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## **Proactive Identification of Work and Situational Factors That Can Affect Safety in Air Traffic Control**

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In an organization where the safety level is high and incidents and serious accidents are very rare, a steady erosion of safety awareness and protective measures can occur, especially when productive demands rise. Thus, it is important to continuously identify and monitor aspects in the organization that can affect work performance and safety. In an ongoing joint research project between the LFV Group (Swedish state agency that operates airports and is responsible for air navigation services) and Lund University, the aim is to develop a questionnaire-based methodology for identifying and monitoring work and situational factors in Swedish air traffic control centers and towers in order to identify in advance aspects that can affect safety in the organization. This paper presents preliminary findings from interviews conducted to determine the variables for assessing work and situational factors as well as initial findings from a pilot study testing the questionnaire. Results from the interview sessions showed that when evaluating work and situational factors the following aspects should be included: safety culture, commitment, organizational climate, psychosocial work environment, leadership, communication, areas of conflict, and participation/involvement. Results from the pilot study showed that the majority of respondents found the questionnaire items to be of high relevance for finding deficiencies in the organization. Follow-up interviews or group discussions were recommended that would give additional and more detailed information. Preliminary results also revealed issues that could be further developed in the respondents' work situations. Respondents with administrative tasks indicated communication skills and teamwork as areas for further improvement. Some air traffic controllers wanted more knowledge about aircraft specifications and a few thought it was too complicated to write reports on small deficiencies and incidents and believed this could negatively affect the safety reporting culture.

### **INTRODUCTION**

The purposes of air traffic control services are to expedite and maintain the orderly flow of air traffic and to prevent collisions between aircraft. The air space is organized into adjacent sectors each controlled by one, two or more air traffic controllers. Air traffic control is a complicated interplay between specially trained staff, advanced technology, and elaborate work procedures driven by imperative safety requirements. The activity is built on international regulations and agreements, and uses English as the common language. A high level of safety is also maintained by using standard operating procedures, safety management systems, performing risk analyses, as well as education and training. Through these activities a certain safety level is achieved. Other factors that increase the safety level are safety attitudes, work motivation, safety behavior and alertness, and safety awareness.

In an organization where the safety level is high and incidents and serious accidents are very rare, a steady erosion of safety awareness and protective measures can occur, especially when productive demands rise (Reason, 1997).

When accidents rarely happen it is easy to forget to fear them and safety margins can be stretched unconsciously. Furthermore, situational factors in the air traffic control organization such as ongoing change processes, salary negotiations and work schedules can have a tendency to occupy the minds of employees and reduce their focus on the core activity of air safety. Thus, it is important to continuously identify and monitor aspects in the organization that can affect work performance and safety.

The aim of the research described in this paper is to develop and implement a questionnaire-based methodology that can provide the LFV Group's Swedish Air Navigation Services Provider (ANSP) with the means to identify and continuously monitor work and situational factors in air traffic control centers and towers in order to identify in advance aspects that can affect safety in the organization. A major goal is that the methodology should contribute to continuous learning and safety improvements in the organization, and to a willingness to make changes when deficiencies are identified. The methodology should promote commitment and participation in each individual and motivate her to take

responsibility for her own work situation. The methodology should also be an aid for management. The information that management supplies needs to be well-founded before it is presented to the organization. A questionnaire that measures the “temperature” in the organization in advance can be very valuable in decision-making processes and can result in well-founded statements.

The development process of the questionnaire-based methodology is currently in progress. So far the research work has focused on three areas: (1) specifying the content of the questionnaire (i.e. variables or aspects for assessing work and situational factors that can affect safety in an air traffic control setting); (2) proposing a process by which the questionnaire can be integrated into daily work; and (3) conducting a questionnaire pilot study to test its relevance and usability.

The proposed methodology involves the ANSP employees responding to a questionnaire with open and closed questions and statements. Work and situational factors need to be monitored continuously to prevent a decrease in safety performance and to identify aspects that affect safety. However, if the data collection ratio is too frequent, it can have a negative impact on response rates and overall commitment. Accordingly, an appropriate data collection procedure also has to be established.

**Aim of the Paper**

This paper (a) presents preliminary findings from interviews conducted to determine the variables or aspects for assessing work and situational factors; (b) presents preliminary findings from a questionnaire pilot study focusing on (i) the relevance and usability of the items; and (ii) the initial evaluation of the current work and situational factors that can affect safety.

