 2005; Tharaldsen & Haukelid, 2009). A model proposed by Reiman and Rollenhagen (2017) elaborates this relation (Figure 1). Culture in this model is understood as shared basic assumptions, i.e. the deepest level of culture in Schein’s terminology. This model shows that organizational structures, on the one hand, influence

behaviour by means of providing possibilities, constraints and offerings, and on the other hand, are influenced by behaviour, which ultimately creates and changes the structures through, for instance, decision-making (Reiman & Rollenhagen, 2017). Organizational structures also “store” culture. Respectively, behaviour is influenced by the existing culture and organizational structures and affects both culture and organizational structures. In essence, this suggests that both behaviour and organizational structures have their unique role in shaping culture, and that organizational culture can be influenced by means of changing behaviour or structures. Importantly, the model implies that one cannot directly modify culture.

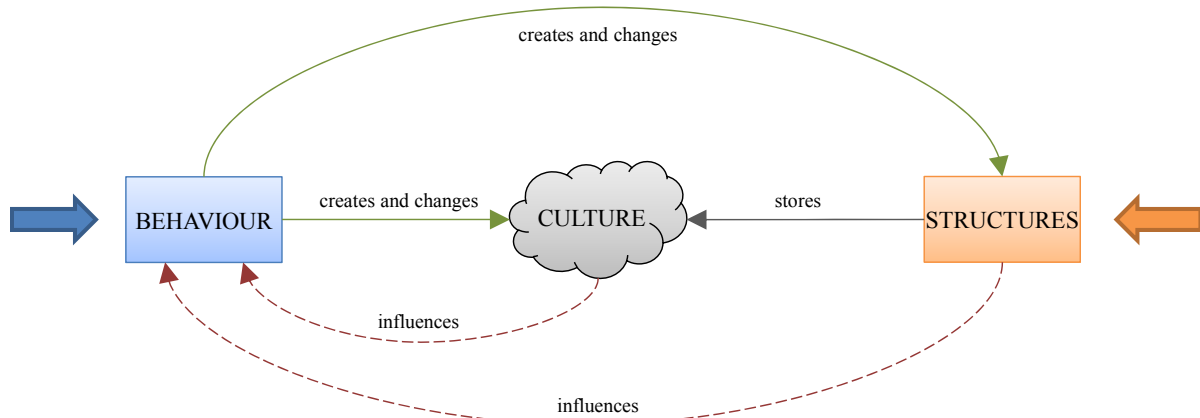


Figure 1. Illustration of how behaviour and organizational structures are related to culture (adapted from Reiman & Rollenhagen, 2017). The blue and orange arrows highlight the potential intervention points for culture change.

Rate of occurrence

Organizational change can also be distinguished by the rate of its occurrence (By, 2005). Here the focus is on whether the change occurs abruptly or smoothly. The former – discontinuous change – can manifest itself as rapid shifts in the strategy, structure or culture of the organization (By, 2005). This implies distinguishable phases of stagnation and change. The latter – continuous change – views change as an on-going process that is characterized by monitoring, responding, and anticipation of environmental contingencies. An implication that is highlighted by the rate of occurrence approach is that the role of those responsible for leading the change differs depending on whether the approach to culture change is continuous or discontinuous. For example, Weick and Quinn (1999) propose that in the context of continuous change, the role of the change agent relates to managing language, dialogue and identity, making sense of change dynamics and recognizing emergent changes, making them salient and reframing them. This directs attention towards practices such as facilitation of interaction and the participation of change agents in conversations (e.g. Weick & Quinn, 1999).

A similar approach is suggested by Antonsen (2009), who emphasizes the facilitation of understanding between various groups within an organization, facilitation of both horizontal and vertical information flows and bridging the gaps between formal and informal working practices. Furthermore, Carrillo (2011) emphasizes the role of change agents as sense makers for the organization. These sense makers can, for example, engage in informal conversations with organizational members and stakeholders to recognize the changes taking place in the organization and redirecting them by reframing them in a meaningful way (Carrillo, 2011).

From the perspective safety culture change, these approaches suggest a role for safety-related change agents that involves informally exploring the organization, interacting with the organizational members and continuously influencing the way they perceive safety (see also the role of safety culture ambassadors in section 3.1). Conversely, in the case of discontinuous change, the role of the change agent is one of designer and controller that finds potential leverage points and utilizes them for change (Weick & Quinn, 1999). The task of the change agent would thus be actively changing the systems or structures that create meaning (e.g. a culture change programme, or another type of change in organizational processes), instead of redirecting their interpretation (Weick & Quinn, 1999).

Scale

Organizational change distinguished by its scale refers to the scope and extent to which the change is implemented within the organization. Dunphy and Stace (1993) propose a model that describes organizational change in terms of four categories. The change of smallest scope is fine-tuning. This involves continuous change activities to match organization's strategy, processes, people and structure with each other. In practice it may include developing the personnel to suit the organization's strategy, or refining policies, methods and procedures (Dunphy & Stace, 1993). A wider change in terms of scope is labelled incremental adjustment – this involves making distinct modifications to organization's management processes and strategies, albeit not including making radical changes. Alvesson's (2002) view of culture change as *reframing of everyday life* can be seen as an example of change at these scales. The reframing of everyday life refers to a small scale culture change usually led informally by one or few senior actors that takes place through re-negotiation of meaning (Alvesson, 2002). This can include, for example, participative leadership, close interaction with employees within a team or informal meeting practices (see e.g. Alvesson, 2002). Alvesson suggests that this type of change is often the most relevant approach to culture change for the majority of managers: this approach relies on natural communication and is well-adapted to local conditions, thus allowing the formation of profound meanings and interpretations – unlike the more extensive and company-wide initiative that need to cover the whole entirety of organizational contexts (Alvesson, 2002).

The more extensive and radical types of change are labelled *modular transformation* and *corporate transformation* (Dunphy & Stace, 1993). The former represents major and possibly radical shifts in one or several organizational departments. The latter is the most extensive type of change, which involves organization-wide, radical alterations in the strategy of the organization. This can include reorganization, redefining mission and core values and altering the ways in which power and status are distributed in the organization. Alvesson (2002) labels this kind of change a *grand technocratic project*, which is characterised by the lengthy and laborious implementation, central role of senior executives as planners and symbols of the change and the utilization of consultants in supporting the senior executives.

The scale of change brings up the developmental needs of the organization and the role of safety culture improvement methods in addressing them. Namely, change that is at the level of fine-tuning or incremental adjustment most likely represents the daily safety culture work that every safety-critical organization is expected to conduct as a manifestation of the continuous improvement principle. Conversely, the more radical types of changes might not be easily initiated – or might not even be feasible, considering that safety culture is by nature a slowly and progressively changing phenomenon. The obvious condition where a safety-critical organization requires radical changes to its safety culture is when it is unacceptably unhealthy. On the other hand, such an organization might not be internally motivated in making radical changes to its safety culture, which suggests that a lot of the methods for

safety culture improvement are rendered ineffective – at least for the purpose of radical change. However, radical change might still be possible. This might take place, for example, through regulator intervention or contractual agreements, i.e. by means of external forces driving the change. Furthermore, in the aftermath of accidents or other disturbances, organizations tend to be susceptible to change and reorganization, which might open a “window-of-opportunity” for the improvement of safety (e.g. Dekker, 2002). Dekker (2002) characterizes this state as an atmosphere where organization is more open for self-examination, vertical boundaries are blurred in an effort of improvement, people become more open to change and resources become available. Being able to capitalize from such states might provide an effective way of creating a wide-scope safety culture change.

2.1.2 Currently used safety culture improvement methods

Based on the findings of our literature review into implementing culture change (section 2.1.1), we formulated the following list of potential approaches to safety culture improvement:

- **Organizational structures:** change the organizational structures with the intention of improving safety culture
- **Direct behavioural modification:** modify the behaviour of a specific target group through conditioning (e.g. incentives and positive reinforcement)
- **Interaction and communication:** ensure that organizational members understand each other and build a foundation for the development of a shared culture
- **Commitment and participation:** ensure that all organizational members (incl. leaders, managers and especially top management) are committed to safety and jointly participate in its improvement
- **Training:** develop safety culture related awareness, behaviour or attitudes of a selected group of people
- **Promotion:** improve the visibility of the concept of safety culture and educate the employees (incl. contractors, outsiders and future employees)
- **Selection:** recruit or assign organizational members that serve as positive role models or enablers of good safety culture

We carried out a literature review in which we identified approaches concerning safety culture change (incl. scientific publications and books) and descriptions of safety culture improvement methods (incl. licensee promotion materials, document repositories from nuclear industry organizations). The results of the identified literature are presented in Table 1. In addition to providing a short description, the table related each reference to the abovementioned categories of approaches to safety culture change. Examples of concrete methods in each of the categories are presented in Figure 2. Apart from using organizational member selection as an intervention technique, the identified approaches to safety culture improvement were mentioned relatively equally frequently in the literature.

Some groups of methods may be missing from our literature review due to the methods not having been explicitly framed as safety culture improvement methods. For example, many organizational learning-related methods such as the use of operating experience are not explicitly considered a safety culture improvement method. Considering the wide variety of mechanisms through which safety culture change can take place (see section 2.1.1), it can be assumed that there are concrete change methods that result in safety culture change as a secondary outcome, but because their primary goal is something else, they are perceived safety culture improvement methods. For instance, the process of developing organizational

structures or making changes to physical surroundings usually has other primary goals than safety culture improvement; however, they can also affect safety culture. This suggests that the potential effects on safety culture should be on the agenda when organizational change is considered.

Many approaches to safety culture change also emphasize the role of *monitoring* as an essential part of change. Monitoring can provide insight into the strengths and weaknesses of the existing culture and thus help guide the improvement process and measure its impact. In the context of this intermediate report we have left this category out so as to focus on the change and improvement methods – the ones that are used once the state of the organization has already been diagnosed. Finally, although most of the literature emphasize the importance of leadership as a driver of safety culture change – and while we acknowledge its importance – in the context of this study we do not specifically classify leadership as a safety culture improvement method. Instead, safety leaders can utilize the methods for the improvement of safety culture.

Table 1. Selected literature on safety culture improvement categorized by the approaches they utilize

| <u>Reference</u> | <u>Description</u> | Organizational structures | Direct behavioural modification | Interaction and communication | Commitment and participation | Training | Promotion | Selection |
|---|--|---------------------------|---------------------------------|-------------------------------|------------------------------|----------|-----------|-----------|
| Antonsen (2009) | Describes an approach to safety culture improvement that highlights the existence of conflicting and heterogeneous views as potentially positive drivers of safety, including a case study utilizing “captain’s forum” – a method to facilitate safety-related participation and collaboration between planners and operators in maritime industry | ■ | | ■ | ■ | | | |
| Biggs, Dingsdag, Sheahan, Cipolla and Sokolich (2005) | Proposes a framework for establishing a compendium of safety-critical roles and safety competencies as a basis for utilizing HRM strategies to improve safety culture | | | | | | | ■ |
| Campbell and Thompson (2007) | Describes the practical application of patient safety rounds (meetings between the chief of staff and caregivers on individual patient care units). | | | ■ | ■ | | | |
| Cooper (1998) | Provides extensive insight into various approaches to safety culture improvement to guide the efforts of managers and safety practitioners | ■ | ■ | ■ | ■ | ■ | ■ | |
| Donald and Young (1996) | Describes a set of initiatives that use safety attitudes as a basis for safety performance improvements | ■ | | ■ | ■ | | | |
| EFCOG/DOE ISMS Safety Culture Task Team (2009) | Describes activities and practices to improve safety culture at DoE facilities | | ■ | ■ | ■ | ■ | ■ | ■ |
| Hale, Guldenmund, van Loenhout and Oh (2010) | Describes safety management and culture interventions and distinguishes the factors behind the successful ones and the unsuccessful ones | ■ | ■ | ■ | ■ | ■ | ■ | |
| Hudson (2007) | Describes the Heart and Minds™ program which consists of various principles and practical “micro-tools” with which safety culture has been developed in an oil and gas corporation, with a focus on generating a willingness for change rather than being forced to change | ■ | | ■ | ■ | ■ | ■ | |

Table 1 Continued

Reference

IAEA (1997)

Description

Provides observed and documented examples of good (and bad) safety culture practices from nuclear facilities to illustrate the safety culture attributes of INSAG-4

IAEA (1998)

Describes a list of specific practices to develop safety culture in nuclear facilities

INPO (2012a)

Summarizes a total of 72 safety culture related policies or practices identified during benchmarking trips to multiple nuclear facilities worldwide

Joint Planning and Development Office (2010)

Provides suggestions for practical tools for improving safety culture within aviation organizations with an emphasis on fostering an atmosphere of trust, enhancing safety awareness and safety behaviours and improving communication.

Krause (2005)

Describes a case study concerning NASA’s approach to transforming its safety culture which was implemented in response of the Columbia Space Shuttle accident

Mannan, Mentzer and Zhang (2013)

Presents a framework for Best-in-Class process safety management that can be used to improve safety culture in high-risk organizations

Mathis and Galloway (2013)

Describes the STEPS method of safety culture improvement, which includes seven broad milestones for achieving excellence in safety culture – each illustrated with case studies of how the steps have been carried out in practice.

