Organisational and methical results from a large scale assessment of safety culture

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SUMMARY

This paper describes a large-scale assessment of safety culture in the Norwegian National Rail Administration, NNRA. After a short review of the concept of safety culture, it describes the methods used in the first assessment in 2010 and in a follow-up study in 2011. Results from the 2010-study are discussed, including differences between questionnaire-data and data from the interviews. A proposition is made that using questionnaires alone is insufficient when assessing safety culture.

The results from the follow-up study are discussed, showing that NNRA had put significant effort into mitigating actions following the 2010-study. It is proposed that these actions suffered from similar organisational shortcomings that they were intended to improve, indicating that NNRA should improve their management of change processes and their ability to understand the underlying values and assumptions that guides everyday practice, before undertaking more specific actions. It is discussed how these studies have given NNRA valuable insights into its strengths and weaknesses facilitating NNRAs ability to transform and adapt to a changing framework of conditions and society's expectations. Finally, it is suggested that the cultural traits characterising NNRA might be traits representative for the railway industry in general.

INTRODUCTION

The concept of safety culture has received increased attention over the last 10 to 15 years and a range of research projects has been carried out in order to investigate it further (see for example [1]). There exists a wide range of definitions of safety culture (for example [2, 3, 4]), but it will be outside the scope of this paper to discuss these further. Here, it is sufficient to state that organisational culture will influence organisational performance. Thus, safety culture should be seen as the specific properties of the organisational culture that influence safety. An organisation with a good safety culture will be less exposed to incidents and accidents.

Despite the increased attention towards the concept of safety culture, this area of research is still in an early phase. In addition to the many definitions, there are disagreements about which dimensions of safety culture should be regarded as most important. The conceptual framework used in these assessments is based on a set of dimensions that often is cited in the literature when describing elements in a good safety culture (for example [5, 6]):

- Safety as a goal is given importance by the whole organisation, and especially by top managers. There is a shared acknowledgement of the fact that safety exists alongside and in unavoidable conflict with other organisational goals

- There exists a shared understanding of the fact that all organisational activities can impact on safety

- All parties are involved in the process of defining, prioritizing and controlling risk

- Safety is never taken for granted, members of the organisation demonstrate "creative suspicion"

- Safety is considered as everyone's responsibility, and there is a shared acknowledgement that everyone needs a watchful eye

- The organisation learns through open communication regarding failures and learning experiences

- The organisation and its members know that causes of incidents are not only to be found in individual behaviour, but in the interaction of many causal factors

Jernbaneverket (Norwegian National Rail Administration, NNRA) is responsible for the management of the national railway infrastructure in Norway, on behalf of the Ministry of Transport and Communication. In 2009 the Norwegian Rail Authority, being the National Safety Authority in Norway, gave NNRA a safety authorisation with a duration of three years. The safety authorisation was given on condition that NNRA improved their safety management processes and practices, including the organisations safety culture. Det Norske Veritas (DNV) was commissioned by NNRA to carry out an external assessment of the existing safety culture in the organisation. DNV was also asked to monitor the ongoing process of improving the safety culture, and to carry out a second assessment one and a half years after the first. DNVs assignment was mandated by the General Director in NRRA. The main purpose was to give her information about the current safety culture as well as to document if and to what extent organisational development activities gave desired results on safety culture. The strong commitment and involvement from the General Director facilitated a high level of cooperation between DNV and NNRA.

METHOD

DNVs conceptual framework for safety culture assessment is shown in figure 1. *Culture*, consisting of shared norms, attitudes and values, is constantly interacting with *structure* and *co-operatoin.* Structure consists of topics such as the organisational map, the governing system, procedures and technical infrastructure while Co-operation includes topics such as information flow within and between units and degree of collaboration.
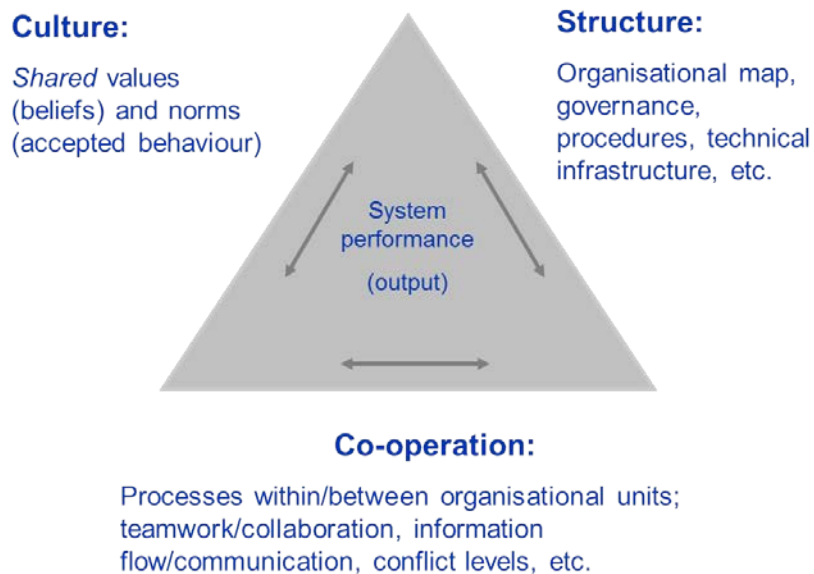
Culture:
Shared values
(beliefs) and norms
(accepted behaviour)