**METHODOLOGY**

**Specifying Aspects and Items to be Included in the Questionnaire**

To specify the content of and the existing needs concerning the questionnaire, interviews were conducted on two occasions with two groups of representatives made up of employees from different organizational levels at the Swedish ANSP. The two groups consisted of operation managers, safety managers, watch supervisors, and air traffic controllers with and without administrative tasks. Through a first round of exploratory interviews the respondents’ spontaneous opinions about relevant indicators of organizational safety were obtained. Based on this, a number of aspects were identified and questionnaire items designed (see Appendix). Both open and closed questions were included. The aspects and questions identified were further tested through a second round of confirmatory interviews with other ANSP representatives.

**Pilot Study to Test the Questionnaire**

In the pilot study, the questionnaire was sent electronically by e-mail to a selection of ANSP employees who answered the questions directly on a computer. The completed questionnaires were sent back to the researchers by return

e-mail. All in all, 33 employees were invited to participate in the pilot study. The respondents varied in job tasks and positions, as well as age and gender as can be seen in Table 1. A total of 15 questionnaires were completed and returned, resulting in a response rate of 45%.

Table 1. Age, time in company, task, gender and position of the respondents in the pilot study.

Age (in years)	< 21	21-30	31-40	41-50	>50
	-	-	8 (53%)	4 (27%)	3 (20%)
Time in Company (in years)	< 2	2-5	6-10	>10	
	1 (7%)	-	1 (7%)	13 (87%)	
Task	Op.	Op./Adm.	Adm.	Technical	
	5 (33%)	4 (27%)	2 (13%)	4 (27%)	
Gender	Female	Male			
	4 (27%)	11 (73%)			
Position	Manager	Non- manager			
	4 (27%)	11 (73%)			

Note. Op. refers to operative working tasks; Adm. refers to administrative working tasks.

**RESULTS**

**Aspects Considered Important for Assessing Work and Situational Factors**

The preliminary analysis of the results from the exploratory and confirmatory interview sessions shows that when evaluating work and situational factors that can affect safety in an air traffic control setting, the following aspects should be included: safety culture, commitment, organizational climate, psychosocial work environment, leadership, communication, areas of conflict, and participation/involvement.

A safety culture reflects individual, group and organizational attitudes, norms and behaviors concerning safety. An organization’s safety culture is very much reflected in the management’s commitment to safety and how the workforce perceives it (Flin, 2003).

Commitment has to do with the motivation to make progress in the safety work and having the resources to do so. The employees’ general commitment to performing their work well is also of vital importance.

Organizational climate is defined as typical behaviors, attitudes and feelings in the organization. It is considered important since it can have an impact on various outcomes such as safety, productivity, quality, efficiency, and well-being (Ekvall, 1990).

Psychosocial work environment is a multidimensional concept. A poor one can have detrimental effects on quality of life and work. It can influence overall well-being among employees, their social relations and family life. Effects can be noticed in terms of absenteeism, early retirement, low productivity and low quality in service or products (Kristensen,

Hannerz, Høgh and Borg, 2005). In high reliability organizations such as air traffic control where the performance of the controllers is directly linked to safety outcomes this is a crucial aspect to monitor.

The leadership influences a number of organizational outcomes in various ways. In the context presented here, leadership attentiveness to dissatisfaction in the workforce and a willingness to listen, understand and correct problems or deficiencies when identified have been considered as especially important.

Good communication and listening skills across organizational levels, groups and individuals strengthens a shared situational awareness with respect to risk and safety. Effective communication and employee involvement have been identified as factors that drive organizational change (Greenbaum, Jackson and McKeon, 1998).

It is important to identify the areas of conflict in the organization, issues that repeatedly are brought up and that disturb the employees, and that can potentially affect their work performance.

Participation/involvement in decisions is considered as important to enable motivation and acceptance for the use of the questionnaire-based methodology as well as to foster commitment to take action and implement change when needed (Yukl, 2006).

In the preliminary design of the questionnaire the two aspects "organizational climate" and "psychosocial work environment" were placed under the heading "Work situation".

## Results From the Pilot Study

*Relevance and usability of questionnaire items.* The respondents were asked to give their overall impressions and opinions about the questionnaire and to comment on the relevance and usability of the items.

The results show that the majority of the respondents found the questions to be of high relevance for finding deficiencies in the organization. Some thought that a combination with follow-up interviews or group discussions would give additional and more detailed information on the situational factors. The open questions were found to be more difficult and time consuming to answer than the closed ones. Some also raised the concern that issues could be overlooked and preferred more specific questions. However, several respondents understood the purpose of having open questions, as these require more reflection on the actual situation. One respondent found it important to sell-in the methodology in the organization in order to achieve high response rates in the long run and receive useful answers.