NASA (2015)

Defines NASA’s Safety Culture Program, including descriptions of practical methods to support the improvement of safety culture. In addition to conventional trainings, this document highlights the role of day-to-day “informal trainings” such as workshops and staff meetings.

| Organizational structures | Direct behavioural modification | Interaction and communication | Commitment and participation | Training | Promotion | Selection |
|---------------------------|---------------------------------|-------------------------------|------------------------------|----------|-----------|-----------|
| ■ | ■ | ■ | ■ | ■ | | |
| ■ | | | ■ | ■ | ■ | |
| ■ | ■ | ■ | ■ | ■ | ■ | |
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| | ■ | | | ■ | ■ | |
| ■ | | | ■ | | | |
| ■ | ■ | ■ | ■ | ■ | ■ | |
| | | ■ | | ■ | ■ | |

Table 1 Continued

Reference

National Academies of Sciences (2016)

Description

Examines two case studies of safety culture improvement – U.S. Navy’s SUBSAFE program and the history of the development of safety culture in an oil and gas company – and provides suggestions to how safety culture challenges in offshore can be overcome, along with practical examples of potential methods

Roughton and Mercurio (2002)

Provides guidelines for managers in their effort to improve safety culture, describes essential steps for successful safety culture formation along with examples of concrete tools to achieve them

Tweeddale (2001)

Examples of management actions and initiatives are described which have either positively or negatively affected safety culture

Vecchio-Sadus and Griffiths (2004)

Outlines a number of methods inspired by marketing to improve safety culture

Vredenburg (2002)

Describes and evaluates six management practices in terms of their efficiency in reducing employee injury rates in healthcare environment

Zuschlag, Ranney and Coplen (2016)

Describes and evaluates Union Pacific’s Clear Signal for Action safety culture improvement intervention, which consists of peer-to-peer feedback, continuous improvement and safety leadership development activities.

| | Organizational structures | Direct behavioural modification | Interaction and communication | Commitment and participation | Training | Promotion | Selection |
|---------------------------------------|---------------------------|---------------------------------|-------------------------------|------------------------------|----------|-----------|-----------|
| National Academies of Sciences (2016) | ■ | | ■ | ■ | ■ | | |
| Roughton and Mercurio (2002) | ■ | ■ | | ■ | ■ | | |
| Tweeddale (2001) | ■ | ■ | | ■ | | | |
| Vecchio-Sadus and Griffiths (2004) | | | | | ■ | ■ | |
| Vredenburg (2002) | | ■ | ■ | ■ | ■ | | ■ |
| Zuschlag, Ranney and Coplen (2016) | | | ■ | ■ | ■ | | |

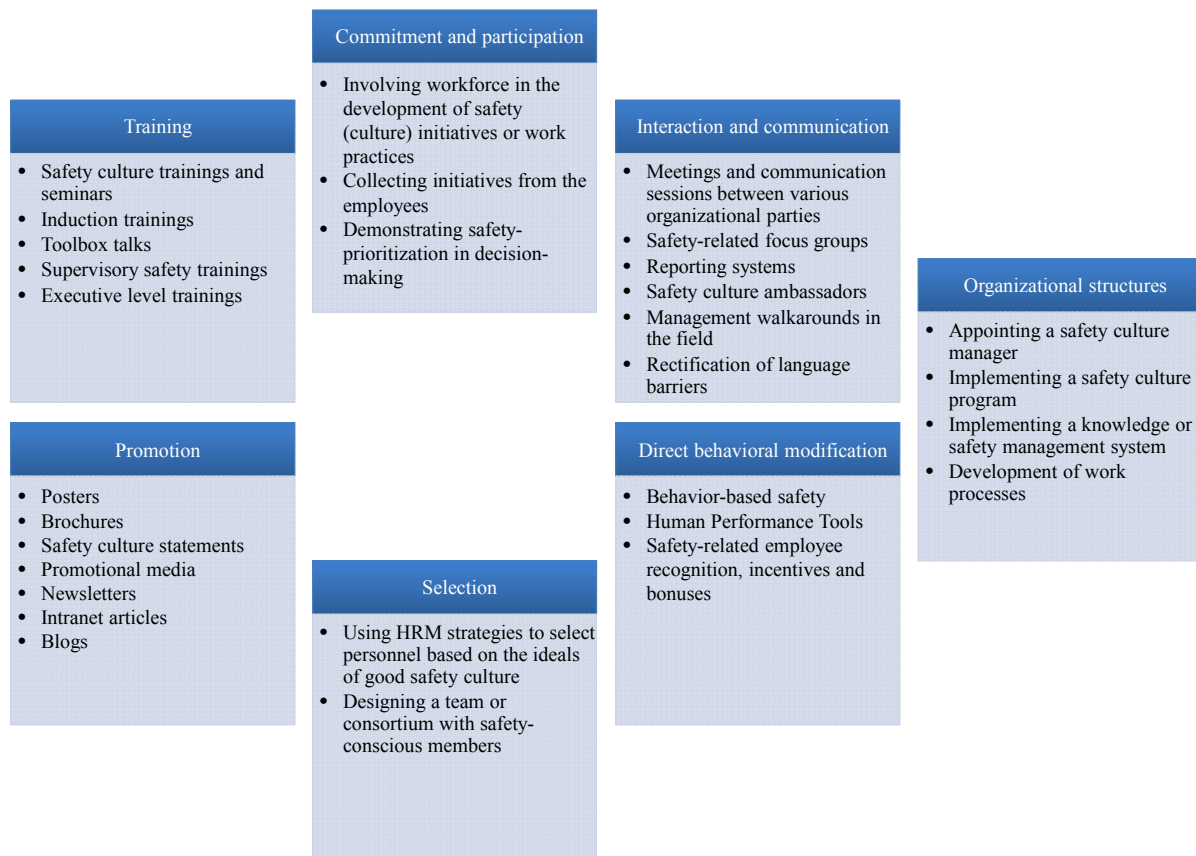


Figure 2. Examples of safety culture improvement methods categorized by their objective

2.2 Special Characteristics of Project Organizations

The nature of projects has been widely discussed in scientific literature. Four lines of research relevant to this study can be identified: interpreting projects as temporary organizations distinct from permanent ones, identifying the special characteristics of culture in projects, understanding the effects of carrying out safety-critical work in project organizations, and ascertaining the effects of organizing in networks. In the following subchapters we will discuss some of the main insights along with the possible implications on safety culture improvement.

2.2.1 Projects as temporary organizations

Packendorff (1995), referring to Morgan (1986), argues that projects have traditionally been perceived as tools: machine-like entities that are designed for a specific purpose and are then dissolved after that purpose has been fulfilled. This represents a perspective that overlooks certain essential characteristics of an organization, namely the human and social aspects of it (Packendorff, 1995). In response, projects have been increasingly viewed as *temporary organizations* to better understand how a group of individuals organize around a common, yet non-routine and time-limited activity. Temporary organizations have been studied under various labels in scientific literature throughout the late 1900s (e.g. Lundin & Söderholm, 1995; Miles, 1964), however, attempts to integrate the existing research to form an overview have been scarce (Bakker, 2010). To address this, Bakker (2010) reviewed the essential literature on temporary organizations and proposed an integrative framework describing the most important themes, namely *time*, *team*, *task* and *context*.

Time

Temporary organizational forms are inherently time-delimited, which means that they have defined starting and ending points. This leads to conceiving time in a *linear* manner (as opposed to cyclical or spiral, which are more characteristic to permanent organizations) and dividing the task into a *number of consecutive phases* (Lundin & Söderholm, 1995). In the project management literature, there exists a variety of life cycle models. Although some models also include post-handover phases such as operation and disposal as parts of the life cycle (see e.g. Lester, 2014, p. 38), on a general level, project life cycles are usually consisting of the following four generic phases:

- **Initiation:** objectives are defined and solutions are identified
- **Planning:** solutions are developed, tasks are defined and resource requirements identified
- **Implementation:** work is performed
- **Handover:** project deliverables are handed over to the customer

Each of the project life cycle phases involve unique goals and conceptions of what actions are desirable (Lundin & Söderholm, 1995). The initiation phase may involve risks such as unclear definitions or differing opinions regarding the objectives of the project (Ward & Chapman, 1995). Some of the key success factors in this phase are ensuring mutual understanding between key stakeholders, having sufficiently competent project designer and receiving political support for the project (Khang & Moe, 2008; Ward & Chapman, 1995). In the planning phase, the focus shifts to ensuring commitment of the key parties and the availability of adequate resources (Khang & Moe, 2008). As the project proceeds to implementation phase, the main risks relate to coordination and control, and coping with unexpected design changes (Ward & Chapman, 1995). Competencies of the project management team, support and commitment from stakeholders are examples of success factors of this phase (Khang & Moe, 2008). The final stage, handover, involves verifying the compliance of the deliverable and its performance; one of the risks in this stage is the failure to meet expected performance criteria (Ward & Chapman, 1995).

Phases can also be identified in macro-level phenomena such as in the life cycle of a nuclear power plant. Gotcheva and Oedewald (2015b) have proposed the following five life cycle phases (cf. IAEA, 2007): design, construction, commissioning, operation and decommissioning. Each of the life cycle phases has unique safety culture challenges and inherent developmental needs (Gotcheva & Oedewald, 2015a, 2015b; IAEA, 2012). For example, whilst the characteristic challenges in construction phase relate to understanding the safety significance of own work or managing the diverse set of temporary organization and employees, challenges in operational phase relate rather to continuous improvement, avoiding complacency and understanding the safety effects of aging phenomena (Gotcheva & Oedewald, 2015a). This suggests that in order to lead a successful safety culture assurance and improvement process, it is necessary to acknowledge, anticipate and consider the influence of project phases and plant life cycles to safety culture.

The linear conception of time can also contribute to interpreting time as a scarce and valuable commodity (Lundin & Söderholm, 1995). The *scarcity of time* may result in either perceived or actual time pressures to achieve the predetermined task, which can contribute negatively to safety, for example in situations where corners are cut in order to keep the schedule. The time pressures may also lead to radical task orientation (see the subsection “Task” below) and a neglect of beneficial secondary goals such as team development or knowledge management. Effectively this suggests that in temporary organisations, the threat of prioritizing

“production” over safety may occur more naturally than in permanent organizations. A potential means to rectify this might be to explicitly allocate sufficient resources for safety-related activities in the project, which emphasizes the role of the coordinating organization in ensuring these resources are actually available.

Finally, limited time can also affect the *depth of culture formation*. Because deep cultural structures require time, stable memberships and interaction to develop (Wilkins & Ouchi, 1983), short-lived temporary organizations or turnover may render any attempts to integrate the culture ineffective. For example, if the project provides sufficient continuity to its members (e.g. long-term projects that are done in stable groups with little turnover), the formation of a project culture can be quite plausible. On the other end of the extreme there would be short and intensive projects that probably do not provide a fruitful foundation for the development of a shared culture. This suggests that there is variation between projects and that this variation may have an effect on the prerequisites for the formation of culture. That is, at least in cases of short-term organizing, deep (i.e. on the level of basic assumptions) cultural integration might not be attainable. For instance, Ogbonna and Harris (2002) describe a case study in hospitality industry and argue that structural elements such as high turnover rate and low pay limit the extent and nature to which cultural control can be achieved: contingent, uncommitted and dissatisfied workforce are less likely to adopt deeper cultural values. Furthermore, since the hospitality industry is characterized by dual labour markets (i.e. core and peripheral workforce), additional challenges to the development of organizational culture are created: should the same approaches be used towards both types of workforce (Ogbonna & Harris, 2002)? Ogbonna and Harris (2002) conclude that this has led to some organizations utilizing a “two-tier” approach to culture development, which can include, for example, limiting the culture change efforts mainly on the core workers. These insights may be of relevance to the development of safety culture in situations where safety-critical projects are implemented by a network of subcontractors where also the dual market phenomenon can be seen (i.e. temporary and permanent organizations). For example, instead of utilizing the same approach for both the coordinating organization and the subcontractors, a two-tier approach to safety culture development might involve putting emphasis on assuring a good safety culture in the coordinating organization and then developing efficient interfaces towards the subcontractors to facilitate the dispersion of the good safety culture from the coordinating organization into the network.

Team

Temporary organizations are also characterized by special team and group interdependencies (Bakker, 2010). For example, the ability of the team to manage a diverse set of skills and knowledge while negotiating project uncertainties without prior collective working experience, and leading, designing and cooperating in a team are some of the distinctive challenges (Bakker, 2010). These characteristics can be especially prominent in projects such as the construction of new nuclear power plants where nuclear safety-related tasks often need to be carried out by subcontractors who might not have previous experience in the nuclear industry. This lack of experience can lead, for instance, to misunderstandings regarding the requirements, regulations or procedures, lack of openness in communicating and reporting, or quality control deficiencies (see e.g. OECD NEA, 2012, 2015, STUK, 2006, 2011). The project members may also be tempted to prioritize their own local goals as opposed to the overall goal of the project (Leufkens & Noorderhaven, 2011). This may be especially conceivable in case of subcontractors that are involved in multiple simultaneous projects. Overall this can lead to a decrease in organizational *commitment*. The safety culture improvement challenge thus relates to ensuring that the project team or consortium has sufficient level of shared understanding of the hazards and nuclear safety significance of their

tasks, is willing and able to communicate swiftly and openly, and is committed to the project and achieving its targets.

Another special characteristic of team development in temporary organizations related to the formation of *trust*. In permanent organizations that are characterized by long-term relationships between the members, trust is formed gradually as the members evaluate and confirm each other's trustworthiness. In the context of safety-critical organizations it has been acknowledged that a high level of trust should exist between the organizational members (e.g. Conchie et al., 2006; INPO, 2012b). The potential benefits emerging from trust in safety-critical organization can include open and honest communication and willingness to cooperate and learn – both within shop-floor personnel but also between shop-floor and management (Cox et al., 2006). However, in temporary organizations, there might not be time or opportunities for a gradual formation of trust: the organizational members may not have previous experience with working with each other, yet, they require certain level of mutual trust already immediately at the start of the task in order to avoid decrease in performance (e.g. delays). This means that the temporary team either carries out its task despite the insufficiently developed trust, or utilizes alternative methods of developing trust.

For temporary organizations, alternative mechanisms of the formation of trust have been proposed, such as *swift trust* (Meyerson et al., 1996). Swift trust theory proposes that structures such as the reputation of the coordinator of the temporary organization can serve as a proxy for shared history: the organizational members can assume that other members are trustworthy because the reputable coordinator has selected them based on sound criteria (Meyerson et al., 1996). In the nuclear industry, such criteria may include previous experience in nuclear projects or capability to organize for and achieve high quality work. Another enabler of swift trust is the focus on roles instead of persons, which conversely means that any out-of-role behaviour may breed distrust (Meyerson et al., 1996). As opposed to conventional trust that has formed over a long period time, swift trust is argued to be much less resilient to disturbance, i.e. it is lost easily (Meyerson et al., 1996). The time-delimited nature of temporary organizations can sometimes also be beneficial from the perspective of trust. That is, in a short time frame, there are fewer opportunities for the formation of deeply-rooted dysfunctional group dynamics that decrease trust among organizational members (Meyerson et al., 1996).

Other factors relevant to temporary organizations that can affect trust is the utilization of contingent employees which has been associated with threatening the existing safety culture by eroding the trust of core employees in management (Clarke, 2003) and contractual agreements that can sometimes function as a substitute for or complementary to trust, or a sign of commitment (Woolthuis et al., 2005). Concerning the relationship between contractor-subcontractor, change management, payment practices, economic climate, perceptions of future work opportunities, performance of the subcontractors and project-specific factors such as its size and nature have also been mentioned as factors that influence trust formation (Manu et al., 2015). Finally, it has been argued that the existence of trust might not always be a good thing in safety-critical domains (Burt et al., 2009): especially in situations where newcomers enter the team – a commonplace in temporary organizations – blind trust regarding the safety competency of team members may lead to adverse outcomes. This suggests that a conservative approach to the formation of trust in safety-critical domains is necessary.

