

SAFETY CULTURE IN AIR TRAFFIC MANAGEMENT: AIR TRAFFIC CONTROL

Åsa Ek¹, Marcus Arvidsson², Roland Akselsson¹, Curt R Johansson², Billy Josefsson³

¹Department of Design Sciences/Ergonomics, Lund Institute of Technology, Lund University & Lund University Centre for Risk Analysis and Risk Management (LUCRAM), Lund, Sweden

²Department of Psychology, Lund University & Univa AB, Lund, Sweden

³Swedish Civil Aviation Administration, Norrköping, Sweden

Abstract

In a joint research project – Human Factors in Air Navigation Services, HUFA – between the Swedish Civil Aviation Administration and Lund University the focus is on human and organizational factors and safety in air traffic control.

The Swedish Air Navigation Services (ANS) are undergoing major organizational changes in order to adapt to changing demands on efficiency and technical development in air traffic control. In these change processes the foundations of the safety work can be affected and changes in the existing safety culture can be introduced.

The aim of the project is to study safety culture and related organizational areas in order to monitor these during the change processes. Another aim is to study relations between safety culture on one hand and the team climate, organisational climate, psychosocial working environment and leadership on the other hand in order to develop a base for improving safety culture. In the investigation three measurement rounds will be conducted during the course of about three years. Study locations are the two main air traffic control centers (ATCCs) in Sweden and parts of the ANS office.

This paper will present the project and give some results from the safety culture part of the study, gained from the first completed measurement round. Preliminary findings concerning the psychosocial working environment will also be presented here.

The results suggest that most dimensions in the safety culture model used in the study can be

described as predominantly positive at all three study locations (e.g. Attitudes to safety, Safety related behaviors and Risk perception). However, some individual safety culture-topics were found to be problematic, and imply a need for improvement.

The results of the psychosocial study showed a pattern indicating that managers experience the working environment as better than the non-managers at all three study locations. At the two ATCCs there was also a pattern showing that the group of administrative personnel judged the psychosocial working environment to be better than the operative personnel did.

Introduction

This paper presents a joint research project – Human Factors in Air Navigation Services, HUFA - between the Swedish Civil Aviation Administration (SCAA) and Lund University concerning human and organizational factors and safety in air traffic control. The paper will also present results from a safety culture study and an assessment of the psychosocial working environment conducted within this project.

The civilian air traffic sector is very much under organizational stress due to factors such as fast technology development and international and national competition within the aviation sector and with other transport media as fast trains. Furthermore the decrease in passengers due to recession and the September 11, 2001 terror attacks contribute to the stress.

It is known that organizational changes, as downsizing, have contributed to major accidents in other sectors [1,2].

Thus there are strong reasons for the aviation sector to look for and implement strong safety management routines.

The SCAA and Lund University have started a joint programme in order to keep and continuously improve safety despite strong organizational stress.

Basic ideas behind the programme are

1. In accordance with Rasmussen's system view the risk management should be goal-oriented at all organizational levels with strong and fast feedback loops between them [3].
2. There should be efficient single and double loop organizational learning [4] at all levels.
3. Different sources for learning such as learning from accidents, incidents, occurrences, proactive risk analysis, and research should be used.
4. Strategies for implementation of good risk management should be of major concern.
5. Foci should be on human errors as free lessons, on good man-artifact systems considering complexity and on system weaknesses.

These ideas are summarized in the requirement of a good safety culture where we are seeking a definition of safety culture that constitutes a strong driving force towards safety. Furthermore, a goal is to develop a way of measuring safety culture that is useful for identifying efficient ways to improve safety.

Air traffic control

The above research programme includes the HUFA-project that is the focus of this paper. In this project we limit ourselves to air traffic control i.e. to the process level, the local management at the Swedish air traffic control centers and a part of the central civil aviation administration.

In order to adapt to increasing demands on efficiency, technical development and harmonization with international standards of air traffic control the Swedish air navigation services (ANS) are undergoing major changes concerning

e.g. establishment of commercialized spheres, new leadership structures, new work organizations and new work practices i.e. transition to a more computerized (and strip (paper) less) air traffic control system (System 2000).

These fundamental changes in the organization can have effect on the foundations of the safety work and introduce changes in the existing safety culture and driving forces for safety. This in turn, could have effect on air safety.

The SCAA is aware of this fact and attaches great importance in maintaining a good safety culture. The aim of the HUFA-project is therefore to study and monitor the safety culture, organizational climate, psychosocial working environment, work climate at a team level, as well as leadership effectiveness during the course of these change processes. During the course of three measurement rounds, investigations will be made to see how these areas will be affected by the undergoing changes. The aim is also to study relations between these areas in order to develop a base for improving safety culture.