Structure:
Organisational map,
governance,
procedures, technical
infrastructure, etc.

System performance

(output)

Co-operation:
Processes within/between organisational units;
teamwork/collaboration, information
flow/communication, conflict levels, etc.

Figure 1: DNVs conceptual framework for safety culture assessment

Culture, structure and co-operation influences safety performance through 9 main topics:

- Competence – the organisations ability to establish and maintain relevant competence for the employees at all levels. The topic includes relevant competence in safety and safety management.

- Collaboration – the organisations ability to share and coordinate tasks to achieve higher-level goals

- Management of conflicting goals – the organisations awareness of the existence of conflicts between safety and other goals as well as their practice in solving such conflicts

- Compliance – if and to what extent the employees adhere to procedures, rules and routines in daily work practices and if and to what extent the organisation is working to ensure that procedures, rules and routines are seen as helpful and not as an obstacle to "get the work done"

- Incentives – if and to what extent formal and informal systems for punishment and reward motivate towards certain actions or absence of such actions

- Organisational learning – the organisations ability to learn from incidents, accidents and good practices and its ability to change working practices on basis of such learning

- Creative worry – the ability of the members of the organisation to imagine what could go wrong next and to act accordingly

- Error tolerance – the organisations awareness of normality of human error and to what extent this knowledge is reflected in the daily safety management

- Management's involvement in safety management – this topic runs through all the others, but is crucial and deserves its own heading

These topics are not mutually exclusive, and some degree of overlap will exist. For each topic, the current state in the organisation is compared with an "ideal situation", where the ideal is derived from the safety culture literature. As an example, the ideal for the concept "management of conflicting goals" is as follows: All employees are aware of the existence of goal conflicts. Guidelines for the solution of such conflicts are established on a high organisational level in order to ensure that situations with conflicting goals are handled equally and in accordance with established risk acceptance criteria. Management is clear on in which situations safety should be given priority and employees act accordingly and experience management support.

Finally, in the DNV framework, a good safety culture includes a certain understanding of the concept of safety, characterised by the following:

- Safety is not necessarily the most important goal of the organisation, but should be seen as a framework condition, setting the limits for production

- Safety includes both large-scale incidents and accidents and individual incidents and accidents. It is important to distinguish them, because causal factors and corresponding measures for improvement are different.

- Safety is not a product of technical factors alone, but must be understood within a MTO (man-technology-organisation) framework

- Safety is not a static entity within an organisation, but a dynamic factor that has to be established on an everyday basis. Safety must constantly be prioritised against other important organisational goals. An absence of accidents and incidents cannot necessarily be seen as proof of a high safety level.

Both assessments (in 2010 and 2011) were carried out through the use of questionnaires and semi-structured interviews.

Questionnaires

Two questionnaires were used, both of them developed according to established principles for developing questionnaires and carrying out surveys. The different factors in the surveys are related to the above mentioned elements in a good safety culture.

DNV Management Safety Questionnaire measures managers opinions related to a range of safety related topics. The questionnaire was originally developed by NTNU – The Norwegian University of Science and

Technology - as part of a study on safety culture in the Norwegian offshore industry. DNV has developed the questionnaire further and has used it towards other industries such as shipping.

DNV Workforce Safety Questionnaire measures employees opinions related to a similar range of safety related topics. It was originally developed as a part of a Norwegian R&D project [7].