Task

Temporary organizations have specific, finite, often unique and complex tasks as their objective (Bakker, 2010). Lundin and Söderholm (1995) view task as something that

legitimizes the temporary organization and consider it comparable to a permanent organization's devotion to its goals. The comparison of task and goal highlights the differences in focus between these types of organizations: the goals of permanent organizations direct attention towards decision-making, and the tasks of temporary organizations steer focus towards action (Lundin & Söderholm, 1995). Thus, a temporary organization can be seen as vehicle created for purpose of executing the tasks decided outside of it in the permanent organization (see also Turner & Müller, 2003). Therefore, the temporary and the permanent organization need to be to a certain degree in agreement and share a common understanding of the task at hand. This has implications on the interactions and interfaces between the permanent organization and the temporary one. For example, Turner and Müller (2003) draw from project management principles and introduce concepts such as the stakeholder conflicts of interest, role of the project manager as a broker and steward and the need to put monitoring systems in place to follow the progress of the project as elements of temporary organizations. From the perspective of safety culture improvement, this can include ensuring there are processes for identifying and managing such conflicts of interest that may have an effect on safety (e.g. the interest of subcontractors to gain more profit at the expense of safety or quality of the product, differing interpretations regarding how safe product should be specified, etc.), ensuring that the project leaders have sufficient understanding of the safety significance of the task at hand, and that there are monitoring systems that enable the identification of deviations from the safety-conscious execution of the task. Such targets emphasize the need for transparent and efficient interaction and bi-directional communication channels between the members of the temporary and the permanent organization, and compliance to specifications and questioning attitude from the temporary organization.

The type of task of temporary organizations can be classified in terms of its uniqueness. This means that in addition to the perhaps more traditional view of seeing temporary organizations as built around completely unique tasks, the tasks can also be repetitive and routine (Bakker, 2010; Lundin & Söderholm, 1995). This has implications, for instance, regarding the opportunities for learning that the task provides. Bakker (2010) summarizes the previous literature on this topic and suggested that repetitive projects are more likely to contribute to learning than the unique ones: the experiences from previous iterations of the task can be used to improve the execution of the forthcoming ones. From the perspective of safety culture this highlights, on the one hand, the need for continuity so that excellence in project activities can be achieved, and on the other hand ensuring that the learning takes place once the tasks are repeated.

Another theme brought up by the uniqueness of task is the role of adaptation in carrying out the task. For repetitive and routine tasks, the task is probably already well understood and it is likely that procedures have already been created. On the other hand, for unique tasks, improvisation may play an important role, for example in coordinating the activities (Bakker, 2010). This suggests that differing safety culture challenges may exist depending on task type: for repetitive tasks, attention is most likely on avoiding complacency, adhering to procedures and applying questioning attitude; for unique tasks, the main challenges might concern the understanding of the safety significance of one's decisions or actions, and being able to identify and monitor the boundaries of safe activities (cf. Rasmussen, 1997).

Context

The last general theme in temporary organizations literature is context, which covers the relation between the temporary organizations and their relatively permanent environments. For instance, in safety-critical projects, communication and cooperation with the external

environment and the line organization have been found to be important success factors (e.g. Hannevik et al., 2014). Bakker (2010) identifies two levels of analysis of context: firm and wider social context. The most common topics of relevance within the firm context according to Bakker (2010) are the ways in which the firm collects, retains and utilizes the body of knowledge and the innovations created within the temporary organization. This directs attention towards the *organizational learning* and *knowledge management processes* that are implemented in the organisation. Lindner and Wald (2011) summarize the existing literature on knowledge management in temporary organizations and identify the following challenges: uniqueness and time-delimitation may affect the development of organizational routines (e.g. the socialization processes may be disrupted and tacit knowledge might not be transferred; Bresnen et al., 2003), discontinuity may contribute to knowledge being fragmented and not integrated between individuals and the organization, transfer of knowledge from one project to another or to the permanent organization may be difficult, and the knowledge management activities themselves may receive little attention due to the secondary and long-term-oriented nature of them in relation to the primary task. It is to be noted that although temporary organizations pose challenges to knowledge management, they can also be important source of new innovations and ideas because of the diversity of actors and tasks in comparison to the permanent organization.

In the nuclear industry, post-job reviews are often utilized to collect and document information from a completed task (see e.g. DoE, 2009). However, the usability of post-job reviews has been found as rather limited due to the project participants already being reoriented towards other tasks and thus having little interest in contemplating already-completed tasks, or that the project team (especially if subcontractors have been involved) has already been dissolved and thus not easily available for reflection (Viitanen et al., 2015). On the other hand, even if tasks are done in multiple separate projects, but if the projects include an element of continuity (e.g. if a similar project is repeated), there may be increased motivation for collecting information to be used as an input in the next repetition of the project. For example, in a recent study on learning from successes in nuclear power plant operations, a practice was observed that involved the project manager of an unprecedented modernization project assigning a project member to document all project activities in a diary (Viitanen et al., 2016). This diary would then be utilized when the modernization activities continue during another outage – a potentially effective mean to transfer knowledge from one project to another. Schindler and Eppler (2003) summarize the key reasons for the loss of knowledge created in projects as follows: time pressures towards the project completion, lack of motivation or willingness to learn from mistakes or share successes, lack of enforced and institutionalized practices and coordination for project-based learning and not having sufficient skills to utilize learning methods.

When examining temporary organizational forms in the wider social context, factors such as the interpersonal networks and multiplicity of communities their members belong to are revealed (Bakker, 2010). The contextual influences on temporary organizations also lead to the discussion of how the loyalties of project participants are managed in relation to their membership in other projects, in the permanent organization or in other social groups such as subcultures (Bakker, 2010). The multiple loyalties have been associated with issues such as competing commitments (e.g. Mortensen et al., 2007). The existing safety culture literature does not extensively discuss the management of subcultures and rather sees safety culture as an integrated phenomenon. There are, however, some exceptions in the literature that acknowledge the issue of non-integrated safety culture (e.g. Edwards et al., 2013; Haukelid, 2008; Richter & Koch, 2004). The existence of subcultures is most likely not unique to temporary organizations, because permanent organization can also be characterized by

cultural diversity such as the multiplicity of occupations and nationalities. Perhaps the type of subculture most unique to temporary organizations is that of organizational, i.e. the members are differentiated by either the departments of the parent organization (see also Figure 5) or by different parent organizations. This suggests that attention needs to be paid on the implications of forming a team with backgrounds from different organizational cultures.

Table 2 summarizes the characteristics of temporary organizations and their implications to safety or safety culture improvement based on the literature review and discussion above.

Table 2. Characteristics of temporary organizations and their potential implications for safety culture

| | <u>Characteristics of temporary organizations</u> | <u>Potential implications for safety or safety culture improvement</u> |
|------|---|--|
| Time | Dynamics of lifecycle phases | <ul style="list-style-type: none"> • Temporary organizations tend to be divided in consecutive phases – each with its own risks, goals and contexts. These can include also macro-level life cycles such as that of a nuclear power plant and the transitions between the phases • The project phases and the transitions between them can pose safety culture challenges (or opportunities) and they need to be identified and considered |
| | Time pressures | <ul style="list-style-type: none"> • Time is often interpreted as scarce and valuable, which can lead to radical task-orientation, and a neglect of secondary goals such as team development or knowledge management • Real or perceived time pressures can also contribute to cutting corners which may have adverse safety consequences |
| | Deep-level cultural integration may be unattainable | <ul style="list-style-type: none"> • The formation of shared basic assumptions regarding safety might not be possible, which can decrease the impact of cultural control • A two-tier approach to safety culture improvement, which distinguishes the organizational members by their stability in the organization, may be needed |
| Team | Diversity of skills and knowledge | <ul style="list-style-type: none"> • In special projects such as nuclear new-builds, there may be members in the consortium that are experts in their respective domain, but may lack expertise of nuclear industry – an issue that needs to be acknowledged and considered a safety culture challenge • Ensuring that project participants have sufficient knowledge and understanding of the safety significance of one’s tasks and have the competence to meet the requirements of the safety-critical task is important already when designing the consortium • The diversity also creates the need to put special attention on the coordination and safety-related communication between the stakeholders |
| | Unique mechanisms for formation of trust | <ul style="list-style-type: none"> • Trust may be formed in unconventional ways (e.g. swift trust). Paying attention to the prerequisites of the formation of swift trust (e.g. selection of organizational members based on safety-conscious criteria, ensuring that contractor reputability in terms of safety is sound, avoiding out-of-role behaviour) may facilitate the formation of trust in the organization • Trust in temporary organization is less resilient and thus more susceptible to disturbances in comparison to the conventional trust that is formed through long-term interactions in permanent organizations – care needs to be taken to avoid the loss of trust mid-project • A conservative approach to formation of trust is advisable to avoid blind trust towards the safety competency of new team members |

Table 2 Continued

| <u>Characteristics of temporary organizations</u> | | <u>Potential implications for safety or safety culture improvement</u> |
|---|--|--|
| Task | Radical orientation on task and action | <ul style="list-style-type: none"> • Conflicts of interests between the stakeholders may emerge which may have an effect on safety; these need to be identified and managed • The task and its safety significance may not be understood in the consortium and in the same way as in the parent organization; sufficient interaction and bi-directional communication, and managing the interfaces to the temporary organization are needed • Monitoring processes in the temporary organization are needed to identify any deviations from safety-conscious execution of the task • The role of the coordinating organization and the project manager are central in managing the abovementioned challenges |
| | Platform for learning | <ul style="list-style-type: none"> • Tasks done in temporary organizations can provide input for learning, either from the execution of the task itself, or from the participants of the consortium • Creating a sufficient continuity in tasks can facilitate the formation of lessons or good practices and thus contribute to excellence |
| Context | Loss of knowledge | <ul style="list-style-type: none"> • Discontinuities may lead to safety-related knowledge being fragmented and disintegrated within individuals and organizations • There might not naturally exist processes and practices to allow safety-related knowledge created within a project to be passed along to other projects, or to the permanent organization • As a result of the radical task-orientation, strategies for managing safety-related knowledge may be considered secondary to the primary task of the project and thus long-term knowledge management activities may be neglected • Creating the motivation for long-term learning strategies and sharing of safety-related knowledge, even if there is no immediate benefit for oneself • Ensuring that there are learning methods for project environment available, relevant personnel are trained to use them, and that they are also used in practice |
| | Subcultures and multiple loyalties | <ul style="list-style-type: none"> • Temporary organizations can be characterized by multiple loyalties which can affect prioritization and commitment of the members • The formation of universally shared culture might not be a feasible goal in temporary organizations, thus the existence of multiple subcultures needs to be considered as a context for improving safety culture |

2.2.2 Projects as cultures

Further insights to project organizations can be gained by approaching them from cultural perspective. According to Söderlund (2004) much previous research about project management has, by and large, taken two directions. The first has its basis in engineering and focuses on planning and other means to control projects in order to limit uncertainty and maximize project efficiency. The other direction has its foundation in human sciences and focuses on climate and culture in the context of projects. The aspects of organizational climate and culture exhibit an important role for understanding project outcomes and have been documented by several researchers (e.g. Eriksson & Westerberg, 2011; Gray, 2001; Hanisch & Wald, 2011; Nauman et al., 2010; Rudolph et al., 2008; Sharma & Gupta, 2012; Smith et al., 2009; Yen et al., 2008). However, *exactly how* such factors influence projects is still an open issue (Hannevik et al., 2014).

Judging from the literature it then seems that much remains to be done regarding how *culture* influences projects more specifically. It may then prima facie seem as somewhat premature to

specifically explore the notion of *safety culture in projects* before more general aspects of culture in projects has been explored to more depth. After all, the concept of culture without the prefix “safety” opens a much broader scene in comparison with safety-culture, so why start with safety culture? However, due to the perceived importance of safety one could argue that from a pragmatic perspective, it is still worth, even essential, to explore if the concept of safety culture can be efficiently applied in the context of project management. This quest raises problems, however, mainly due to the many different notions and definition of culture in general and safety culture in particular. For instance, the concept of culture is often assumed to exhibit some stability over time with respect to those assumptions, values, behavior etc. which characterize a group – actually this is an often mentioned hallmark of a “culture”. Project organizations, on the other hand, are not results of a historical development, but are purpose-built systems that exist only for a predetermined period of time, after which the organization is dissolved. In projects, we would thus not expect to find the same kind of “cultural stability”, that, for example, may be present in an operating or maintenance organization. On the other hand, culture not only can be defined as shared cognitive properties but it can also become manifest in terms of various artifacts, i.e. the *products* of culture. In that sense, projects can also take place against a cultural background of artifacts, such as organizational structures, planning tools and project management practices. These can form a context that may exhibit stability over time and interact with the cognitive manifestations of culture (e.g. shared values, norms, assumptions etc.).

The engineering tradition, as mentioned above, has explored project management in terms of artifacts (plans, tools etc.) but not so much on the cultural history associated with such tools. The cultural track of investigations in project management, on the other hand, has had less focus on the artifacts used. In the context of this study we take a pragmatic stand and view both the engineering approach and the culture approach to project management as equally relevant and propose that they should be combined for a richer understanding of projects.

2.2.3 *Projects as safety-critical organizations*

Scientific studies on the implications of project organizations on safety are scarce, even though projects are widely used to carry out activities in safety-critical organizations. A notable exception is Saunders’ work with safety-critical projects, that is, projects that operate in fields involving significant safety risks to the environment or society. Saunders (2015) conducted a literature review (summarized in Table 3) that identified the similarities and differences of safety-critical operational and project environments in order to ascertain whether the same models of achieving safety (in this case the High Reliability Organizations theory) are applicable in both environments. The key findings of this literature review are that the on-going operations and projects are differentiated by uniqueness of tasks or technology, time-delimitation, the extent of change, and level of uncertainty in the environment. Conversely, many characteristics are shared by the two types of organization, such as the complex sociotechnical environment, consequences of failures, safety significance and the overall level of complexity of the activities.