Furthermore, the implementation of a system for reporting and analyzing near-incidents run by air traffic controllers themselves is followed in the project [5].

Study locations are the two main air traffic control centers (ATCCs) in Sweden and the ANS office. The first ATCC is mainly an en route center with only about 35 per cent of the work connected to air traffic arriving and leaving airports in the area. The work tasks therefore mainly consist of surveillance. About 90 per cent of the work at the second ATCC deals with air traffic arriving and departing from the main national airport and surrounding airports. This means that the air traffic controllers have to be rather active, working within fairly small sectors with airplanes at low altitude.

The first measurement round is completed and has given baseline values that can approximate the status before the introduced organizational changes. This paper focuses on the parts of the investigation that concern safety culture and psychosocial working environment.

The research programme also includes a minor pilot project on assessment of safety culture in ground handling activities at Swedish airports. The

projects are also connected to a larger safety culture research programme. This research programme also includes assessment of safety culture in another area of transportation, i.e. safety culture in passenger shipping [6, 7].

Safety culture

There exist several definitions of the concept of safety culture. Guldenmund [8] list 15 definitions in his article. But generally it concerns the basic values, norms and attitudes concerning safety that exist in an organisation. We would like to use the concept to be a powerful tool to increased safety. The concept must contain dimensions that are important for safety and suitable for increased safety. The safety culture concept can increase the awareness about hazards and risk factors in air traffic control and thereby strengthen the need for safety. If this need is weak or compete with other strong needs the safety can be poor. The need for safety must also be combined with good conditions (as knowledge and competence, technology, organisation and economy). The safety and the safety culture are also affected by stress from the world around (as competition, laws and regulation etc.)

Safety culture model

The safety culture model used in the studies is based on a system perspective for controlling safety. In a system perspective one is aware that a socio-technical system is divided into levels (politicians, regulators, managers, safety officers, work planners and workers) and that these levels need to have well functioning co-ordinations for safety [3]. It describes the importance of strong connections between the levels in the form of goal orientation with feedback, learning and action both within and across levels. Learning becomes a basic principle in a dynamic socio-technical system. To study all corresponding levels in the area of air traffic control is too big a goal within the same project. The safety culture study is therefore focusing on the levels of management and operative work.

Dimensions

When studying safety culture, a working definition consisting of nine dimensions is used which is described in this section. Learning in an organization is connected with a proactive approach

to safety, which demands obtaining updated knowledge about how the work and safety are functioning. Thus a

- Learning culture is created where one learns from collected information and is willing to introduce changes when needed. Learning in an organization comprises creating a
- Reporting culture where individuals are willing to report incidents and anomalies e.g. faulty work equipment. This is closely connected to a
- Just culture where a well-balanced blame approach enhances the willingness to give such reports. (A no-blame culture is not realistic.) A Just culture also has to do with defining safe behavior.
- Flexibility in an organization concerns the ability to transform the work organization in order to stand prepared for changing demands, e.g. periods of high workload. It also comprises respect for individuals' skills and experiences.

These four dimensions are based on Reason's perspective of a safety culture [9].

The other dimensions in the working definition are:

- Communication in normal work, which comprises e.g. need of and clarity in information, and communication between people and between work groups.
- Safety-related behaviors comprise e.g. discussions about and encouragement to increased safety.
- Attitudes to safety (from both management and staff) concerns e.g. commitment to safety.
- The perceived Working situation concerns cooperation, support and appreciation, and the influence of the design of work.
- Risk perception, which concerns for example the perceived risk for harming others or oneself, and the experience of having an influence on safety in the work.

The safety culture expresses itself in observable outputs such as safety management practices [10]. Variables such as motivation,

knowledge, training and application of resources are therefore also relevant. In an early study of safety culture/safety climate performed by Zohar [11] it was found that in activities or enterprises where safety and safety issues were given high priority there existed a strong commitment to safety among top and middle management. Safety training was emphasized and there existed frequent contacts between workers and management creating a good communication. There were low staff turnover and frequent safety inspections.

Psychosocial working environment

The question at issue is if and how the psychosocial working environment differs between the two ATCCs with respect to the different prevailing operating conditions.

Of interest is also to investigate if and how the two ATCCs differ from the ANS office with respect to the psychosocial working environment. These three units differ mainly from each other with respect to working tasks and methods. Still they are part of the same organization, working together towards the same superior goals. Besides studying differences between the two ATCCs and the ANS office, the study also aims at investigating if there are any differences in the psychosocial working environment between the administrative and the operative personnel and if managers and non-managers differ in their assessment of the psychosocial working environment.