The questionnaires were distributed electronically. Respondents' anonymity was guaranteed through the technical set-up, and neither DNV nor NRRA could identify the identity of respondents. The response rate was high – 74% in the 2010 assessment and close up to 80% in the 2011 assessment.

Interviews

More than 200 interviews were carried out in total during the two assessments. The group of informants represented the different divisions in the NNRA, including staff units, as well as different geographical areas. In addition, the group consisted of all levels in the organisational hierarchy as well as different levels of experience in the organisation. Unions and other important stakeholder groups were also included. The basis for the interviews was a semi-structured interview-guide reflecting the same factors as the questionnaires. Each interview took approximately 1 hour and 10 minutes and was followed by an immediate analysis by the interview team.

RESULTS 2010 ASSESSMENT

It will not be possible to present all results in this paper. The findings considered to have highest relevance for other organisations are therefore highlighted.

The results from the 2010 assessment clearly show that NNRA is an organisation where managers and employees show a genuine dedication towards safe operations. At the same time, the results showed important improvement potential in the way the organisation transformed this dedication into daily working practices.

Organisational learning

While some of the questionnaire data points towards a good and healthy practice with regard to reporting, other questionnaire data and especially the interview data pointed in other directions. Through the interviews, it was revealed that although technical malfunctions and other hardware-related problems were reported, incidents where employees had made a mistake or for some reasons not followed applicable procedures were not reported. The main reason seems to be that this was seen as bad practice towards colleagues. In addition, employees were afraid of negative consequences of reporting. Seen together, the result indicates that NNRA in 2010 had a substantial improvement potential related to systematic organisational learning. This included a lack of distribution of knowledge and experience between the units and geographical regions on things that had gone wrong or could go wrong. As will be shown later, this contributed to the general feeling in NNRA that safety was taken well care of and to a corresponding false sense of security.

Collaboration

Collaboration was another important topic that emerged in the results of the 2010-assessment. Although the results show a good level of co-operation related to daily operational tasks and duties, several important areas for improvement were identified.

One of these was related to the climate for collaboration in NNRA. The combined results from the questionnaires and interviews shows an organisation where it is quite common to speak about other departments in a patronizing way, and this negatively influences the level of cooperation. The following is a typical quote from one of the questionnaires:

> *"I have the impression that the division don't talk much together. This often results in Infrastructure Construction building something that Traffic Management finds it challenging to operate and Infrastructure Management struggles to maintain"*

It was interesting to note that our interview objects did not relate a negative climate for cooperation to safety and safety management. From a safety cultural perspective, the level of cooperation in any organisation will impact its ability to manage safety. Thus, one of DNVs conclusion to the NNRA was that the organisation should increase the awareness of the fact that lack of cooperation can influence safety. Further, that NNRA had to understand the process of safety management as a part of – and not separated from – other organisational processes.

Compliance

The results showed an organisation with a substantial variety related to compliance. Depending on who we did interview, we got different explanations on which rules were followed and which were not. A common theme, however, was that the complexity of the governing system combined with the number of rules and procedures in reality made it impossible for an individual to have a complete overview. This, in addition to a deep-rooted opinion stating that it was not possible to follow procedures and at the same time get the job done, meant that some sort of prioritisation had to be made. This prioritisation was governed by each individual's opinion on the extent to which a specific procedure was safety critical or not. The threshold for violating procedures seen to be safety critical were high. Safety critical procedures were mainly related to train operations (i.e. traffic rules), with large-scale accident potential if something went wrong. Procedures related to individual SHE, with limited consequences if something went wrong, were more common to violate.

The understanding of the concept of safety

A set of results both from the questionnaires and the interviews were useful in order to understand how NNRA understood the concept of safety. As already mentioned, in DNVs conceptual framework for safety culture, safety is seen as a dynamic entity that has to be established on an everyday basis. Very early in the study, we saw a tendency to treat safety as something that was taken for granted, and we formulated a hypothesis stating that NNRA had a static understanding of safety. The results from the questionnaire amongst managers gave support to this hypothesis. The results from this questionnaire are shown in figure 2. Answers are given on a five-point scale where "1" is lowest and "5" highest.