Table 3. Similarities and differences between on-going operations and projects in safety-critical organizations (adapted from Saunders, 2015)

| <u>On-going operations</u> | <u>Projects</u> | |
|--|---|--------------|
| Highly complex-sociotechnical systems Consequences of failures are high Demanding political and social environment Safety is the overarching priority Uncertainties are many and often nontrivial Utilize resources to deliver products or services that are demanded by a set of customers and stakeholders Underpinned by key processes (e.g. operating procedures, project processes, license conditions and safety cases) Centred on action (e.g. decisions, meetings, tasks) | | Similarities |
| Permanent and continuous Tried and tested technology High tempo Focus on operational stability Environment of lower uncertainty | Transient and temporary Unique and novel Measured tempo Focus on implementation of change Environment of higher uncertainty | Differences |

For the purpose of understanding project uncertainty, a framework called the Uncertainty Kaleidoscope has been developed (Saunders et al., 2015, 2016). Referring to The Oxford English Dictionary, they define uncertainty as a multi-faceted concept, generally, “*a state of unknowing – where the individual lacks full and complete knowledge of a situation*” (Saunders et al., 2015, p. 468). In safety-critical projects activities need to be implemented comfortably, within schedule and within budget for prolonged period of time, even in an environment of high uncertainty. Saunders et al. (2015, 2016) carried out qualitative studies in the civil nuclear and aerospace projects, and identified six interrelated determinants of project uncertainty: complexity of the project, the environment in which it is being delivered, the capability of both the project team and the wider supply chain, temporal issues such as the timescales and speed of the project, the availability of information and individual team member perceptions of uncertainty. Out of these determinants, the most commonly mentioned was the *environment*, followed by *complexity*, *capability* and *information*, whereas the impact of *time* on project uncertainty and individual perceptions of uncertainty were mentioned less frequently by the respondents. Understanding the determinants of project uncertainty is important for assuring and improving safety culture in complex projects because these can act to a certain degree as determinants of which methods are most beneficial in a certain project environment. That is, using the Uncertainty Kaleidoscope to identify the sources of and influences on uncertainty may help the project management practitioners, safety culture managers and other experts to better position a project for successful performance, since the way the project organization is dealing with the “unknowns” may affect significantly the project implementation and the stakeholders’ confidence in the project delivery team (Saunders et al., 2015, 2016).

2.2.4 Projects as networks

Recent studies carried out in the Finnish nuclear industry context argued for the need to frame projects as networks. Especially with regard to governance of new build projects, there is a recognized need to better understand the relationships between coordination of activities in a subcontractor network and the overall system safety (Ruuska et al., 2009, 2011). These network management studies imply that to improve the success of complex projects the networks should be managed both as a single entity and as a collection of partially

autonomous partners, which calls for strong balancing competences of project managers and project's top management.

Oedewald and Gotcheva (2015a) highlighted the importance of seeing nuclear industry projects as *networks of companies*. They identified a set of theoretical and practical challenges in applying the concept of safety culture in a complex dynamic network of subcontractors, including the unit of analysis, the temporary nature of the project network and the discontinuation and insecurity that the project environment brings, and the national culture differences and heterogeneous nuclear knowledge of the actors. These findings have implications for safety culture assurance and improvement as well. It was proposed that safety culture development activities should take the entire network activity as the unit of analysis, instead of focusing on separate companies, yet the interactions between different parties should be paid attention to when the aim is to improve safety culture in a complex project (Oedewald & Gotcheva, 2015a). This approach is in line with the *systems thinking* that argue for the need to shift in attention from the part to the whole.

Kujala, Aaltonen, Gotcheva and Pekuri (2016) explored the dimensions of governance in inter-organizational project networks and studied implications for safety performance in a nuclear industry project network. They highlighted that in complex project networks, multiple organizations are often making decisions that influence the project performance, including safety performance, and no single organization has full control over the project. This study also highlighted the importance of interactions among the project partners for improving nuclear safety, as well as the role of the institutional context in which the project is embedded (Kujala et al., 2016).

The perspective of viewing projects as networks emphasizes the importance of taking the complexity feature of nuclear industry projects into account when safety culture improvement and assurance initiatives are planned and implemented in a the project network, as well as paying attention to relationships between the project partners.

3. Empirical Work on Improving Safety Culture in Complex Projects

The empirical work was carried in collaboration with three Nordic nuclear industry organizations and consisted of three different approaches. First, as our main case study, we conducted an in-depth examination of a particular safety culture improvement method – the use of safety culture ambassadors. Second, a pilot seminar was organized for project managers that included safety culture as one of the topics. Finally, information exchange sessions were held with experts from a third organization on the topic of safety culture improvement in complex projects.

3.1 Safety Culture Ambassadors Group at Organization A

3.1.1 Introduction

In organizational settings, ambassadors are often used by business consultancy companies as a method to facilitate change. This method bears resemblance to a concept of “change agent” used in the leadership literature. The task of change agents is to steer or facilitate change in some part of the organization by using other means of control or authority than formal power (Honkanen, 2006). Change agents can range from external consultants and managers responsible for internal development to shop-floor supervisors, and can be either formally or informally assigned (Honkanen, 2006). Honkanen (2006) summarizes the following four basic roles of change agents as follows:

- **Expert:** the change agent has the state-of-the-art, best solutions for the problems and functions as an advisor;
- **Instructor:** the change agent has knowledge which is disseminated and then utilized in practice by others;
- **Analyst:** the change agent collects and analyses information to help other solve problems or introduce novel perspectives to it;
- **Facilitator:** the change agent functions as a coach and creates the prerequisites for others to be able to understand the problems and find solutions to them.

Ambassadors can be interpreted as a specific case of change agents: they are grass-roots change agents, i.e. a group of people within the organization that have the task of facilitating organizational development in their respective departments. The ambassadors can be used in the context of organizational culture change for purposes such as ingraining and disseminating desired values or practices.

Variations of the use of ambassadors have been utilized in the context of safety-critical organizations. For example, the roles of ombudsman (i.e. provides an opportunity for employees to voice their concerns), safety culture advocate (i.e. observes decision-making and intervenes to avoid groupthink or missed opportunities) or safety champion (i.e. promotes and encourages safety-conscious work practices) involve activities that relate to the role of change ambassadors. Overall, these methods are not particularly well established and their definition and task description varies between the organizations.

Ambassadors have also been utilized for safety culture improvement. For example, in the nuclear industry, the International Atomic Energy Agency (IAEA) organizes trainings for nuclear facilities to create an in-house self-assessment team called “Safety Culture Ambassadors” (Haage, 2014; see also IAEA, 2016b). This cross-functional and cross-hierarchical team then focuses on performing high-quality self-assessments. In addition, some nuclear power companies have implemented an ambassador group for safety culture

improvement independently of the IAEA's program. In this chapter we will focus on how safety culture ambassadors have been implemented and utilized at Organization A.

3.1.2 Methods

Semi-structured interviews were the main data collection method used in this case study. We carried out a total of ten interviews with safety culture ambassadors at the case organization. The total number of ambassadors in the organization was 14 at the time of the data collection. The main focus of the interviews was on understanding what the interviewees currently do to improve safety culture as safety culture ambassadors and what do they consider important to do in the future. We also discussed other topics such as impact assessment, challenges related to the of the activities of safety culture ambassadors, distribution of responsibilities between other organizational actors, individual motivation and the characteristic safety culture challenges the ambassadors face in the organization. The interviews were recorded with the interviewees' consent and transcribed by the research group. After this, a thematic analysis was carried out to identify patterns in the interview dataset.

In addition to the interviews, the researchers also carried out a workshop with the organization's safety culture manager and made observations during two safety culture ambassadors' group meetings. The purpose of the workshop and the observations was to understand the reasoning behind the safety culture ambassadors group and how it is implemented in practice.

3.1.3 Safety culture ambassadors at Organization A

The Organization A was at the time of data collection in a transition phase. This was characterized by rapid growth of the number of personnel, high level of diversity of the personnel in terms of experience in the nuclear industry and a dynamic organizational environment caused by the transition.

In the Organization A, the proclaimed purpose of safety culture ambassadors group was to facilitate the sharing of information (both bottom-up and top-down), support the managers in their effort to implement a good safety culture and to generally be active in the development of a good nuclear safety culture. At the time of the empirical data collection, the use of safety culture ambassadors was still at its early phases. Safety culture ambassadors were nominated from (almost) every organizational department. There were no formal criteria for the selection of the ambassadors; rather, the selection appeared to be based on the individuals' previous safety culture-related experience and personal interest in the topic. The ambassadors were either managers or experts within their respective departments. This method of selecting the ambassadors resulted in a diverse group of people ranging from experienced nuclear safety culture specialists to newcomers with little previous experience in the nuclear industry.

In addition to the nomination of the individual ambassadors, a safety culture ambassadors group (SCAG) was initiated. The SCAG holds periodic meetings, which are led by the safety culture manager with invitations sent to each of the safety culture ambassador. The agenda of a typical meeting included topics such as discussing various safety-related issues – both positive and negative – that have been identified by the ambassadors in their respective departments.

Practical tasks and responsibilities of the ambassadors were still under discussion, which means that most of the findings from the data collection of this study relate to the activities that the ambassadors have been carrying out naturally as an extension of their primary

responsibilities, or what they found important to do in the future as safety culture ambassadors. The current and desired activities of safety culture ambassadors as identified in the interviews are summarized in Table 4. The sheer extent and variety of the different activities of the ambassadors implies that this method of safety culture improvement is special in its character. Namely, instead of focusing on some particular mechanism of action related to culture change, the use of safety culture ambassadors can instead be seen as an organizational structure that employs different safety culture improvement methods. The essence of this tool appears to be the nomination and coordination of safety culture conscious individuals that utilize a set of means of influencing safety culture at grass-roots level. In the following subchapters we discuss the various concrete activities that the ambassadors do or consider important to do, and present insights regarding these activities based on the findings from the case study. Due to the diversity of the method, we approach the findings from the perspective of five relevant mechanisms of influencing safety culture, as described in the following subchapters.

SCAG as an interaction and communication development tool

The findings reveal that one of the fundamental functions of the SCAG is the facilitation of interaction and communication within the organization and potentially in the project network. This function of the SCAG entails both top-down and bottom-up information flows, and various activities that relate to ensuring organizational learning. The role of the SCAG as a central hub and facilitator of the organizational information flows is illustrated in Figure 3. The bottom-up information flow involves each individual ambassador bringing messages from the field to the SCAG meeting. This information can then be disseminated within the SCAG and transferred downwards by other ambassadors to their respective departments, or possibly upwards in the organization as a joint SCAG statement. Top-down information flows can manifest themselves as SCAG and the ambassadors receiving messages from higher levels of the organization, such as top management, and then forwarding them downwards in the organization in the respective departments of the ambassadors. In addition to functioning as messengers, the ambassadors also have a role in translating the messages to the context of their respective departments.

A matter to consider is that SCAG is not the primary channel for the collection and dissemination of information within the organization. Rather, it is focused only on safety-related topics and can also be somewhat redundant to many other organizational mechanisms. Therefore, it is relevant to discuss the special characteristics of the information flows promoted by the SCAG, and the organizational contexts, in which they are relevant. Examples of how both bottom-up and top-down flows were utilized in a particular situation were given by one of the interviewees as follows:

“I have used the [information flow] from the safety culture manager through the ambassadors downwards in the organization as additional information flow in case the message starts fade in the organization. I have, sort of, restored the message again. [...] If messages upward in organization begin to dilute, we [the ambassadors] can be used – and should be used – to get messages to SCAG meetings with the safety culture manager, and he has close connection to the top management.”

The examples given by the interviewee highlight the issue of a certain type of complacency that results as the knowledge accumulated in the organization begins to lose its perceived significance. As suggested by the interviewee, SCAG can be active in monitoring this process, and reacting by reinforcing the safety culture message.

Table 4. Current and desired activities of safety culture ambassadors

| | |
|---|-------------------------------|
| <p><u>In the field</u> (acquire)</p> <ul style="list-style-type: none"> • Providing an easy-to-approach and confidential method of receiving employee concerns or initiatives, deployed at shop-floor • Listening to people and being open to receiving safety-related information during informal encounters such as coffee or lunch breaks and corridor talks • Actively approaching people in safety-related matters <p><u>In the field</u> (disseminate)</p> <ul style="list-style-type: none"> • Bringing topics from SCAG meeting to own department and discussing them with colleagues • Communicating about safety culture topics towards subcontracts • Acting as messengers of the organization’s safety culture vision <p><u>In the field</u> (enable)</p> <ul style="list-style-type: none"> • Encouraging personnel to be open and inquisitive • Encouraging personnel to put forward their concerns • Removing organizational silos by connecting people from different departments and being an intermediary <p><u>During SCAG meetings</u></p> <ul style="list-style-type: none"> • Transferring messages from the field to SCAG meetings for making them available for further discussion and reflection • Facilitating the sharing of information between different organizational levels (incl. top management) and units by discussing experiences from various departments in the SCAG meetings and forwarding them within the organization | Interaction and communication |
| <ul style="list-style-type: none"> • Discussing the safety culture principles of the organization within own team or department to understand what they mean in each one’s work • Ensuring that new workers that are unfamiliar with the nuclear industry appropriately adopt the idea of a good safety culture • Holding short safety culture related information messages in the field (cf. toolbox talks) • Holding on-site safety culture trainings to newcomers and to other members of the organization | Training |
| <ul style="list-style-type: none"> • “Probing” the atmosphere; sensing how people feel about the safety-related messages that have been disseminated by the organization and how safety-relevant things have been dealt with in the organization • Observing the state of safety culture or safety-related activities in one’s own department • Providing feedback to the SCAG and the safety culture manager regarding the state of the organization and its culture | Monitoring |
| <ul style="list-style-type: none"> • Making it visible in the organization that there are safety culture ambassadors appointed and that people would know who they are • Maintaining and encouraging discussion on safety-related topics in own department • Reminding in meetings or in informal conversations about the special nature of the requirements of working in the nuclear industry and about the nuclear safety relevance of the activities within own department • Showing good example by demonstrating commitment and openness | Promotion |
| <ul style="list-style-type: none"> • Interfering in meetings if decisions are made without considering their nuclear safety consequences • Interfering if someone displays a bad safety culture or attitudes that are not suitable for a nuclear organization | Behaviour modification |

