SAFETY CULTURE AND SAFETY MANAGEMENT SYSTEMS – AN AUTHORITY PERSPECTIVE

T. Reiman[1] and K. Pajunen (lead presenter)[2]*

[1] *Lilikoi, Kisakuja 4, 08700 Lohja, Finland*

[2] *Finnish Transport and Communications Agency, P.O.Box 320, 00059 TRAFICOM, Finland*

*Corresponding address (Email: kirsi.pajunen@traficom.fi, +358-504116593)

Abstract

The paper considers the relation between ERA's Safety Management System requirements and the new Safety Culture Model. The Finnish safety authority Traficom was interested in clarifying the relationship between the two models and identifying ways to include safety culture issues in Traficom's supervision activities. A project to clarify the relation between the models was carried out during 2021. Project focused on safety culture in safety management systems of railway organizations, with a focus on the regulator's role and possibilities to influence and assess safety culture. The main goal of was to produce information and tools to Traficom for its assessments of safety culture in the rail organisations. To accomplish the main goal, the project first clarified the relation between ERA SMS requirements and ERA safety culture model. An approach was proposed for the regulator to conduct three types of safety culture assessments. The project was a theoretical study and the approach as well as the methods that were developed needs to be tested empirically.

BACKGROUND

Safety culture as a concept originates from the nuclear industry where it was first used to explain the Chernobyl nuclear accident. Deficient safety culture has been identified as a contributory factor in the development of numerous human-made disasters, from BP Texas City refinery explosion and Fukushima Daiichi nuclear disaster to Piper Alpha offshore platform, Challenger and Columbia Space Shuttle explosions, Deepwater Horizon disaster (Waring, 2015, Reiman & Rollenhagen 2018). Safety culture concept strives to catch the influence of social and organizational phenomena to accidents and contribute to improved safety.

ERA (2018) defines Safety Management System as "the organisation, arrangements and procedures established by an infrastructure manager or a railway undertaking to ensure the safe management of its operations". Safety culture in turn refers to interaction between the requirements of the safety management system, how people make sense of them, based on their attitudes, values and beliefs and what they actually do, as seen in decisions and behaviours (ERA 2020). ERA also reminds that it is "the match between the structural [SMS] and cultural part of the organisation that ultimately creates safety" (ERA 2020, p. 14). Thus, safety culture and the safety management system are closely connected.

The relation between ERA's Safety Management System requirements (ERA 2018, 2022) and the elements of the new Safety Culture Model (ERA 2020) have raised discussion in Finland. After several years of experience on the Safety Management System assessment and supervision, participating in the development of the Safety Culture Model and participating into the European Safety Climate Survey, the Finnish safety authority was interested in the relationship between the two models and interested in the ways to include the safety culture model in the supervision activities. Some overlap between the models was observed, but the exact relations between their various elements were not known. At the same time, the Finnish regulator was planning to put more emphasis on safety culture in addition to safety management system auditing in its oversight activities. To clarify the relations and develop Traficom's approach to safety culture, a project was initiated with Lilikoi in December 2020.

OBJECTIVE

Project focused on safety culture in safety management systems of railway organizations, with a focus on the regulator's role and possibilities to influence and assess safety culture. The main goal of the project was to produce information and tools to Traficom for its assessments of safety culture in the rail organisations. To accomplish the main goal, the project first clarified the relation between ERA SMS requirements and ERA safety culture model. Project was carried out as a theoretical review. In addition to the theoretical review, three workshops with Traficom experts were arranged during 2021 to discuss and elaborate on the results. Safety Management System requirements were based on the Version 1.2 of the model ERA document (ERA 2018). Safety Culture Model was based on ERA introductory document published in 2020 (ERA 2020).

RESULTS 1: MODELS and ASSESSMENT

ERA Safety Culture Model (ERA 2020) was found to be quite well in line with the general definitions of safety culture found in the scientific literature (Reiman & Rollenhagen 2018). Some overlap between the SMS requirements and the ERA Safety Culture Model was found, but the study did not identify any major contradictions between the two models. On the contrary, the models were found to complement each other by elaborating on issues touched upon in the other model. For example, ERA's SMS model requires setting safety goals and monitoring their fulfilment (ERA 2022), whereas the Safety Culture Model emphasizes the role of a safety vision that is integrated into the SMS processes. Also, the Safety Culture Model specifies leadership aspects further and puts more focus on continuous improvement of safety based on open reporting from the personnel. The Safety Culture Model also specifies some key principles of management of safety, that should be incorporated into the safety management system:

- Safety cannot be achieved only by constraining human performance with various technical or administrative barriers. Safety relates to how the organization is able to succeed under varying conditions, adapt to changes, adjust its performance, and learn from events.
- Safety requires good anticipation, but in complex systems such as railways, it is never possible to anticipate everything. For this reason, organizations also need to prepare for unexpected events and build capability to act in situations where there are no written rules or guidelines.
- Regarding the written guidelines, it needs to be taken into account that work as described (in these guidelines) and work as done are never exactly same. For this reason it is important to understand how the work is actually done – it may be as safe or safer as the one described in the guidelines.
- To cope with complexity and unpredictability, an organization needs to be resilient. The discipline of resilience engineering (Hollnagel et al. 2006, 2011) emphasizes the adaptive capacity of organizations and their capability to deal with both anticipated and unanticipated threats, anticipate, monitor, respond, and learn.

These issues should be considered also in the safety management system.

The relation of human and organizational factors (HOF) to Safety Culture Model and SMS requirements were also considered in the project. Neither of the models (SC and SMS) include a detailed description of HOFs, but especially organizational factors are widely considered in both models (e.g. resources, work conditions, roles and responsibilities, communication, competence and organizational structure are found in both models). However, the concept of HOFs in the ERA models remains still somewhat unclear, especially as their visualization as the outer layer of the SMS model gives an impression of a kind of semi-independent cluster of elements. In reality, HOFs should be part of all activities. They are more a way of thinking about organizing and work itself rather than a particular list of dimensions. Safety management system needs to create the preconditions for managing human factors alongside the technical and organizational issues. Safety culture needs to support this integration. Many elements of the ERA Safety Culture Model can thus be interpreted as safety management system requirements.

The ERA Safety Culture Model includes many good "additions" to traditional safety management, such as resilience and emphasis on understanding of system complexity and workplace reality. However, these elements are not described in much detail in the current

guidance documentation and further guidance is needed on how to interpret and apply them in the safety management system context. Similarly, the ERA Safety Management System model can provide framework for systematic development of safety culture, but it requires an understanding of the interrelations between the models. This understanding is challenging since, as was already mentioned, both models include so called cultural elements as well as organizational, or management system, elements. Thus, to identify those elements that are unique to the Safety Culture Model, an analysis of the similarities and differences between the models was done in the project. Four types of elements were extracted from the ERA Safety Culture Model (Figure 1):

1. Elements that are nearly identical with management system elements such as roles, responsibility and resource allocation. These issues can be considered as prerequisites for a good safety culture.
2. Elements that indicate how the safety management system is implemented, or that facilitate its implementation. Examples of these elements are communication and leadership. This level can be considered the surface level of safety culture.
3. Elements that indicate aspects of safety culture, such as questioning attitude or understanding system complexity. This is the first layer that primarily deals with safety culture instead of the safety management system.
4. The deepest level of safety culture, the level of shared patterns of behavior, basic assumptions and values (cf. Schein 2017). Only parts of E1.2 element "Interpersonal values" directly represents this level, although ideas of appropriate assumptions are stated indirectly in other elements (e.g. assumption that accidents do happen).