Although all the factors and corresponding questions relates to safety and safety management, some contains the word "safety" in the actual question while others do not. The answers to these sets of questions are significantly different. On questions containing the word safety, the answers indicate that NNRA have a very good safety culture. Answers to questions were the word safety is missing have a significantly lower average and much more variation. It seemed that the word safety immediately led to a high score, by some sort of an organisational reflex. This idea was reinforced when we discussed the results in workshops with all the managers. We asked them why they thought the questions was answered differently, and a typical answer was:

> *I think that when we see "safety" our organisational reflexes kick in with a good score as a result. In questions were "safety" is not included, we think things a little more over, and the answer can be very different.*

In the interviews, we had similar experiences. The following quotes are representative:

> *(Answer to the question "Is the NNRA safe?") Yes, I would say so. It has to be. With all these rules, regulations and procedures, I cannot imagine that it is not safe.*

> *We have been brainwashed with regard to safety, it is a part of our DNA*

> *(Answer to the question "What do you think are the cause behind the next big rail accident in Norway)? Must be something induced by nature.*
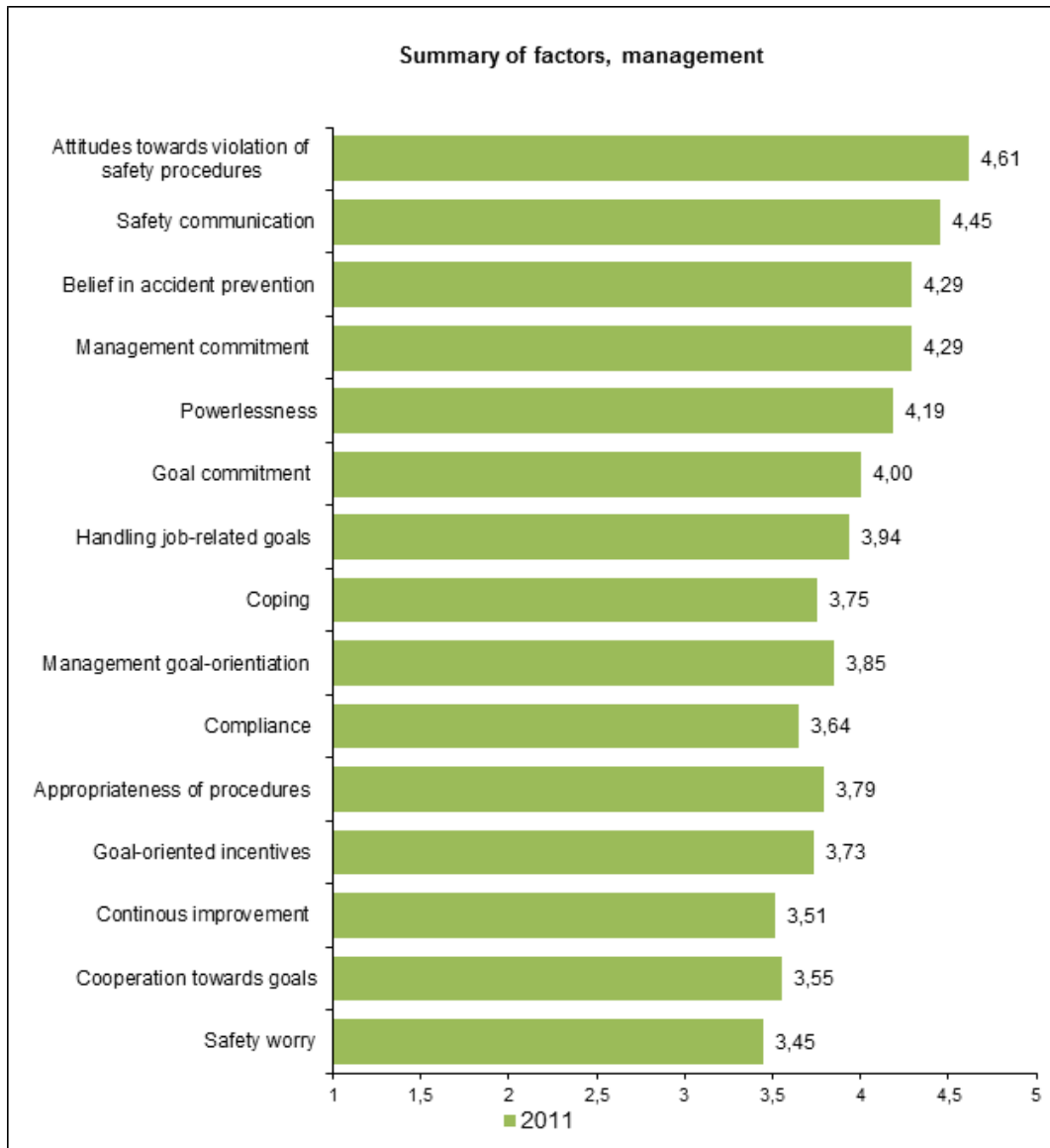
Figure 2 Results from management questionnaire, 2010