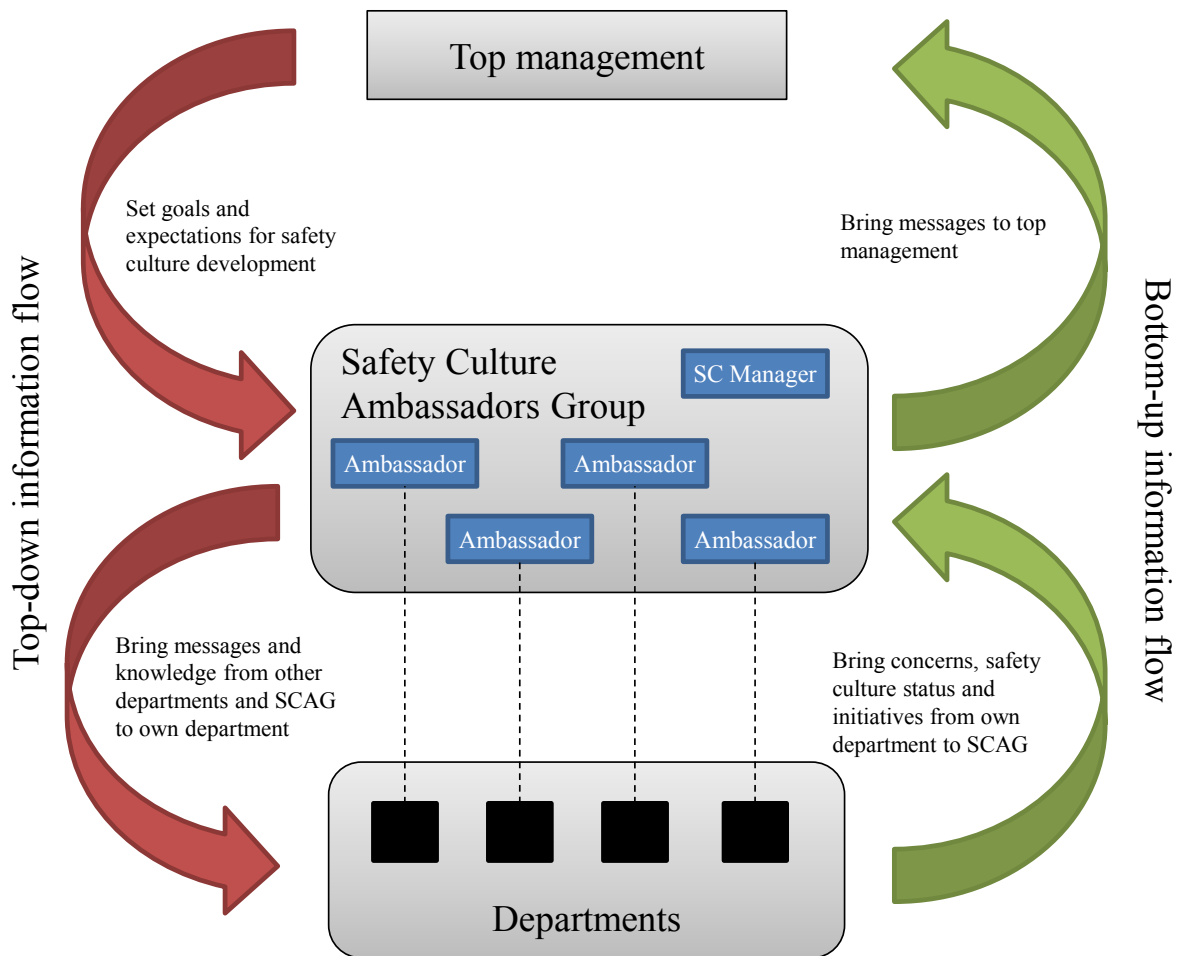


Figure 3. The role of Safety Culture Ambassadors Group as a facilitator of organizational information flows

The activities of the ambassadors that relate to organizational learning that came up during the interviews were acquiring and disseminating information, facilitating safety-related communication in the field and discussing the acquired information jointly with other safety culture ambassadors and the safety culture manager at the SCAG meetings.

Acquiring information from the field was one of the most important functions of the ambassadors. Ambassadors saw themselves as an easy-to-approach, low-threshold method of communication. Some interviewees also brought up that being an ambassador can be a “pretext” to approach someone and start discussing safety culture related topics. It appeared that the strength of utilizing ambassadors for the purpose of information acquisition is their closeness and familiarity with shop-floor personnel and the fact that ambassadors are peers to the personnel in their department rather than being external experts or coming from higher levels of the hierarchy. Such a position has the potential to help the ambassadors identify processes and weak signals not easily available or noticeable to other groups of personnel. For example, one of the interviewees noted the relevance of safety culture ambassadors as bringing informally identified concerns to SCAG meetings:

“[In SCAG meetings] you can bring up things you have heard during coffee breaks. [...] In that sense it can be a quite good channel – for example if colleagues don’t consider something worthy of filing a concern report.”

When the researchers asked about what safety culture ambassadors should do in the organisation, another interviewee begun reflecting what the ideal implementation process

would look like. This interviewee emphasized the importance of an informal role for the ambassadors and rationalized that in some situations the personnel might perceive a certain threshold to filing an official concern: the ambassadors could be useful in dealing with such situations:

“Maybe it would be best if the deployment [of safety culture ambassadors] was informal – so that if someone feels pressured in terms of schedule or if managerial will is too strong, the worries can be voiced by openly discussing without having to file a concern. There is always a threshold for filing a concern: Am I willing to do it or do I dare to do it?”

As implied by the above quotes, the relationship between the ambassadors and other personnel at the department requires a sufficient level of trust and openness to be effective for information acquisition. Being able to create and maintain trust between the ambassadors and other personnel – but also between ambassadors and their supervisors – was characterized by several interviewees as an important success factor for the ambassador activities.

In this organization, safety culture ambassadors come from a variety of departments and technical backgrounds. An interviewee characterized the benefits of this arrangement as follows:

“One positive thing is that the SC ambassadors are taken from different departments and they have different feedback and definitely different feedback is useful for development of safety culture: they may provide some kind of input from their point of view – from their disciplines or from their scope of work.”

Also a few other respondents found that interacting with the diverse ambassadors group is beneficial for understanding different perspectives to the safety culture of the organization. This suggests that nominating ambassadors from different parts of the organizations can be beneficial in terms of the richness of information covered by the SCAG.

Disseminating messages was another organizational learning activity carried out by the ambassadors. In practice, this included bringing topics discussed in SCAG meeting to the ambassadors’ respective departments, and communicating about safety culture towards subcontractors in those cases where the ambassador works in close contact with the supply chain. The message dissemination can function as a redundant or complementary information channel, which can be especially useful in those situations where the line organization functions sub-optimally or if a specific message needs to be emphasized. For example, multiple interviewees mentioned a report which was initially not effectively disseminated or reflected upon in all parts of the organization. After the report had been discussed in the SCAG meeting, some of the ambassadors increased awareness of the contents of the report in their respective department.

Two means of *enabling* interaction and communication emerged during the interviews. The first relates to the ambassadors’ role as encouraging personnel to be open and active in communicating their concerns or initiatives. This can be interpreted as building the prerequisites for information flows where the ambassadors do not have to actively involve themselves in acquiring or disseminating information. Emphasizing openness also contributes to introducing newcomers to nuclear safety culture. For example, one interviewee stressed the importance of encouraging newcomers to be inquisitive and avoiding overconfidence:

"Because we have newcomers from various backgrounds and many without background from nuclear industry, I've tried to bring the message that those that come from elsewhere should stop thinking they can cope alone. And I've tried to encourage that if there is even a slight hint that there is something more than meets the eye, you should remember to ask."

Focus on the introduction of newcomers most likely reflects the characteristics of the particular organizational context – since teaching the newcomers to the right way of conducting work is one of the main developmental goals of the Organization A, ambassadors in this context can be active in facilitating this process.

Some interviewees noted that safety culture ambassadors can also be useful in enabling communication between the various parties by functioning as an intermediary. This can involve, for example, identifying organizational silos or people that should interact with each other and then connecting them together. This theme was probably brought up due to integration being a topical organizational challenge in this organization. However, it is important to consider the difference between collecting and disseminating information and being active in managing employees in the field. One of the ambassadors cautioned about the use of safety culture ambassadors for connecting people in situations where other means are more suitable:

"The challenge [of connecting people] cannot be solved with ambassadors. This is something that the organizational management should deal with. [...] The ambassadors shouldn't be applied where they are not the proper medicine – this could further blur the role of the ambassadors."

This comment emphasizes the idea that safety culture ambassadors should not be utilized as a long-term fix that compensates organizational deficiencies. This suggests that the ambassadors are rather a means to identify the problems, potentially provide temporary help for them, and give proposals for how the issue can be rectified in long-term, for example through the creation or change of organizational structures.

Finally, the practice of organizing periodical *SCAG meetings* can be seen as a central “hub” that provides a forum for the ambassadors and the safety culture manager for sharing their findings from the field, discussing topical issues and reflecting upon them. Many of the interviewees found the meetings useful from the perspective of transferring of information and insights between different departments and potentially towards top management.

SCAG as a training tool

Our findings suggest that the SCAG can be utilized for training purposes in two ways. On one hand, being a member of the SCAG can provide *learning opportunities for the ambassadors themselves*, and on the other hand, *safety culture ambassadors can help carry out safety culture training activities in their respective departments*. Many interviewees found that individual safety culture ambassadors can benefit from being a member of the SCAG from educational perspective. The ambassadors can learn experientially when carrying out the practical safety culture facilitation and promotion activities in the field and in the SCAG meetings. Furthermore, learning can be enabled in classroom settings by inviting the ambassadors to advanced safety culture trainings, seminars or workshops. Actively participating in SCAG activities also provides the ambassadors an opportunity to gain a more profound understanding of the concept of safety culture. This also means that in the long-term, the SCAG naturally “creates” a group of grass-roots safety culture experts for each of

the organizational departments, which can be essential for the efficient development of safety culture. Learning new things about safety culture was also considered a motivating factor in participating in SCAG activities – especially by those ambassadors that had less experience in the nuclear industry.

Two types of training-related roles potentially suitable for the ambassadors were mentioned by the interviewees: informal sparring or coaching, and holding formal training sessions. The former can involve keeping the issue of safety culture visible during all activities, in meetings or in informal discussions. These informal training activities can be seen a somewhat unique characteristic of the ambassador activities, since they allow safety culture to be influenced socially (as opposed to applying technical or structural means) and continuously or on-demand (as opposed to performing one-off or fixed-schedule, periodical interventions).

The ambassadors were also found potentially useful for holding short safety culture training sessions in their respective departments. One of the interviewees rationalized this approach by mentioning that since there are many safety culture ambassadors and they cover a large portion of the organization, safety culture trainings – if held by the ambassadors – could be much more frequent and adaptable to schedules or local training needs. However, when designing training programmes to be implemented by the ambassadors, the expertise of individual ambassadors needs to be taken into consideration. The role of an educator might be best reserved for the most experienced of the ambassadors. For example, some interviewees felt slightly uncomfortable with the idea of holding safety culture trainings – they found that they would need more training and guidance on the topic of safety culture to be successful in this task. This suggests that a proper balance between training others and being trained needs to be established.

SCAG as a monitoring tool

Due to the continuous presence of ambassadors at the shop-floor and in close contact with the personnel, the SCAG provides a potentially useful tool for monitoring the state of safety culture in the organization. Through their information acquisition and the subsequent bottom-up information transfer and reflection in SCAG meetings (as described in previous subchapter), the ambassadors can provide insight potentially unavailable to conventional methods of safety culture self-assessment. In practice, this can include identifying both intangible elements (e.g. general atmosphere, attitudes, and opinions) and tangible elements (e.g. concern reports, decisions, contents of meetings) – all of which can be useful for assessing the current state of safety culture.

SCAG as a promotion tool

We found two aspects to promotion when interpreting SCAG as a safety culture promotion tool. On one hand, the safety culture ambassadors were active in reminding about safety culture issues, and maintaining and encouraging discussion on safety-related topics in the ambassadors' respective departments, or towards subcontractors. And on the other hand, safety culture ambassadors themselves needed to be promoted in order to gain sufficient visibility in the organization.

Organizational culture is by nature a slowly changing phenomenon. This can cause issues when there are clearly distinguishable stages in the activities of the organization, each with different level of safety-criticalness. A long-term orientation to the development of safety culture is thus required. One of the interviewees illustrated the promotional aspect of the ambassadors that work closely with subcontractors by describing how long-term orientation

for safety culture development can be maintained even if the task at hand is not nuclear safety-critical:

“Some contractor might ask why must something be done so exactly or that something doesn’t necessarily require so much precision, then also the contractors need to be reminded that even though it’s not exactly needed, we nevertheless prepare for that in the future things need to be done at this level of precision when building an NPP. So we’re practicing the right working practices well in advance.”

To be successful, the SCAG also requires some “meta-promotional” activities: in addition to promoting safety culture, the ambassadors should also make themselves known in the organization. Many of the interviewees brought up that due to the relative newness of the ambassadors group, not many people in the organization were aware of them. This lack of knowledge may either relate to not knowing about the existence of the ambassadors or not knowing which persons are the ambassadors. An interviewee speculated that the issue in this particular organization relates to the latter:

“At this moment hardly anyone knows that I specifically am [an ambassador]. But everyone probably knows at the moment that we have safety culture ambassadors and they can be found in the firm and names can be found from intranet.”

In addition to the aforementioned intranet, the visibility of the ambassadors has also been promoted during a Safety Culture Theme Day in the organization. This involved introducing each ambassador to other members of the organization. In addition, some interviewees mentioned that they have attempted to make their role as an ambassador known in their department. However, many interviewees found that the ambassadors were still somewhat invisible at this stage of the implementation of the SCAG and that some found it challenging to find ways to make oneself known as an ambassador.

SCAG as a direct behaviour modification tool

In the interviews not many indications of the use of the ambassadors as a direct behaviour modification tool were found. Some examples were related to ambassadors’ intervention in situations where decisions were made without sufficient attention put on considering their nuclear safety significance or if attitudes not suitable for a nuclear organization were displayed. In comparison to many other direct behaviour modification tools, such as checklists or human performance tools, which are typically passive and impersonal by nature, the interventions that the safety culture ambassadors engage in are active and personal. This may mean that safety culture ambassadors need to have certain social skills for carrying out these interventions. For example, one of the ambassadors brought up courage as one of the attributes of an ambassador:

“The role of message bringer demands courage to bring those kinds of things in the open. Because, if an employee doesn’t have the courage to bring the issue up by oneself, the ambassador should be able to help. So you need to have courage and have confidence that you have certain immunity in this role.”

Although generally having the title of safety culture ambassador was not considered as providing additional organizational status to the individuals, some interviewees found that being an ambassador can be helpful in carrying out certain challenging tasks such as

intervening. An interviewee provided the following example of how the title of safety culture ambassador can be beneficial in the behavioural modification:

“I feel that being an ambassador gives you the mental support that you are better able to intervene if you notice something. [...] It gives an additional weight to what you are saying, in contrast to if you were to start making remarks as a common engineer.”

3.1.4 Challenges in implementing a SCAG

Since the SCAG activities were in early phase of implementation in the case study organization during the data collection, we can only reflect on the initial challenges that relate to the introduction of the SCAG. The challenges identified during the interviews seemed to stem from four main areas: the organizational context, implementation-related challenges, social issues or practical limitations.

The *organizational context-related challenges* included both existing organizational culture but also contextual challenges such as the way in which the organization is structured or the inherent characteristics of the current life cycle stage of the organization. For example, the interviewees brought up issues such as the difficulty of carrying out long-term safety culture work due to turnover of subcontractors or personnel, communication difficulties due to a lack of experience in nuclear industry of other organizational members, or experiencing contradicting messages within the organization.