A few respondents suggested additional questions that would focus on psychosocial work environment issues such as the overall climate, bullying, attitudes and the general well-being among the personnel. Otherwise, there were no more specific requests for additional questions. None of the respondents thought that there were any redundant or unnecessary questions. The questions that most of the respondents had problems with concerned the most positive and valuable events/decisions made in the work organization recently, and the two safety culture questions (see Appendix). The last question asked if the respondent had any other comments or suggestions. Most of the participants did not.

However, one found it hard to see how this instrument could give any clear-cut results, since many questions were quite broad.

*Current work and situational factors that can affect safety.* The pilot study results also constitute the first evaluation of work and situational factors affecting air traffic control safety using this newly developed methodology. Preliminary findings are presented here.

Work situation question (Q): *What should I further develop regarding what my work assignments require of me today?*

The most common required improvements among the air traffic controllers (ATCOs) concerned more knowledge about aircraft specifications (e.g. speed and performance). They wanted to always be updated on these issues, as well as on new regulations. Some respondents also point out the need for training in emergency situations.

Respondents with administrative tasks indicated communication skills and teamwork as areas that needed further improvement. Knowledge about the ATCOs' work, the ATC system, rules, regulations, working procedures and routines were also mentioned, as well as computer skills and knowledge about safety management.

Areas of conflicts Q: *What are the greatest risks for conflicts at my workplace today (excluding air space conflicts)?*

According to the participants they were:

- Pay negotiations
- Unclear and incomplete information
- Overtime
- Lack of personnel
- Different units having different agendas
- Lack of information about when changes are to be implemented
- Management cares more about numbers than about the individual
- Misunderstandings due to rumors
- Lack of involvement and participation
- Changes in work situations

Q: *What are the most positive and valuable events/decisions in my work organization recently?*

According to the participants they were:

- More discussions within and between units concerning safety
- Increased salary
- New organization with better role clarity and communication
- A change to a more business oriented way of working
- More frequent and open communication between the management and staff
- Despite the regression and decreasing air traffic volumes, there are still ongoing training activities and recruitment of new personnel

Q: *My expectations concerning my job or the organization are usually met. Q: If there are expectations that have not been met, what are they?*

Seventy-three percent of the respondents agreed that their expectations were usually met. Nevertheless, expectations that were not met included inertia in the organization when changes are to be made, knowledge about the air traffic controllers' work situation, good communication about

operative regulations and a continuous update of the operative manual.

Safety culture Q: *What are the biggest risks that can weaken the safety culture in my work organization today?*

The respondents listed things such as too many changes in a short time span, focusing on human factors issues too late in the design process which resulted in an unwillingness to listen to problems, and lack of resources. Some thought it was too complicated to write reports on small deficiencies and believed this could negatively affect the safety reporting culture. Some also raised the issue of routine behaviors resulting in unfocused job performance.

Q: *What are the biggest threats in my work situation today that can affect air safety?*

The biggest threats were lack of a system view of safety and deterioration in the work situation (payment, work schedules) which placed the focus on issues other than air safety. However, some respondents did not see any existing threats to the air safety.

## DISCUSSION

Results from the development process of the air safety questionnaire-based methodology show that many of the ATCO respondents in the interviews and pilot study considered the items to be of high relevance for finding deficiencies in the organization. However, some were concerned about the number of open questions and the difficulty they had giving valuable answers to these. Some were afraid that they might overlook some important issues; others found the open questions too difficult and time consuming. This should be taken into consideration in the further development of the methodology. Open questions can provide important and additional information that closed ones cannot. Open questions also force the respondents to reflect on the current situation, which can increase their commitment and awareness about the state of the organization and their work situation. On the other hand, the amount of information that is received from open questions make the analysis more complex, which is a concern when trying to automate the analysis process. In addition, the time it takes to answer open questions might have a negative impact on the response rates.

Some of the respondents also suggested that the questionnaire data collection should be followed by interviews or group discussions since this would give additional and more detailed information on the situational factors. This is a very valid comment, but again it would have implications on the ability to automate the data collection and analysis process. Such an approach would entail an additional workload for the employees. Since lack of time seems to already be a problem in the organization, additional time-consuming demands have to be considered with care.