A range of similar data resulted in a conclusion that there existed a fundamental organisational assumption in NNRA stating that the organisation managed safety very well. Further that safety is something NNRA had as a result of rules, procedures and barriers. Threats to safety were largely perceived as being external to the organisation. Only occasionally did we find an understanding of the fact that procedures and barriers in themselves does not guarantee anything and must be seen as a part of a complexity including people, organisation and technology. Thus, one of DNVs most central recommendations after the first study was as follows:

> *"DNV concludes that employees and managers in NNRA to a large extent have a static understanding of safety. This involves a fundamental organisational assumption stating that safety is something the NNRA has as a result of rules, procedures and barriers. The majority lacks an understanding of safety as a dynamic entity that constantly has to be established and developed."*

By a tragic coincidence, NNRA was stunned by an accident with the loss of three lives as we were finalising our interviews in the first assessment. A freight car set consisting of empty container freight cars rolled uncontrolledly from Alnabru shunting yard, down to Loenga and into the sea at Sydhavna in the Port of Oslo. The triggering cause of the accident was a simple misunderstanding. Causal factors included a range of

organisational issues. The accident can be seen as an example of "drift into failure" and served as a dramatic example of what can happen when an organisation stops being afraid of what can go wrong next.

Safety culture – questionnaires, interviews or both?

It has been stated that questionnaires have not been very successful in exposing the core of an organisations safety culture [8].This study supports such conclusions. Although the questionnaires used in this assessment complied with scientific requirements related to reliability and validity, the results were different – sometimes very different – from the results obtained from the interviews.

As an example, the data from the questionnaire (both in 2010 and 2011) showed that employees in NNRA scored their organisation quite high on reporting practice (se figure 3). This could easily have been interpreted as data supporting a conclusion that NNRA had a healthy reporting practice. The interviews, however, clearly showed us that such a conclusion would have been wrong. In contrast to the questionnaire, the interview gives us the opportunity to ask additional questions, get examples, point out and understand contradictions etc. In the present assessments, this led us to understand that in NNRA, technical malfunctions as well as incidents involving external organisations were frequently reported. Incidents involving personal mistakes or violations, as well as mistakes and violations committed by colleagues were not. The interviews also gave us the ability to understand the underlying cultural components behind these practices. The reporting practice was mainly a result of an assumption that reporting own or colleagues mistakes would lead to negative sanctions. Therefore, any deviation were managed on the lowest organisational level, but not shared with anyone else. In addition to the lost opportunities for learning, this reporting practice could also be seen as an ingredient underlying the common perception of NNRA as a perfectly safe organisation.
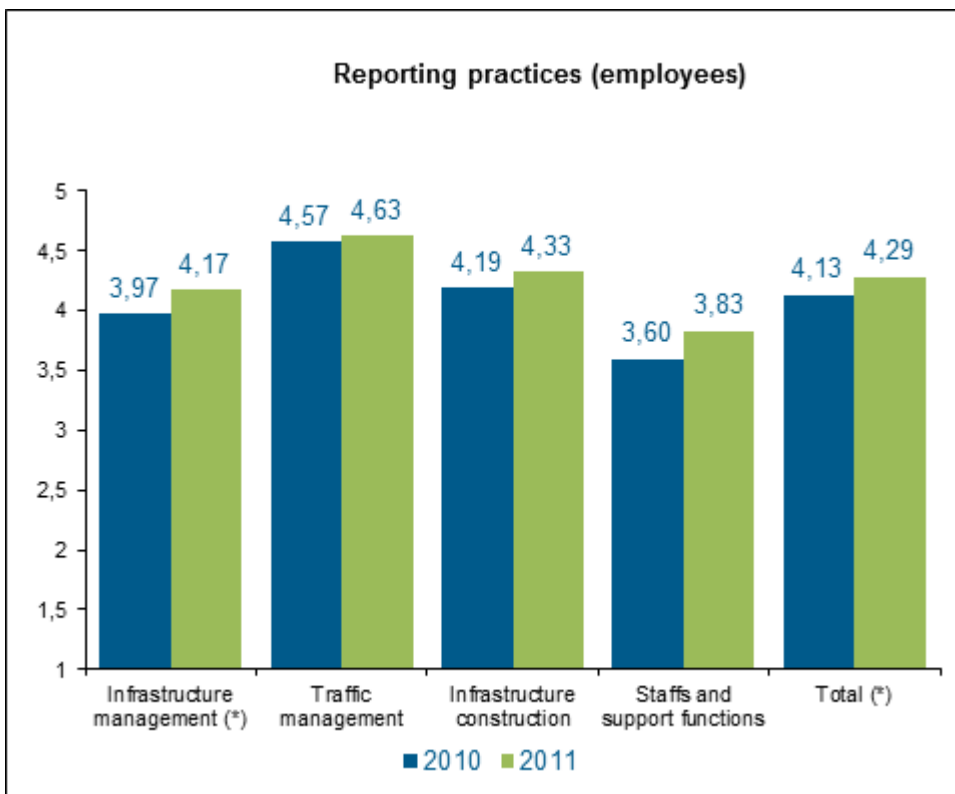