The *implementation-related challenges* mentioned by the interviewees included a lack of clear definition of the safety culture ambassador's role and tasks. This issue was mentioned by several ambassadors and is indicative of the early stage of the implementation of the SCAG. As our research study progressed, we witnessed an ongoing effort to define the tasks and responsibilities of the ambassadors in a more explicit manner. However, we also noticed in the interviews and observations that there were contradicting views regarding the tasks and responsibilities. The concerns appeared to relate to the contradictory issue of standardization and adaptation: Sufficient coherence and harmonization of activities needs to be ensured between the tasks of the ambassadors, but on the other hand, due to the diversity of the group, some level of degrees of freedom and informality needs to be maintained in order for the ambassadors to be able to tailor their activities to the context of their respective departments. Additional complexity is introduced by the differing workloads between the ambassadors, which means that some of them cannot be as active as others.

Social challenges were also brought up during the interviews. Since a significant portion of the work done by safety culture ambassadors involves interacting with other people, the role of the ambassador in the working community and the relationship between the ambassador and his/her peers within the department are essential. Some of the social issues mentioned during the interviews related to having courage to intervene or other personnel not actively approaching the ambassadors to present ideas or concerns. Furthermore, one of the interviewees implied that if the social structures and roles within a team have already been established, being nominated as a safety culture ambassador may require some effort to integrate the safety culture ambassador as a constructive and functional role into the team:

“One challenge is to keep the issue serious enough within your own team that it doesn't become a joke that now we have a great safety culture because someone has some kind of an ambassador's hat on his head.”

Finally, some *practical challenges* were brought up as well. These included inability to engage in carrying out ambassador tasks, or preparing for and participating in SCAG meetings due to the workload caused by the primary job. Being an ambassador appeared at this stage of the implementation to be an add-on, which means that specific tasks defined for the ambassadors might be omitted in case more urgent tasks appeared. Formalizing the tasks of the ambassadors and allocating work time for them might provide a fix for this issue; however, this might not be the case in all situations, as described by one of the interviewees when the researchers inquired whether work time should be allocated for the ambassador tasks:

“Hard to say. In my case if it would be formally allocated, it wouldn’t change things in practice. Big project and priorities override formalities.”

Another interviewee suggested that ambassador tasks could be integrated into one’s developmental goals:

“Maybe it could be a part of your personal goals – so when you’re working as an ambassador, it’s one of your goals. This would again mean that you can use time and prioritize on the grounds of this being one of your goals.”

Furthermore, indications of language and location-related separation issues were observed by the researchers. These may make organizing SCAG meetings more difficult or affect the activeness of the participants – and ultimately the efficiency of the SCAG method.

3.1.5 Discussion and conclusions

At the point of data collection, the SCAG was still in its early phase of implementation and had not yet fully developed. Because of this, the experiences of the ambassadors were mostly related to the activities that they naturally do, consider important to do, or what was done during the SCAG meetings. This will limit the extent to which inferences can be made at this point of our study. In this discussion we focus on three specific topics to summarize the findings of this case study: hypothesizing whether or how SCAG activities can influence safety culture, reviewing the most apparent limitations of the method, and discussing the role of adaptiveness in defining the goals of SCAG.

Potential usefulness of SCAG for safety culture improvement

The usefulness of the SCAG for influencing safety culture can be approached from two directions:

- **Meta-method:** the ambassadors can influence safety culture by utilizing various safety culture improvement methods in their respective environments
- **Organizational structure:** nominating the ambassadors and implementing the SCAG institutionalizes the role of safety culture ambassadors in the organization

The first approach – interpreting SCAG as a meta-method – focuses on what safety culture ambassadors *do*, while the latter focuses on what the safety culture ambassadors *are*. We found during our case study that the ambassador group appeared as potentially useful for quite a variety of different activities, ranging from facilitating informal bi-directional communication and active intervening in safety-related matters to holding training sessions. Carrying out these activities can have a positive influence on the safety culture of the organization, for example, by increasing safety culture-related knowledge of the shop-floor personnel (e.g. trainings and conversations) or by making it socially acceptable to talk about

and act on safety-related issues (e.g. interventions if decisions are not made in a safety-conscious manner). Since safety culture ambassadors represent a group of departments of the organization, they can reach a broad range of organizational members – this can further intensify the safety culture improvement effect. Furthermore, this may also provide opportunities to carry out such grass-roots level safety culture work that may not be possible using traditional safety culture improvement methods, such as adopting safety culture messages to fit the context of a particular department. However, this also means that it is essential that the ambassadors conceptualize safety culture in a similar way to avoid unaligned safety culture promotion. The periodical SCAG meetings and safety culture training for the ambassadors may be beneficial to create this shared understanding.

Many of the activities carried out by the ambassadors can also be conducted by the regular members of the line organization such as supervisors or group managers. This leads to the question of what is the added value of institutionalizing the role of a safety culture ambassador and the SCAG in the organization. We found during this case study that the institutionalization can be beneficial in many ways. For example, the ambassadors gain knowledge of safety culture and the insights from different departments in their joint SCAG meetings and can utilize this knowledge in the work in their respective departments. Furthermore, even though many interviewees found that the ambassador activities are a natural part or extension of their primary work, it was also argued that being known as a safety culture ambassador at the shop-floor may give either subjective or social acceptability for being active in promoting safety culture. Thus, being a member of the SCAG, carrying out joint activities, and having the title of safety culture ambassador may make enough difference to make it beneficial to implement a SCAG instead of just assigning regular managers to do the similar things.

Possible limitations

Even though the nomination of the ambassadors in different departments can expand the reach of safety culture work and thus help deal with the challenges posed by turbulent organizational settings or project environment, *the efficiency of the practical approaches utilized by the ambassadors can still be vulnerable to the contextual contingencies*. For example, from the perspective of training or other means of acculturation, turnover or cultural diversity of personnel is likely to cause issues regardless of whether it is the safety culture manager, training personnel or the ambassadors that lead the activity in practice. However, the use of ambassadors might help meet the topical safety culture needs of a turbulent organization in a more agile manner due to the closeness to the field of the ambassadors.

We also found some indications of *person-dependence* as success factors in the implementation of SCAG. This can include the knowledge, experience, social skills, social role in one's own team, motivation, and available time and resources of the ambassador. This suggests that when nominating safety culture ambassadors, care should be taken to ensure that the person chosen is competent and/or interested in the task, and perhaps even more importantly, has time and opportunities to actually participate in the activity. However, the ambassadors' diversity in terms of knowledge or experience is not necessarily an insuperable obstacle. In fact, it probably cannot be assumed that there is advanced safety culture know-how in every department of the organization – especially in a young organization in the nuclear industry. The joint SCAG activities can be helpful in developing the competences by training the ambassadors and facilitating knowledge transfer from the more experienced members of the group to the less experienced ones.

Due to the diversity and wide scope of applicability of the SCAG method, organizations may be tempted to use it as a *universal cure for every organizational inadequacy*. While the SCAG can be useful as a redundancy for some organizational functions, organizations should be careful to not rely too much on the ambassadors to carry out activities that could be better solved by organizational structures or by other organizational members such as supervisors. Careful definition of the goals and tasks of the ambassadors is therefore advisable.

Need for adaptive goal definition

The need to define the goals and activities of the SCAG in a flexible manner manifested in two ways. First, *the activities of the SCAG should be in line with the current and prospective states of the organization*. As the organizational context and the maturity of the safety culture changes, the SCAG should be able to either anticipate or respond, and change its goals accordingly. For example, in the case study organization, several notions were made regarding information flow issues which were partially caused by rapid growth – this was an organizational challenge that was reflected in some of the activities mentioned by the ambassadors in their interviews (i.e. the need to improve interaction and communication or to connect people from different departments). Respectively, once this challenge is addressed as the organization matures, the SCAG should be prepared to change its orientation and focus to other issues. The implementation of the SCAG might therefore benefit from continuous updates to the job and task descriptions of the ambassadors in order to adapt to topical organizational challenges. From the perspective of safety culture development this suggests that the SCAG would initially serve as a redundancy for the organization's safety culture related functions (e.g. safety-related communication and interaction, concern reporting, etc.), but once the organization has adopted the ability to maintain these functions without external help, the SCAG would move its focus to other challenges.

Secondly, the individual ambassadors carry out their work in different contexts with different requirements, and the relation to nuclear safety between the organizational departments differs. This suggests that *there needs to be certain level of flexibility regarding how the individual ambassadors carry out their ambassador tasks within their respective departments*. For example, there may be significant differences regarding what are the suitable tasks for office ambassadors as opposed to on-site ambassadors. Furthermore, the competence differences between the ambassadors increase the need for flexibility for goal definition – rather, the way in which each of the ambassadors performs their tasks depends on the strengths and weaknesses of the individual person and the characteristics of his/her department.

3.2 Project Management Seminar at Organization B

3.2.1 Introduction

With the primary objective (for this research study) to test a methodology for the improvement of project management (here taking place within the nuclear sector of Organization B), a seminar with a sample of project leaders was conducted. For the participating project organization, the primary objective and rationale for participation in the project was to identify weaknesses, strengths and to suggest ideas for further improvements in the context of project management. It was specifically mentioned in the invitation to the seminar participants that safety culture associated with projects would be discussed.

Three human factors specialists participated in the pilot test. Below the results of the pilot test are described with a primary focus on the method used and its judged validity for further

studies about project management. Specific results (outcomes for the participating project organization) are of secondary importance for this report and will only be mentioned briefly.

3.2.2 *The seminar*

The seminar participants ($n = 11$) were all project leaders and specialists involved in project management for the nuclear sector at Organization B (one participant from non-nuclear operations was also present). The initial plan for the seminar was to discuss structural issues first (i.e. responsibilities, methods used, etc.) and then move to focus on cultural factors. It was found, however, that *the structural issues and the cultural ones were so closely connected that it became problematic to discuss them separately*. This observation confirmed our hunch that it is very difficult to separate cultural issues from the context in which they occur. Another observation was that *it was rather difficult to separate specific safety culture issues from more general organizational culture factors*. This also confirms an observation made in other studies which suggests that the boundary between general organizational culture factors may be difficult to separate from specific culture issues such as safety culture, innovation culture or quality culture.

To structure the discussion, a generic process description for projects was shown for the participants at the start of the seminar (see Figure 4). This chart had previously been discussed with the project office in order to validate its correctness. The main phases of a typical project conducted at Organization B were described. Under each phase, a set of support functions were suggested as inspiration for the discussions. In this exercise, safety culture was added to the chart as one of the support functions. The participants were informed that they could add any support function that they thought were important to discuss.

| Support functions and project phases | Analysis | Planning | Establishment | Realization | Handover | Project Conclusions |
|--------------------------------------|----------|----------|---------------|-------------|----------|---------------------|
| Safety culture | | | | | | |
| Training | | | | | | |
| Procedures | | | | | | |
| Management | | | | | | |
| Time | | | | | | |
| Money | | | | | | |
| Tools | | | | | | |
| Risk analysis | | | | | | |
| Reviews | | | | | | |
| Others... | | | | | | |

Figure 4. Generic project phases and support functions

After a presentation of the background to the seminar, introduction of participants and presentation of the chart, the project participants were asked to discuss in small groups (2-3 persons) about what experiences and problems they perceived at different phases of a typical project. After about 20 minutes each group reported their results in plenum.

3.2.3 *Some examples of problems identified*

Decisions in the early phases of a project

Regarding the first phases of a project, a majority of the participants identified a problem that was associated with what they perceived was as a too long and slow decision process where too many different stakeholders at different positions were involved. The participants suggested that it would be good to highlight this problem further and try to seek out a more

efficient decision making process. A majority of the participants also argued that one strategy to cope with the initial phases of a project would be to give more responsibility to the project organization itself: this statement was repeated several times throughout the seminar.

We also observed that the discussions that focused on the initial phases of a project had clear connections to cultural dimensions, specifically how *trust* is perceived between the project members and other stakeholders residing outside the project organization. Another issue that was discussed was that people in the project organization sometimes perceived that *external stakeholders underestimated the complexity* that was evoked in some projects.

Risk analysis in projects

The support function tentatively labeled “risk analysis” evoked a longer discussion. It became clear that *different stakeholders in a project had different expectations* regarding what type of risk analysis that should be performed: some stakeholders argued that the risk analysis should be more detailed whereas others suggested that it should be more global. By and large, the type of risk analysis that was mentioned was associated to project risks and not so much to safety risks. Furthermore, the risk analyses that were normally performed had little room for sensitivity/uncertainty analysis.

3.2.4 *Safety culture and projects*

As already mentioned above, cultural issues became an integrated part of the discussions and became hard to separate from the other support functions that were discussed at the different phases of a typical project. However, in order to more explicitly attempt to focus on safety culture, parts of WANO’s criteria for a healthy safety culture (see WANO, 2013) were used as prompts for the discussion. Some illustrations of the responses are described below.

One of the issues discussed concerned to what extent the persons directly involved in the project organizations are aware of the influences their activities may have on safety. The respondents thought that in those projects that were in some way safety-critical, there was awareness about the safety issues. The issue did not trigger much discussion. However, the subsequent issue evoked more discussion: “I challenge the organization if I perceive that I do not have the right resources to satisfy the safety needs”. By and large, the group asserted that concerns about safety are spoken out if such situations arise. However, the group also said that a factor that influences this attribute of safety culture concerns the age and the experience of the project members. Several of the participants had noted that younger and inexperienced persons sometimes were in need of support from older colleagues to develop a questioning attitude. The project manager was seen as an essential actor in order to create a questioning climate in a project and especially in relation to external consultants – the project manager was seen as the most important resource for asking if the consultant perceived problems and weaknesses – it could not be expected that external consultants or entrepreneurs spontaneously always raised such issues. Other specific results from the seminar are not further discussed here. We shall rather now focus on the generic lessons about the method used and particularly its relation to safety culture.

3.2.5 *Discussion and conclusions*

The pilot study confirmed the initial assumptions that formed the basis for the pilot study. Namely, for the understanding of projects, both cultural and structural properties are deeply interwoven in an ontological and epistemological sense. *Culture should be discussed in context of work processes and structures rather than as some context free abstractions.*

The seminar discussions were supported by presenting the process (i.e. a generic project in terms of phases and support functions) and this gave structure to the discussion. But also here, the holistic nature of the process was observed: the list of support functions evoked discussions that combined several functions rather than being perceived as fragmented and separate from each other. It has become popular to discuss safety culture in form of various “traits” that could be investigated more or less “one by one” – this is however a gross oversimplification of reality and one which we became aware of during the course of the seminar. Whereas the strategy of dividing support functions into components helped structuring the discussion, one should be aware of that such a strategy also has its disadvantages. The seminar participants were very positive about the seminar and it seems that the basic reason for this was that it gave an opportunity for an *open dialog* about their everyday work. Perhaps this is the most important lesson: to develop a process – whether it is for project management or some other process – *the key strategy is to create opportunities for people to meet and exchange ideas*. This may at first sight be seen as something very trivial: did we not know this already? However, in times characterized by rapidly increasing quest for more and more cost effectiveness, specialization in different roles etc., the opportunities for dialogue may in worst cases be increasingly limited. Extending this reasoning to the concept of safety culture in general, the search for methods for safety culture enhancement will of course proceed in many directions, but perhaps one of the most effective “methods” for this endeavor is to open the room for people to meet and share their ideas about problems and solutions. A further step in this direction will be taken in our study where the basic idea is to involve more stakeholders in project management.