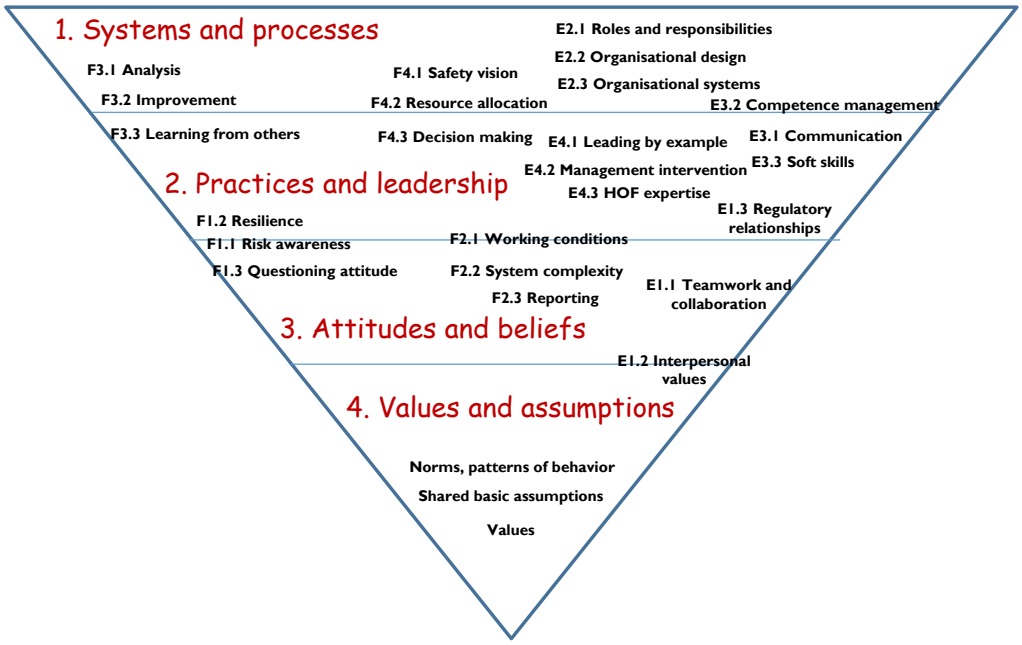

Figure 1. Illustration of ERA Safety Culture Model's elements in terms of their main content and depth at four levels of analysis

When the elements and levels in Figure 1 are compared to the Safety Management System requirements, it can first be noted that safety management system as a whole belongs to the level 1. Thus, level 1 includes other dimensions in addition to the safety culture

dimensions listed in Figure 1, since the ERA Safety Culture Model includes some, but not all, safety management system requirements. Level 2, in turn, describes organizational practices. This level is the interface between safety management systems and safety culture, as it both manifests the underlying safety culture as well as current implementation of the management system. Levels 3 and 4 are specific to the Safety Culture Model (even though some dimensions are briefly mentioned in the Safety Management System requirements), and they include beliefs, attitudes, conceptions, values and assumptions. Level 4 also includes norms and shared patterns of behavior.

RESULTS 2: PROPOSAL FOR A REGULATORY APPROACH

When assessing safety culture, the attention is focused on the views and experience of the employees and on the routines and shared practices at the organization. Technical details and audit-like verification of facts from records is not the primary focus. Culture manifests in how things are experienced and perceived (i.e., what they mean for the personnel), and safety culture assessment needs to uncover these.

In addition to the focus of the safety culture assessment, the following preconditions that have been pointed out by the International Atomic Energy Agency (IAEA 2016) were taken as a starting point for the approach.

- Sufficiently diverse set of data collection methods (one method, such as a questionnaire, is not enough to sufficiently grasp the complexity of culture)
- Using an established normative safety culture model (e.g., IAEA safety culture model in the nuclear or the ERA Safety Culture Model in the railway domain)
- Identification of cultural strengths and weaknesses by comparing collected data (description of what culture currently is like) to normative model (what culture should be like)
- Development of improvement and corrective actions that address the weaknesses
- Top management awareness of results and commitment to implementing improvement and corrective actions

As Figure 1 illustrates, the elements of the ERA Safety Culture Model can be divided into several levels of depth. Safety culture assessments focus on any of the levels. However, when assessing levels one or two (see Figure 1), one is basically assessing the management system and its implementation (including leadership aspects). Thus, the biggest added value to already conducted safety management auditing at Traficom are assessments focused on level 3. Indepth assessments focusing on level 4 are not recommended for Traficom except in exceptional situations. Table 1 describes three types of safety culture assessments ("Approach"), which were proposed to Traficom in this project. The Table also includes information on what methods were proposed to each of the three approaches, and what elements of safety culture (as defined by ERA) the proposed assessment reaches.

Table 1. Three approaches to safety culture assessment

Approach	Methods	Safety culture focus [Figure 1]	Notes
Focused assessment	Short interviews Document analysis or participation in SMS audits	Elements at level 3: F1.1, F1.3,F2.1, F2.2, F2.3,E1.1,E1.2	Document analysis and the audit should also focus on level 3.
Full assessment	Short interviews Comprehensive document analysis or a dedicated safety culture audit	All the elements (levels 1-3)	Document analysis and the audit should focus on levels 1-2 in order to assure that all levels are adequately covered.
Wide assessment	Long interviews Comprehensive document analysis A dedicated safety culture audit or participation in an SMS audit	All elements and basic assumptions	

Wide safety culture assessment is very demanding and time consuming to conduct. These types of assessments can be done when there is a very good reason to conduct them. For example, previous incidents or SMS audits raise a serious concern over safety culture which requires investigating. In most cases the focused assessment would be most beneficial addition to Traficom oversight.

Next the three methods (interviews, document analysis, audits) that were elaborated as part of the project are described in more detail.