Figure 3 Results from employee questionnaire on reporting practices

In short, while questionnaires seems to pick up and measure respondents attitudes and perceptions related to a particular subject, the interview process has the potential to also understand the underlying cultural components of these attitudes and perceptions. While the questionnaires can give us input on "what", the interviews give us insights into "why". For DNV, a strong learning point after this project is that safety culture studies based on questionnaires alone should be avoided.

RESULTS 2011 ASSESSMENT

DNV delivered our report on the first assessment in august 2010. We then conducted a series of presentations for the National Rail Authority, Ministry of Transportation, and the Accident Investigation board of Norway in addition to extensive presentations for the NNRA. The report and the conclusions led to a range of different measures for improvement. Amongst these were one-day safety-workshops for all employees as well as an intensive push to improve the reporting rate and improve organisational processes related to analysis of incident and accident reports. Of perhaps greatest importance was the way the top management in NNRA bought into DNVs message. It was very clear that our work would be used as a part of long-term organisational development processes.

In the second half of 2011, DNV conducted a second assessment, using the same methods as in 2011. We did not anticipate or expect any changes on a cultural level during this short period of time. A change on a cultural level can be said to have taken place when the members in the organisation have discovered or developed new shared assumptions and beliefs on how to deal with small and large everyday challenges. In addition, these experiences must be seen to be valid over some time in such a way that they are brought forward to new employees – "this is the way we do things around here". We assumed that the time-span from the first assessment was too short to see changes on cultural level. Figure 4 show the results from the questionnaires in 2011 compared to 2010 for employees.
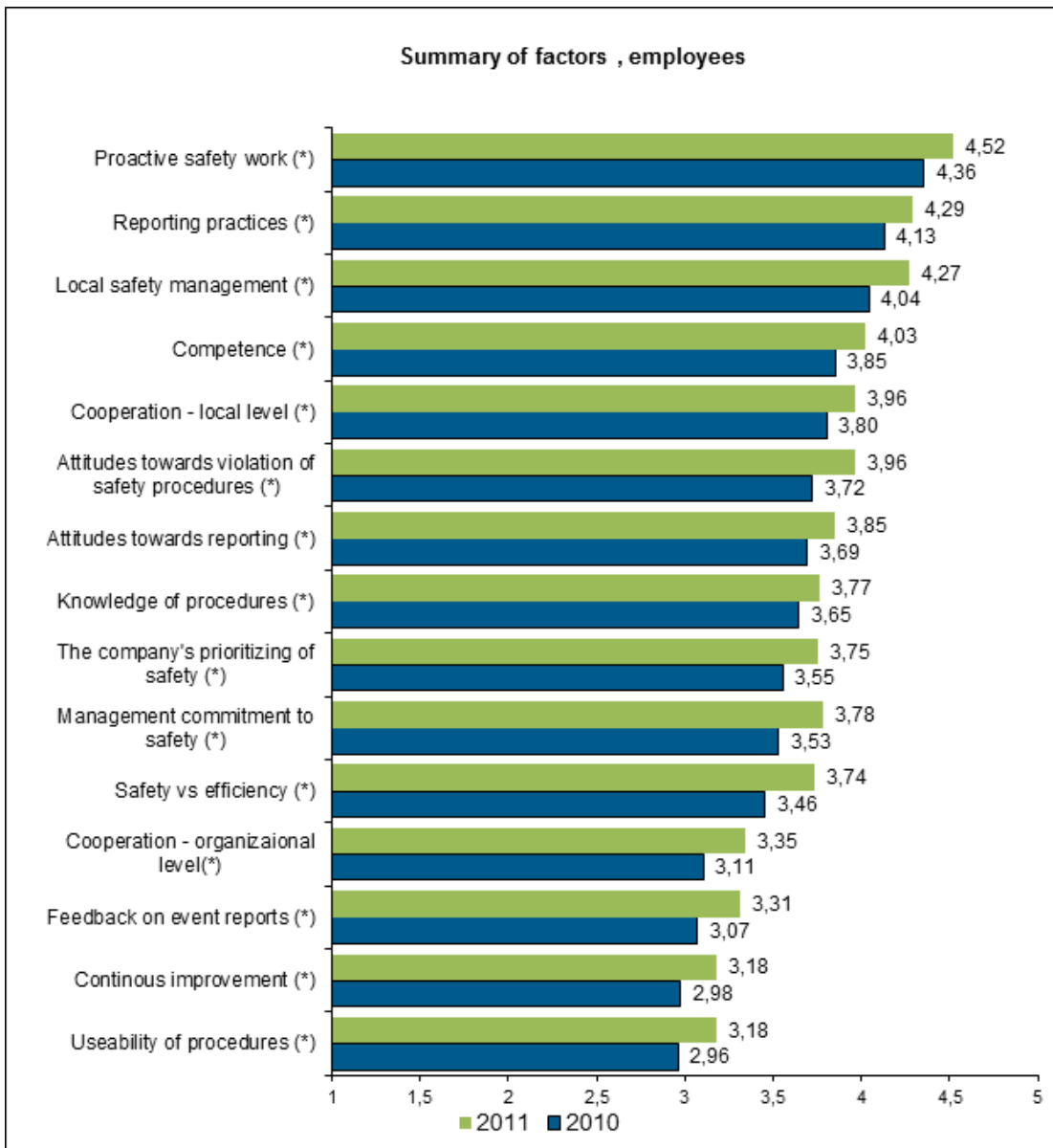