3.3 Information Exchange with Organization C

3.3.1 Introduction

The information exchange with Organization C was not a full scale case study but aimed at exploring their current activities and practices for improving and assuring safety culture in complex projects. The information related to these practices was communicated informally by digital means or via joint telephone conversations. The information exchange also facilitated the process of mutual learning since the contact persons at the case organization had an opportunity to learn about the theoretical approaches to managing complex projects and the implications of complexity and project environment to safety culture and nuclear safety. The researchers, on the other hand, learned about the practical approaches and challenges in assuring and improving safety culture in contemporary operational Nordic nuclear power plants.

In Organization C, projects are initiated by the Engineering Department (line management). When a project is ready to be started, the project is run through the project organization, as depicted in Figure 5. For the duration of the project, the project managers serve as consultants and are placed in the project, planning and outage department. Project managers previously employed directly by Organization C are now employed by another organization, while other project managers are employed by consulting companies. A project manager is usually assigned to a number of projects (depending on the size and complexity of the project) and the resources for the necessary project roles are requested by the project manager from relevant departments in the line organization.

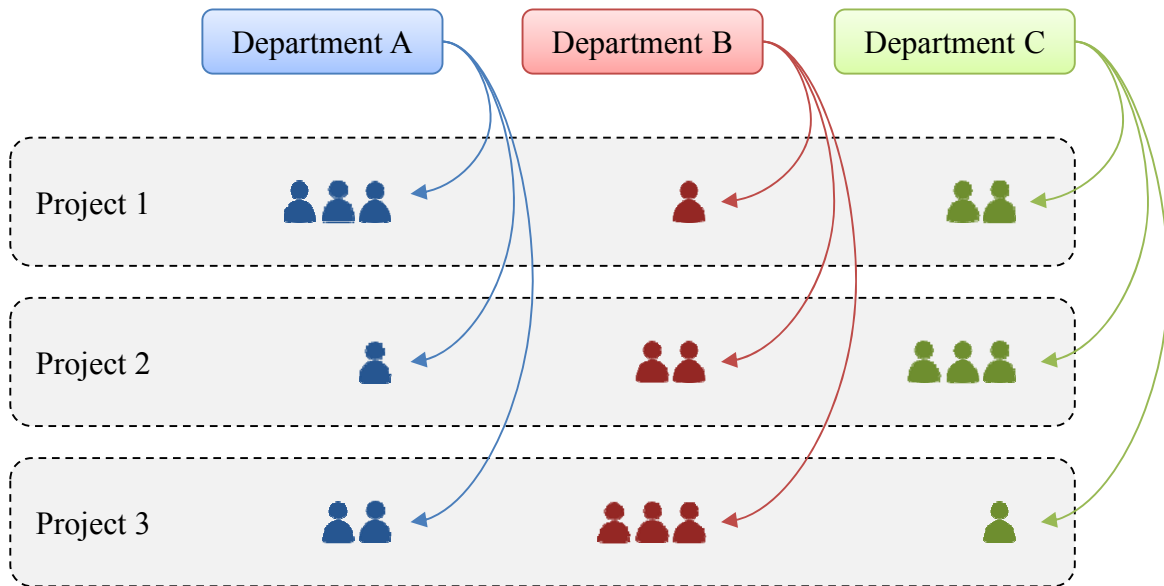


Figure 5. Illustration of the matrix organization where line management (departments) assign human resources to projects at Organization C.

Projects are organized in such a way that the project organisation is a separate entity from the line organization. Although the responsibility for safety is shared between the line organization and the project organization, as the operating license is held by the Organization C, the main responsibility for safety remains in the line organization. The assessment and assurance of a healthy safety culture, as well as actions and initiatives to that extent, are the responsibility of the line organization.

3.3.2 Methods

Two approaches to data collection were utilized in this case study: free form information exchange sessions with two human and organizational factors (HOF) experts of the Organization C, and results from safety culture interviews with persons connected with projects, carried out by the aforementioned experts. Regarding the former approach, multiple tele-meetings between the researchers and the HOF experts were held with the goal of discussing the assurance of safety culture in project environments, the development of an interview scheme suitable to gain insight into how project managers ensure good safety culture during projects, and reflecting upon the results of the safety culture evaluation carried out by the HOF experts.

The latter approach utilized document analysis and interviews ($n = 5$) for data collection. The document analysis included, for example, a focused overview of the electronic archive of Organization C. The first four interviews were conducted with employees at different departments and roles in projects. Two of them were project managers, one was a project initiator and one was a mechanical design engineer. Two of the interviewees were employed by Organization C, and the other two were full-time consultants. Their employment relation ranged between four and twenty years. Some of the interviewees had experience from other industries, including transport, paper industry or from another nuclear power plant in the country. The fifth interview was conducted with two project managers, and the purpose of this interview was to find out if there was a recognized need for methods to be used to improve safety culture in the project organization at Organization C. All of the interviews were semi-structured and their duration was 1.5 – 2 hours. The interview scheme included for example the following topics:

- How do the interviewees understand the concept of safety culture;
- What do they currently do to improve safety culture;
- What concrete methods do they apply for to improve safety culture;
- What challenges have they faced in complex project environments

Two projects were studied in this information exchange case. Project One was a larger project, spanning over several years, and initiated by a regulatory change. There were several stakeholders involved in this project: internal (at the NPP), company (NPP owner) and external (supply chain and entrepreneurs). Resources for the project were supplied by the line organization. The project was prioritized by the organization, which means that the resources were assigned to experienced people to assure quality, mentorship and organizational transfer of knowledge, as well as to more recent employees to allow for learning, knowledge exchange and assuring continuity, especially with regard to experienced employees approaching retirement. Project Two was a smaller project, which spanned over one year and was initiated by an identified damage to a safety critical component during an outage. The goal of the project was to repair the damage in a way that ensures control and testing for damage on the component also in the future.

3.3.3 Results

In this chapter we summarize the main findings gained from the information exchange with the HOF experts from Organization C. The findings are based on the interviews with project managers conducted by the HOF experts, the interpretations of the interviews made by the HOF experts and generic insights provided by the HOF experts that came up during the information exchange sessions with the researchers. The most important topics that emerged were the various safety culture related challenges in project environments, how the interviewees conceptualized safety culture, the distribution of responsibilities for safety culture assurance in projects, and the activities to assure safety culture in projects.

Safety culture challenges in projects

The discussion with the HOF experts regarding project-related safety culture challenges highlighted a variety of important themes. For example, it was brought up that the employees working in projects may find it difficult to *understand how one's work is positioned in the big picture of the organization's activities*. This stems from the matrix-style distribution of tasks and responsibilities between the project and the line organization. It may manifest itself, for example, in difficulties of time planning: knowing where to allocate one's time under the conflicting messages within the organization regarding the importance of the tasks. The HOF experts pointed out that the issue of clear communication of priorities between the line and project organizations is being developed; however, the concept of safety culture is not applied in the context of this discussion.

As a result of the interviews, the HOF experts concluded that one of the main difficulties for project managers is that they do not “own” the resources they utilize in projects; rather, the resources are chosen and lent to the project by the line organization. Sometimes the project manager may request specific people, but the final decision is made by the line organization. Similarly, the project managers are chosen by the line organization. Figure 5 illustrates how the employees from various departments are allocated to projects. Some employees may also participate in multiple projects simultaneously – especially the more experienced and knowledgeable ones. The HOF experts suggested that *the culture in projects is dependent on the employees that the line management allocates to the project*.

Ensuring the *continuity of knowledge* in project context was another acknowledged challenge. The HOF experts brought up that experience feedback, especially between projects, can be an issue: since knowledge is not created within the permanent parts of the organization – but rather in the project organization – special arrangements need to be made. It was noted that this issue can also manifest itself between project phases. The HOF experts mentioned that concise end-of-project experience feedback reports have been utilized at Organization C to address this issue. Furthermore, a database for collecting experiences within projects is currently being developed. However, the HOF experts also noted that motivating project team members to write things down to collect experiences might not be trivial – encouraging them to conduct such data collection and making them see the benefit may pose a challenge. This challenge can be especially pronounced with subcontractors. Further concern expressed by the HOF experts was that the collection of data might not concretize into real learning that extends to other projects.

Furthermore, the interviewees were asked to describe the characteristics of complex projects, which produced the following generic challenges: rebuilds and changes at the plant, introduction of new technology, executing long term projects that involve multiple disciplines, system complexity (at plant), high number of project members, difficulties in knowing what other project members are doing and how it affects your own work, whether components need to be switched off during outage, novelty (e.g. whether it is a new project, or whether the materials used are new), whether spare parts or components are available or not, the level of regulatory demands, and the number of identified risks.

The interviewees' conceptualization of safety culture

In the interviews at Organization C, the project managers were asked to conceptualize safety culture. The concept of safety culture was used by most of the interviewees as a synonym to safety, assurance of safety or technical assurance of quality. One interviewee considered safety culture as something beyond just ensuring that the end product was of desired quality and fulfilled standards and regulations. This interviewee referred to such activities as decision-making or communication practices, resource allocation, and competencies and experience as elements of safety culture. Overall, the responses indicated that the interviewees implicitly understood how to improve safety culture, because safety culture was used as a synonym for assuring safety – living up to the regulations or delivering a high quality end product to ensure nuclear safety in the operating plant.

The HOF experts also pointed out that the conceptualization of safety culture might be dependent on the plant life cycle phase: the concept becomes more tangible in installation and commissioning phase, where actual work is done at the plant, as opposed to desk jobs such as design. At Organization C there also appeared to be more focus put on improving the human performance of the operational and maintenance employees (i.e. implementing a human performance program), while there was a lack of tools, for instance, for design workers to improve their human performance.

In addition, the HOF experts brought up that due to the way line and project organizations are set up (see Figure 5), many project managers did not feel like there is an actual project culture as there were no “tightly knit” people that would work together for an extended period of time. On the other hand – the HOF experts added – even though the possible existence of culture might not be perceived explicitly, there might still be a culture, for example in the form of a diverse set of departmental subcultures.

Distribution of responsibilities

Identification of key stakeholders can provide important insights to how safety culture can be assured in project environments. In this information exchange-based case study the following stakeholders were identified: top management, shop-floor workforce, project initiators, and project managers. We focused on the latter two during our information exchange with the HOF experts. The project initiators are a group of people in the line organization that have the responsibilities of the systems at the plant. Nuclear safety is high on the agenda of this group and they are also aware of the concept of nuclear safety culture. During a project, the initiators' responsibilities include communicating with the project manager on regular basis to assure that the project progresses as planned, approving any changes to original plans and assuring that the end result is achieved. Conversely, the project managers' role is to decide how the project is carried out in practice. Whereas the initiators usually have extensive nuclear experience, some project managers might not be very experienced in the industry. This means that in situations where the project manager is inexperienced, the project initiators may need to put extra effort in ensuring that nuclear safety is achieved. The HOF experts also pointed out that there might be increased complexity regarding the responsibility for safety culture in situations where project managers are hired from other organizations since the assurance of safety culture is always the responsibility of the licensee organization.

Activities to assure safety culture in projects

During the discussions with the HOF experts, we also found that previously at Organization C it was assumed that the safety culture of the main organization would disperse naturally into the project organization. Thus, there were no specific, systematic safety culture assurance activities in projects. During the first four interviews carried out by the HOF experts at Organization C no concrete examples of explicit methods to assure safety culture in projects were given. In the fifth interview, two examples of methods planned to address the issue of safety culture in complex projects came up: a project communication guideline has been drafted, and a seminar series was launched on topics such as managing the unexpected, resilience engineering and crisis management. The example of the project communication guideline was found during the search for documented methods of assuring safety culture in projects in the electronic archive of the plant. The communication plan aimed at ensuring relevant project information was communicated to relevant parties in an appropriate manner; however, this document was still in progress and its use was not yet approved.

3.3.4 Discussion and conclusions

The findings from the information exchange with Organization C indicated that currently there is a rather vague and mostly implicit understanding of how safety culture could be improved, facilitated and assured in complex projects. The emphasis is strongly placed on safety culture as equalled to technical quality assurance. That is, the improvement of safety culture was perceived as an activity which is embedded in the daily quality assurance practices. The need for explicit "safety culture assurance and improvement" labelling was not recognized. Furthermore, the methods or tools were not referred to in daily practice as "methods for safety culture improvement". As a result, the interviewees did not identify and label them as such. Recent new activities in this organization seem to embody the recognition that safety culture of the main organization does not disperse naturally into the project organization and that systematic safety culture assurance activities in projects are indeed needed. Importantly, since the ultimate responsibility for safety is not in the project organization but in the line organization, it should be taken into account that these two organizations do not "mirror" each other: since each project participant brings their own understanding and practices to the project, the safety culture assurance activities need to be planned and ensured with systematic efforts and methods.

The recent initiatives at Organization C indicate efforts to shift the focus from annual ticking of the boxes to implementing real change, e.g. creating a reporting culture in projects and encouraging employees to raise concerns. Still, encouraging people to speak openly if they have safety concerns is not yet done in a systematic way in projects as it is recognized that it depends much on the group configuration and power dynamics. Some identified methods for safety culture improvement in complex projects were *the development of a project communication guideline and launching of series of seminars* on various topics. However, these methods were still under development. Also, the need for a broader perspective when using human performance tools has been recognized, as there are attempts to use the tools also for improving safety culture at earlier stages of the projects as well. Certainly, some methods mentioned in this information exchange study were utilized to assure safety culture in projects, but not all of them are explicitly under the umbrella of “safety culture”. It was acknowledged that there is an understanding that assuring safety culture is everyone’s responsibility; however, the assurance process was not systematic.