The questionnaire is to be integrated into a general work process and consequently used on an ongoing basis in the air traffic control organization. It is important to maintain the commitment among respondents by giving continuous feedback from the measurements. The results should encourage employees to have an overall discussion about the current state of the organization and to identify deficiencies, their implications and how to react to them. Thus, it is suggested that such discussion sessions should take place

during formal meetings following each data collection. If such a forum could be established as part of operations it could enable participation among the employees to facilitate commitment and motivation to learn and change when needed. It is also important that the problems identified are taken seriously by the management and that efforts are made to come up with solutions. Otherwise overall motivation and commitment among respondents will most likely decrease. The pilot study results indicate that it is important to sell-in the methodology in the organization in order to achieve useful answers and high response rates in the long run. The success of the methodology thus depends very much on the ANSP itself.

The results indicate that some issues can be improved regarding the respondents' work situations. Those with administrative tasks pointed out communication skills and teamwork as areas needing further development. Some ATCOs wanted more information about aircraft specifications. A few respondents found it too complicated to write reports on small deficiencies and incidents and believed this could negatively affect the safety culture (including the reporting culture). It is important that the air traffic control organization deals with these findings.

Lack of time seems to be a recurrent issue among the ATCO respondents. Both operative and administrative personnel mention this as a problem. Lack of time does not refer to when they are working at the control panel but rather to tasks that have to be accomplished during the rest of their workday.

Another issue that engages a number of respondents is change, both in the organization and in rules and regulations. A lack of willingness to change exists and inertia in the organization prevents an effective change process from taking place when changes are to be implemented. Lack of information is also a problem in this regard. Frequent changes are mentioned as a risk that can weaken the safety culture since when they occur in a short time span, it makes it hard to keep track of new rules and regulations.

An important next step in the development of the methodology is to come up with a clear and user-friendly way of presenting the questionnaire results on each measurement occasion, one that presents what the respondents share in common (general results) and is also able to highlight uniquely significant issues that arise.

## ACKNOWLEDGEMENTS

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## APPENDIX

The following items were included in the questionnaire for monitoring work and situational factors that can affect safety.

### Work Situation

- What should I further develop regarding what my work assignments require of me today? (*Open question*)
- What are the five most troublesome areas in the job assignments I have today? (*Open question*)
- Name two of the previously mentioned five troublesome areas that are most important to change. (*Open question*)
- I am happy and satisfied with my current job. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)
- I feel secure in my work role today (e.g. I have enough knowledge and am up to date). (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)

### Areas of Conflicts

- What are the greatest risks for conflicts at my workplace today (excluding air space conflicts)? (*Open question*)
- What are the most positive and valuable events/decisions in my work organization recently? (*Open question*)
- The atmosphere here is currently positive. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)
- My expectations concerning my job or the organization are usually met. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)
- If there are expectations that have not been met, what are they?

### Communication

- What are the greatest obstacles for good communication in my work organization today (excluding radio communication)? (*Open question*)

### Safety Culture

A safety culture reflects individual, group and organizational attitudes, values and perceptions concerning safety and safety work. Individual behavior related to safety is also an important aspect of a safety culture. Sometimes a safety culture is defined as a culture that is reporting and just (i.e. the organization has succeeded in creating trust between parties resulting in incidents and accidents being reported without fear and discussed with a will to introduce improvements).

- What are the biggest risks that can weaken the safety culture in my work organization today? (*Open question*)
- What are the biggest threats in my work situation today that can affect air safety? (*Open question*)

### Commitment

- I am motivated and take an active interest in my work today. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)

### Leadership

- My supervisor is willing to listen to my problems at work. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)
- The management for the unit is good at listening to people and checks to see that problems are solved. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)
- My supervisor takes action to solve problems that have been identified in my work organization. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)

### Participation/involvement

- I receive information in good time about such things as important decisions, changes or future plans concerning my workplace. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)
- I feel I can influence important decisions, changes or future plans concerning my workplace. (*Do not agree, Agree to some extent, Mostly agree, Totally agree*)
- How often in the last four weeks have you discussed questions/issues about air safety:
  - a. In your group? (*Not at all, On some occasions, Fairly often, Very often*)
  - b. With colleagues outside of your group? (*Not at all, On some occasions, Fairly often, Very often*)
  - c. With your supervisor? (*Not at all, On some occasions, Fairly often, Very often*)
  - d. In your spare time? (*Not at all, On some occasions, Fairly often, Very often*)
- In what context were the discussions held (e.g. during debriefing, coffee breaks)?

### General Impression of the Questionnaire

- Do you feel the questions are relevant to the evaluation of work and situational factors that can affect safety?
- What questions are missing?
- Are any of the questions redundant or unnecessary?
- Are there any questions that are particularly difficult/troublesome to answer?
- Other comments.