Summary of factors , employees

Factor	2011	2010
Proactive safety work (*)	4,52	4,36
Reporting practices (*)	4,29	4,13
Local safety management (*)	4,27	4,04
Competence (*)	4,03	3,85
Cooperation - local level (*)	3,96	3,80
Attitudes towards violation of safety procedures (*)	3,96	3,72
Attitudes towards reporting (*)	3,85	3,69
Knowledge of procedures (*)	3,77	3,65
The company's prioritizing of safety (*)	3,75	3,55
Management commitment to safety (*)	3,78	3,53
Safety vs efficiency (*)	3,74	3,46
Cooperation - organizaional level(*)	3,35	3,11
Feedback on event reports (*)	3,31	3,07
Continous improvement (*)	3,18	2,98
Useability of procedures (*)	3,18	2,96

■ 2011 ■ 2010

Figure 4 Results from employee questionnaire for 2010 and 2011

The tendencies in the results seem clear. Compared to the results from 2010, the 2011 results are significantly higher on nearly all dimensions, both for employees and managers. Is this a reflection of a change on a cultural level? Based on our analysis of all available data, our answer is no – there is not sufficient support in the data to conclude that such a change has taken place. There are many reasons for reaching this conclusion.

Firstly, when comparing the results from the questionnaire with the results from the interviews, we get a much more diversified picture. Except for parts of the management group, most interview objects had challenges when asked to exemplify changes in daily work practices that could explain the increased scores. One example is accident / incident reporting. Although the reporting rate had increased dramatically, we still got the same messages in the interviews as in 2010 regarding reporting. We concluded that the increase in reporting was a result of other measures, mainly the co-ordination of information from different sources into the main incident/accident data-base. It is interesting that we also in the second assessment saw this, and other examples, showing that trusting questionnaires alone is insufficient in order to understand an organisations safety culture.

Secondly, we see that the increase is evenly distributed on all factors in the questionnaire. As mentioned, NNRA has given much structured attention to organisational learning. This should have been reflected in the results from the questionnaire in such a way that the scores on factors related to organisational learning showed a larger increase than others. This is not the case. We therefore concluded that the changes in scores reflects the increased management attention that safety and safety management has received in the period following our first assessment.