Regarding the groups of actors that may play an active role in safety culture assurance and improvement in projects, the role of *top management* for creating necessary preconditions and context for safety culture assurance and improvement was not specifically raised during the information exchange. *Project initiators* usually have quite a good understanding of the technical complexity in the plant, as well as a practical understanding of nuclear safety culture and nuclear safety, yet it does not automatically mean they are also good in communicating their knowledge and understanding to the project team. *Project managers* are not necessarily familiar with the nuclear industry. There is a need to assure that project managers have sufficient understanding of safety related issues, paired with specific knowledge of the organization. For instance, in one of the projects discussed during the information exchange, project managers that had run very big projects outside nuclear were utilized, however, they worked really well with the project initiator.

Project managers in Organization C are marked by both diversity and unity. The diversity stems from project managers’ different backgrounds and levels of experience. Yet, for the most part they are professional project managers and the most qualified project managers are assigned to the most difficult projects. On the one hand, the diversity could be seen as beneficial for safety culture improvement, because project managers may use different methods, based on their professional preferences and experience of what works in certain contexts. On the other hand, the professional certification builds a common ground and ensures that capabilities exist for dealing with complexity in projects and peer support can be asked for, if needed, in terms of sharing of good practices and lessons learned.

The approach to select the project manager and actors, and design the project team plays a role in the consequent efforts for improve safety culture. For example, project resourcing is within the scope of the managerial decision-making, which means that the initial set up of the project is influenced by the line management in terms of how and what to improve when safety culture is considered. In fact, the project implementation process takes place through daily facilitation of interaction and communication, which is seen as one of the methods for safety culture improvement. Still, the focus is on the practical implementation of the project, including emphasis on the project scope, schedule and budget, and identifying project and safety risks. To conclude, currently at Organization C there are no formally documented ways of assuring safety culture in projects, and there is no clearly communicated expectation to document or describe ways of assuring safety culture in projects. The case organization could potentially benefit from making the apparently implicit and tacit developments related to safety culture assurance and improvement in complex projects more explicit and systematic.

4. Evaluation Framework for Safety Culture Improvement Methods

As a result of the theoretical and empirical work carried out within this research study, we developed a preliminary framework for evaluating safety culture improvement methods in project environments. The purpose of the framework is to provide an overview of the factors that can influence the selection and use of safety culture improvement methods in complex project environments. More specifically, this preliminary framework can be useful for identifying how the contextual boundaries (e.g. project environment) can affect the utilization of the improvement method. The project environment sets the boundaries by providing opportunities or challenges for safety culture intervention activities. In the preliminary framework we use the four established domains of time, team, task and context as the main determinants of project environment (see also Table 2). These determinants may help identify how safety culture improvement efforts are influenced by project environment and how the organization can respond to these.

As a summarizing result from the study to date, we propose the following four influence and response patterns to project environments (see Figure 6). First, the safety culture improvement activities can be *vulnerable* to the characteristics of project environments. This can be caused by the traits of project environment, such as the difficulty to form a deep and shared culture, or high turnover. Neglecting this challenge can make safety culture activities inefficient. Secondly, safety culture improvement can *capitalize* from project environment (e.g. by utilizing expertise of subcontractors to form good practices or to create operational options from the organizational diversity). It is thus useful to see project environments also as a potential asset, and not just a threat. Thirdly, the existing safety culture improvement methods may need to be *tailored* to fit the project environment. For example, our empirical study in Organization A illustrated how safety culture ambassadors have the potential to implement traditional methods such as training in a local and adaptive manner. Finally, it may be necessary to target safety culture improvement activities so that the specific challenges created by the project environment are *rectified*. For instance, the issue of diverse skills and knowledge may be rectified by utilizing the ideals of good safety culture during the selection of a consortium to avoid diverging understandings of safety later during the project.

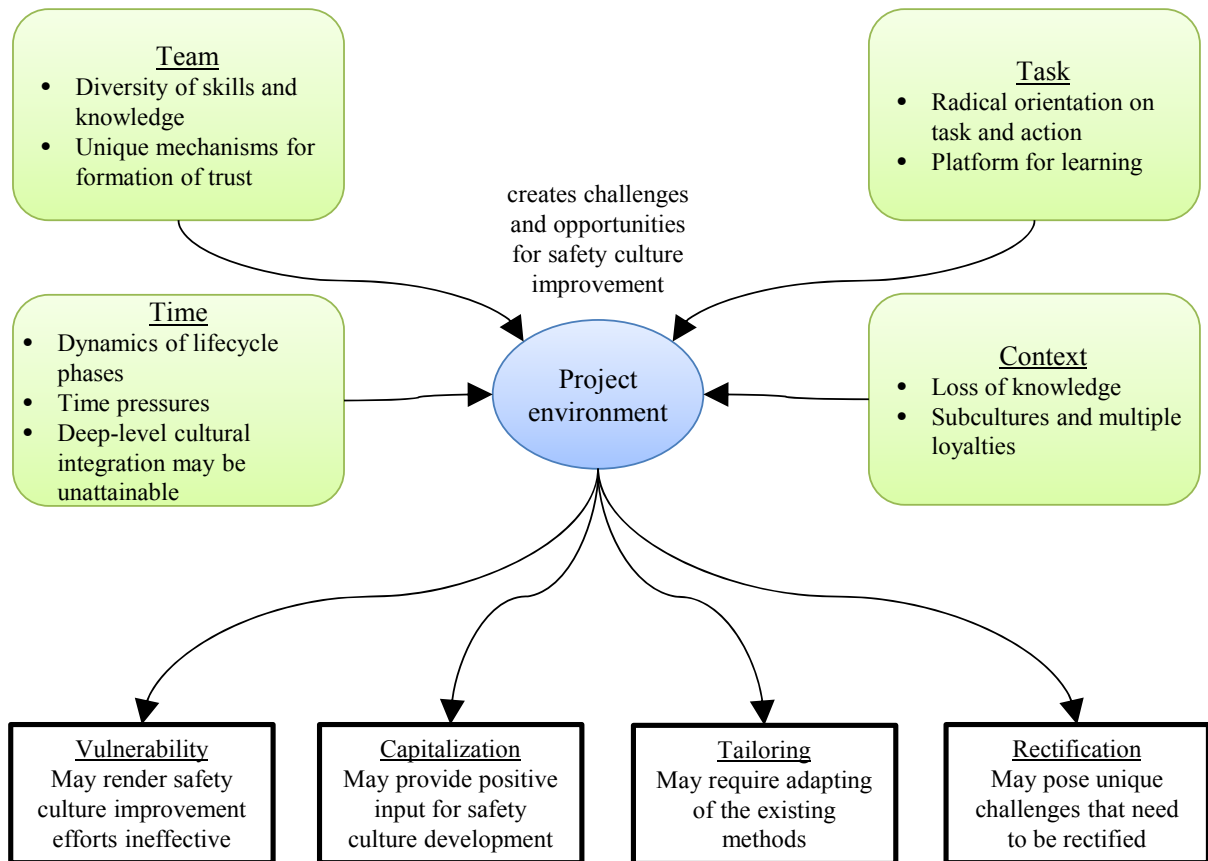


Figure 6. Overview of the characteristics of project environment (green boxes) and the potential response patterns concerning safety culture improvement efforts (four boxes below)

A limited example of how the framework can be applied to evaluate a safety culture improvement method (based on our findings in empirical case A) in project environment is presented in Table 5.

Table 5. Example of the use of the framework to evaluate the applicability of the Safety Culture Ambassadors Group (empirical case A) in project environments

| | |
|----------------|---|
| Vulnerability | <ul style="list-style-type: none"> • If the ambassadors utilize conventional safety culture improvement methods (e.g. training, coaching, facilitating commitment etc.), their impact of their activities may be affected by the contextual challenges (e.g. turnover) in project environment |
| Capitalization | <ul style="list-style-type: none"> • Ambassadors can collect initiatives and good practices from their operational environment into the joint ambassadors group and thus capitalize on the diversity of a dynamic environment – this potential might be further strengthened due to the social nature of the ambassadors, i.e. they can either actively collect information or provide a low-threshold interface |
| Tailoring | <ul style="list-style-type: none"> • Due to the closeness to the shop-floor of the ambassadors, they have the potential to adapt their safety culture improvement activities to the local changing conditions |
| Rectification | <ul style="list-style-type: none"> • The ambassadors can identify information or communication flow issues between project members and help develop countermeasures to address them |

5. Conclusions

The activities of this study were guided by the following aims: 1) to identify and specify methods to improve and facilitate safety culture in complex projects, and 2) to identify and specify methods to assure safety culture in complex projects. The results indicated that there is a multitude of approaches and practical methods for safety culture improvement described in literature; however, not all of them are explicitly framed as such. We classified the methods into the following seven groups based on their apparent objective: organizational structures, direct behavioural modification, interaction and communication, commitment and participation, training, promotion and selection. The literature on methods intended specifically for project environment was found to be scarce. In addition, the study revealed several project-specific challenges in the domains of time, team, task and context, each of which can influence the efforts to improve safety culture.

Our main case study focused on using the method of safety culture ambassadors group for safety culture improvement. This method can be seen as both an organizational structure (i.e. an institutionalized role of a safety culture ambassador and their joint group) and a “meta-method”, which constitutes a variety of safety culture improvement methods that the ambassadors can utilize (incl. training, facilitating interaction, promotion, etc.). The essential benefits of the ambassadors group related to the flexible and far-reaching use of safety culture improvement methods: the ambassadors come from multiple organizational departments and thus cover a wide scope of the organization and can improve safety culture in ways suitable for their own context. Furthermore, having periodical, joint ambassador meetings led by the organization’s safety culture manager provide the prerequisites for carrying out this work in a coordinated and aligned manner. In project contexts this method can be vulnerable to contingencies of the environment since ultimately the ambassadors often use “conventional” safety culture improvement methods such as training or interaction with individuals. On the other hand, due to the closeness to the shop-floor, the ambassador may better be able to cope with any organizational turbulence and thus rectify these challenges. Furthermore, the ambassadors may be utilized to identify, for example, good practices or lessons learned when working within a project – in this sense, this approach to safety culture improvement might actually benefit from project environment instead of being compromised by it.

The second case study described an interactive project management seminar with safety culture as one of the topics covered. This study illustrated the potential of safety-oriented seminars as methods that can, on the one hand, collect and disseminate information, and on the other hand, serve as safety culture improvement methods through the facilitation of interaction and communication between various stakeholders. From the perspective of dynamic project environments, this method can be seen as beneficial for the improvement of safety culture as it provides a forum for dialogue which eventually can facilitate the formation of a shared culture among the participants.

The third case, information exchange with Human and Organizational Factors experts from a nuclear organization, provided us with an insight into how safety culture and its improvement is viewed by project managers and what is the state-of-the-art regarding safety culture work in project. We found that safety culture improvement was not explicitly acknowledged as a necessary label for activities in projects; rather, safety culture was associated with quality assurance and its related practices. This implies that there may be a need for integrating the quality and safety culture vocabularies and approaches. There were, however, initiatives in the case study organization concerning the systematizing of safety culture approach in projects.

The information exchange also highlighted the role of the responsibilities of each type of stakeholder (e.g. top management, line organization, project managers) in creating opportunities for safety culture improvement.

The plans for the next year's activities within this study include the following. First, a follow-up data collection of the safety culture ambassadors group is planned to better understand the impact and best practices concerning the implementation of the method. The follow-up is also relevant because the ambassadors group was at very early stage of the implementation during the first interview round. Secondly, especially due to the positive feedback received from the project management seminar, carrying out a similar exercise with a refined structure can prove to be useful for the study. Thirdly, information exchange with experts from nuclear organizations proved useful and is planned to be continued with the addition of new organizations. Furthermore, next year we plan to expand our focus to safety culture monitoring methods (e.g. safety culture auditing) in complex project networks.

Refinement of the preliminary framework for the evaluation of safety culture improvement methods could take place in the future stages of this study. For instance, the current version of the framework might benefit from analysis of the mechanism of action of a particular method of safety culture improvement: this can contribute to identifying the vulnerabilities of the method in project environment or give clues regarding how it can be tailored. The seven approaches of safety culture improvement identified in this report (organizational structures, direct behavioural modification, interaction and communication, commitment and participation, training, promotion and selection; see also section 2.1.2) can help gain insight into the nature of the mechanism of action of a given method. Furthermore, including the examination of the implementation strategy of the method can help identify the required prerequisites and best means of implementation for the safety culture improvement method (e.g. should the method be continuously used or a one-off intervention, should the preferred approach be top-down or bottom-up, should the targeted change be local or organization-wide; see also section 2.1.1). In addition, the framework could include practitioner-oriented instructions for the evaluation of the applicability of a safety culture improvement method in a particular organizational context. This could include, for example, a decision-support guideline based on the existing framework. Finally, the overview of the methods for safety culture assurance and improvement can be further extended and more closely tied to the mechanisms of safety culture change. The modification of the groups can be further investigated using other approaches as a basis (e.g. Hale et al., 2010), along with using emergent elements of safety culture (e.g. from factor analyses of assessment data) as a basis for the groups.

Another topic of relevance within the topic of safety culture improvement is to understand the influence of organizational contexts on a wider scope, namely, nuclear power plant life cycle stages and organizational transitions (such as those that occur when a power plant shifts from one life cycle stage to another). Understanding the challenges and opportunities these organizational contexts set for safety culture development is a topical area in the Nordic nuclear industry, especially since several operating plants are approaching decommissioning phase and new-builds are under construction.

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| Abstract | <p>A good safety culture is an essential ingredient for ensuring safety in the nuclear industry. The predominant approaches for safety culture are based on the assumption of stable and relatively homogeneous organizations, which often does not apply to contemporary project-oriented and turbulent environments. This study aims to identify and specify safety culture assurance and improvement methods for project environments.</p> <p>A variety of approaches and practical methods for safety culture improvement was identified in the literature. Based on their apparent objectives, the methods were classified into the following groups: organizational structures, direct behavioural modification, interaction and communication, commitment and participation, training, promotion and selection. The literature review did not reveal methods intended specifically for project environments or guidelines for tailoring the existing ones to suit project environment. Further review of the literature concerning project environments revealed a multitude of project-specific challenges and boundary conditions in the domains of time, team, task and context that can potentially influence safety culture assurance and improvement.</p> <p>Three empirical case studies in Nordic nuclear industry organizations were conducted. In the first case study, which focused on the use of safety culture ambassador group, it was found that this method can influence safety culture through multiple mechanisms and that the flexibility of this method can potentially rectify some of the challenges posed by project environment, or even benefit from them. Another case study focused on a safety-oriented project management seminar and showed the potential of this method in influencing safety culture through providing a forum for dialogue between different stakeholders. Finally, information exchange with experts provided additional insight into the current challenges and opportunities of safety culture work in projects. As a result of the theoretical and empirical work, a preliminary framework for evaluating the applicability of safety culture assurance and improvement methods was developed.</p> |
| Key words | Safety culture, project management, organizational change |