Interviews

Interviews are one of the most, if not the most important data gathering method in safety culture assessment. Conducting interviews requires both understanding of safety culture as well as good interviewing skills. During the project two interview schemes were designed, one to be used for employee interviews and one for senior management interviews. Over 40 questions were needed to adequately cover the safety culture elements of the ERA Safety Culture Model. As many questions also include follow-up questions, it is in practice impractical to carry out the whole interview scheme for most safety culture assessments. Table 2 illustrates the interview questions that address level 3 (Figure 1), and which would thus bring the most added value for Traficom to include as part of their regulatory oversight. For all interview questions, guidance for interpreting the answers was also provided to Traficom (Table 2, column “Issues to pay attention to”).

For E1.1 and E1.2 elements the entire interview provides information on how the interviewee talks about his/her colleagues and their boss. Often a lot can be interpreted “between the lines” about the climate in the given company.

Table 2. Examples of safety culture issues to consider in interviews. In the project questions were developed for all elements, but here the focus is on the most important level 3 elements

Element	Interview question	Issues to pay attention to
F1.1	How does your work affect safety? What are the main risks in your work?	Can the person describe the safety effects and risks connected to their work?
F1.3	What is the attitude in your organization toward questioning of issues? Is voicing personal views promoted in your organization?	Does the person feel that the current climate supports questioning and speaking up on issues?
F1.3	In your opinion, what kind of a person is considered an ideal worker in this company? And what kind of a person is considered a difficult worker?	F1.3, depending on the answer can provide information also on E1.1 and E1.2 elements.
F2.1	How do the current work conditions affect safety of work?	Does the person recognize the safety effects of work conditions?
F2.2	Are there some aspects in work conditions or in other work-related factors (work hours, amount of work etc.) that are bad for safety, but people have just learned to live with them? Why these have not been changed?	F2.1 (does the person recognize risk factors) and F2.3, F3.1 or F3.2. Also, why issues have not been changed can tell about F2.3, F3.1 or F3.2.
F2.2	What is the current safety level of the organization? How do you know the current level? Are you satisfied with it?	F2.2 & F1.3 (Tells about how complex view of safety the interviewee has and whether they see any improvement needs in it)
F2.2	What are the typical reasons for dangerous situations at your company?	F2.2 (Tells about the hazards but also about the employee perceptions of hazards – e.g. is there a consensus on dangerous situations, is something missed)
F2.2	When safety is discussed in your company, what is meant by it? Do you separate different safetys such as occupational safety vs rail safety?	F2.2 (Does one recognize that rail safety requires partly different activity than occupational safety)
F2.3	Have your reported safety observations or raised safety issues during the past few weeks? Why? Do the supervisors and management support raising and dealing with safety issues openly?	F2.3 (if the person has raised an issue, it is interesting why they have considered it important to raise up [Tells also about F1.3], if not then it is interesting to consider whether this is due to lack of personal questioning attitude [F1.3] or a wider lack of open climate.
F2.3	In your view, does the management have a realistic picture of the requirements of the work and the work conditions at the field? Justify your view.	F2.3 (does the management – according to the employees - perceive the difference between ”work-as-imagined” and “work-as-done”, and do they recognize the effect of work conditions [tells about management ability to fill F2.1])
F2.3	How does your organization deal with errors? Is it easy to talk about errors in your organization? Why?	F2.2 (whether errors are dealt with individually and with blame, or systemically with a learning view). Tells also about F2.3 (organizational silence).
E1.1	How much do you interact with other people from your organization in addition to your immediate workmates? In what kind of issues do you interact with them? Has your interaction changed?	E1.1 (How focused the interaction is, what kind of possibilities there are for sharing information during normal work).
E1.1	How does cooperation work in your organization? Between the work groups and upwards towards the management?	E1.1 (What is the shared perception of how well the cooperation works)
E1.2	Is it easy to do business with the management on any issue? For example, is it easy to tell them about risks or grievances at work? When you deal with, or listen to, the management do you feel that they genuinely care about you and your views?	E1.2 (How approachable the management is seen)
E1.2	Generally speaking, what kind of climate there is in your organization.	E1.2 (shared perception of general climate)

Document analysis

Document analysis shows how the organization has documented itself, and how it wishes to present itself to others. It is good to separate management system documents and various records. Management system documents show how the organization wishes to perform, what plans it has, how the organization sees the risks and the appropriate ways of managing them, and what priority is set for safety issues. Records in turn show evidence of actual performance. Records include minutes of meetings, non-conformity reports, inspection reports, safety indicators, etc. Records can also include assessments and surveys that the organization has already carried out. Analysis should be carried out with the following questions in mind:

- What is the overall quality of the documentation? Are instructions clear and up-to-date? Is the revision date easy to find?
- How does the roles and responsibilities in the organization look like? How about decision making practices, including necessary authorizations?
- Based on the records, how have decisions been documented? Can the rationale and premises of the decisions be found from the documentation?
- What is the status of safety in the organization's overall vision, mission, and goals?
- What kind of behaviour the organization expects from its employees, either based on explicit guidelines and/or values, or records of promotion, renumeration, disciplinary actions etc.?
- How the organization seeks to learn and develop?
- How are incidents investigated, corrective actions formulated and implemented? Do the investigations take organizational factors adequately into account?
- How does the openness, trust (between management and employees) and communication in the organization look like?
- How are conflicts solved in the organization? How about technical difficulties?
- What kind of trade-offs are made, and what risks are accepted?
- What kind of safety related issues seem to be neglected in the documentation?
- What issues are not considered at all?

Auditing

There is little existing guidance on the use of audits in assessing safety culture. Safety culture specific audits are also rare (Reiman & Viitanen 2017). However, as auditing is the typical method in the safety management system area, there is obvious potential for synergy if audits could provide information on safety culture issues.

Safety management systems auditing is typically focused on verification and based on sampling of evidence and spot checks. The approach differs from the more open ended and subjective approach in safety culture assessment. However, both approaches deal with quite similar issues, as was also discovered in this research when the comparison between SMS and SC models was made. The following means of utilizing audits in safety culture assessments were elaborated in this project:

- Safety culture expert participation in safety management system audits. The participating experts can observe the openness and dynamics during the audit (collaboration, power relations), and inquire further on organizational issues of interest.

- A checklist was constructed for Traficom to pilot in its safety management system audits. The list can be used in safety management system audits to guide the auditor to pay attention to safety culture and organizational factors.

Conduct of specific safety culture audits requires further development of the auditing method. It needs to be remembered that other methods are still always needed for a comprehensive safety culture assessment even with a fully developed safety culture auditing method.

CONCLUSIONS AND NEXT STEPS

The project focused on the relation between safety culture and safety management systems, and how the regulator can assess safety culture. An approach was proposed for the regulator (Traficom) to conduct three types of assessments. However, this was a theoretical study and the approach as well as the methods that were developed need to be tested empirically. There may also be a need to revise Traficom's current SMS auditing method to ensure that information relevant for safety culture oversight is adequately collected and documented during the audit.

As a next step, Traficom pilots the interview schemes first with its own experts and senior management, and after that with one of the railway stakeholders. The work to improve the collection of safety culture information in safety audits continues. Workshops with Traficom experts to facilitate the further development of the methodology will be held during the last quarter of 2022. The final results will be published in the beginning of 2023.

REFERENCES

ERA. (2018). Safety management system requirements for safety certification or safety authorization. Guidance for safety certification and supervision. Version 1.2. European Union Agency for Railways. Luxembourg.

ERA. (2022). Safety management system requirements for safety certification or safety authorization. Guidance for safety certification and supervision. Version 1.3. European Union Agency for Railways. Luxembourg.

ERA. (2020). Introduction to the European Railway Safety Culture Model. Safety Culture Series #1. European Union Agency for Railways. Luxembourg.

Hollnagel, E., Woods, D.D. & Leveson, N.C. (Eds.) (2006). Resilience engineering: Concepts and precepts. Aldershot, UK: Ashgate.

Hollnagel, E., Pariés, J., Woods, D.D. & Wreathall, J. (Eds.) (2011). Resilience engineering perspectives, Vol 3. Resilience engineering in practice. Farnham, UK: Ashgate.

IAEA. (2016). Performing Safety Culture Self-assessments. Safety Reports Series No. 83. International Atomic Energy Agency, Vienna.

Reiman, T. & Viitanen, K. (2017). Safety Culture Assurance by Auditing – limits and possibilities. In A. Bernatik, L. Kocurkova, K. Jørgensen (Eds.), Proceedings of the 9th

International Conference on the Prevention of Accidents at Work (WOS 2017), October 3-6, 2017, Prague, Czech Republic.

Reiman, T. & Rollenhagen, C. (2018). Safety culture. In N.Möller, S.O. Hansson, J-E. Holmberg, C. Rollenhagen (Eds.), Handbook of Safety Principles. Hoboken: John Wiley.

Schein, E.H. (2017). Organizational Culture and Leadership. 5th Edition. Wiley.

Waring, A. (2015). Managerial and non-technical factors in the development of human-created disasters: A review and research agenda. Safety Science, 79, 254–267.

Keywords: safety culture; assessment; safety management system; safety regulation