At the same time, this change tells a very important story about management commitment and support. When we conclude that the change is a result of increased management attention, we also can assume that this attention is perceived to be genuine. To have strong and genuine management support in a cultural change project is essential for success.

Change and change processes

From our perspective, one of the most interesting findings in the second assessment was related to the quality of the change process following our first assessment. We concluded that the process of finding and implementing measures for improvement was subject to the same weaknesses in the safety culture that they were seeking to address. It seemed, for example, that many of the measures for improvement related to compliance was driven by an assumption stating that the system was safe, and that the main cause for accidents was sloppiness by employees in the sharp-end of operations. It is of course important that employees comply with procedures, rules and regulations. At the same time, it is essential that these procedures are relevant, accepted and available and that it is possible to follow them within given constraints. If these preconditions are absent, it is of no use to ask for more compliance. Greater compliance to a poor standard does not result in better safety. So, instead of writing new procedures or reinforcing the need for following already existing ones, managers at all levels should stop, think and ask a very fundamental question; what can be the contributing causes, resulting in lack of compliance? When asking this question, they must keep in mind that it should be their responsibility to have procedures that can be adhered to, that take human strengths and weaknesses into consideration and that allows using expertise and judgement when necessary. In summary, procedures have to be developed in such a way that humans actually can use them. For many organisations, including NNRA, this implies restructuring processes and practices in procedure design, placing much larger weigh on involvement, dialogue and consultation with the end-users. NNRA has started this process of restructuration and it will be interesting to follow the results.

Changing the safety culture in NNRA is not about writing endless lists of plans and actions. The real challenge, as expressed in our second report and exemplified through the discussion about compliance, seems to be to learn how to change. Argyris and Schön [9] have argued that organisations may learn through either single- or double-looped learning processes. Single-looped learning is when members of an

organisation, when facing deviations, seeks to re-establish normality through methods that fits with the organisations underlying norms, theories and assumptions. Second-looped learning, on the other hand, occurs when the organisation continually seeks to identify and challenge such underlying understandings, theories and assumptions, and change them if needed. Organisations characterized by double-loop learning are better suited to learn from mistakes and take actions to avoid repeating them because they are open for changing the underlying norms guiding their day-to-day behaviour.

It should be noted that we in the 2011-assessment heard examples of processes that resembles double-loop learning. An example involved a serious incident on a single-track section, where two trains were very close to be cleared out head-to-head on the same block section. In the interviews in 2011, several employees told us that the typical response to such an episode would be to blame the train controller, since he clearly made a mistake. He would have been summoned to a meeting with his boss, who would explain to him what he already knew, and tell him not to do it again. This time, however, the response was characterised by a systems perspective on safety. It was argued that the correct actions for the dispatcher in this situation were described in several different procedures, which were not readily available. It was also argued that the man-machine interface in the control room was not ideal. Finally, it was argued that given our knowledge about human behaviour, this particular mistake should have been picked up in risk assessments and technical barriers should have been in place to mitigate the consequences. We also heard good reflections on how such challenges could lead to other incidents.

An organisations ability to continually seek to identify and challenge "why do we do it like this", and thus undergo double-loop learning, will not only impact the quality of their safety management. By constantly seeking to understand the underlying values and assumptions that guides everyday practice, it will be possible to find mitigating actions for a range of organisational challenges. The organisations ability to constantly learn and change, will greatly influence their ability to adapt to changing frameworks of condition, such as new marked situations, new technologies or changing political climate.

CONCLUSION

This study shows how a safety culture assessment using a combination of questionnaires and interviews can give the organisation valuable insights into their practices and processes both on safety and safety management, as well as related to the organisations ability to adapt to changes. NNRA is an organisation dedicated to safe operations. Through this assessment, the organisation has received valuable inputs on how to improve the way this dedication is transformed into daily work practices.

This assessment shows that using questionnaires alone when assessing safety culture should be avoided. It is not feasible to pick up and understand the complex relationship between culture, structure and co-operation without having the opportunity to conduct in-depth interviews. Without this understanding, developing and implementing meaningful measures for improvement will be very challenging.

NNRA is not an organisation that exists in isolation. It is a part of a strong and proud industry, sharing the same history and built around the same core principles as other rail-organisations throughout the world. The challenges faced by NNRA might be shared by many others.

Finally, DNV would like to thank NNRA for excellent cooperation in this project. Without the level of openness and honesty we experienced, our assignment would have been very difficult.

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