The introduction of the term “psychosocial working environment” is a consequence of an extended view of the working environment. In designing the working environment we take in consideration not only physical factors like premises design, noise, lighting, chemical, and accidents risks but also social factors such as the working organization, work content and forms of cooperation. The working environment can therefore be separated in “traditional working environment factors“, (physical, chemical) and “psychosocial working environment factors” [12].

The three concepts: working organization, work content and forms of cooperation can be characterized in the following way:

- Working organization refers to the formal and the informal structure of the workplace,

the overall planning, technology, leadership styles etc.

- Work content refers to circumstances connected to planning of work, demands, performance, meaning of work, social values, and possibilities for individual development and self-fulfillment.
- Forms of cooperation refers to relations in and between the organizations, between working teams and the organization, between different working teams, between the individual and working teams, and between individuals. Relations which become established between individuals in a workplace are strongly connected to the “working organization” and the “work content”. These two concepts can be considered superior to the concept “forms of cooperation”.

Good mental and physical health among air traffic controllers is supposed to have a direct connection to good performance. This will in turn most certainly have an impact on safety standards as well.

The COPSOQ questionnaire

When studying the psychosocial working environment, the Copenhagen PsychoSocial Questionnaire (COPSOQ) [13] was used which comprises the following dimensions:

- Quantitative demands: the relationship between the work extensions and the time required to accomplish the tasks.
- Cognitive demands: demands related to decision making, memory processes, ideas and overview.
- Emotional demands: demands dealing with feelings, understanding and compassion.
- Demands for hiding emotions: all sorts of negative feelings that are hold back for clients, colleagues and customers.
- Sensorial demands: demands on sensorial and psycho-motor skills.
- Influence at work: possibilities to influence working environment and working conditions.
- Possibilities for development: development prospects that can affect health and comfort.

- Degree of freedom at work: the individual's influence over breaks and working hours.
- Meaning of work: importance and implication of work for motivation and engagement at work.
- Commitment to the workplace: like meaning of work related to motivation and engagement at work.
- Predictability: information concerning future events within the organization.
- Role-clarity: elaboration and definition of working roles.
- Role-conflicts: role-conflicts occur when working demands come in conflict with the person's ethics or moral values.
- Quality of leadership: leadership is in many ways connected to motivation and engagement among the staff.
- Social support: support at right time from coworkers and managers.
- Feedback at work: appreciation and constructive critics from co-workers and managers.
- Social relations: relations to colleagues, customers or clients.
- Sense of community: the atmosphere, working climate and fellowship at the workplace.
- Insecurity at work: insecurity at work can create worry and anxiety among the personnel.
- Job satisfaction: overall measure of the working environment quality from the staff's point of view.
- General health: overall health among the personnel.
- Mental health: mental health among the personnel.
- Vitality: vitality and energy experienced by the personnel.
- Behavioural stress: symptoms of stress connected to behaviour.
- Somatic stress: symptoms of stress connected to bodily functions.
- Cognitive stress: symptoms of stress connected to cognition.
- Sense of coherence: experience of consistency and continuity also related to how the individual sees himself.

- Problem focused coping: the individual's way of coping with different problems occurring at the workplace.
- Selective coping: the individual's way of coping with specific aspects of the workplace.
- Resigning coping: the individual's resignation when facing different problems occurring at the workplace.

Methods and material

Methods

The methodology for measuring safety culture [14] included the following techniques: 1) observations of the operative work to get experience of the daily work; 2) a standardized questionnaire consisting of 95 questions representing the nine safety culture dimensions mentioned in the introduction. The majority of the questions were answered using a five-point scale. Three questions related both to air safety and work injuries, the answers to these questions were therefore divided up into two alternatives. The questionnaire was to be filled in anonymously by all personnel; 3) a standardized interview with nine employees at each control center. The interview took approximately one hour. The purpose of the interviews was to get explanations and background knowledge to the results received from the questionnaire survey from interviewees belonging to different organizational levels.

The methodology for measuring psychosocial working environment included the COPSOQ questionnaire [13]. The instrument consists of 141 questions. Each question is answered using a five-point scale. Based on factor analysis the 141 questions are grouped in 30 different dimensions as mentioned above.

Study procedure

After an introduction in the general procedures of air traffic control the content of the safety culture questionnaire was slightly adjusted to be relevant to the target group.

Before the safety culture and the COPSOQ questionnaires were delivered to the three study

locations, meetings were held at the two control centers, mainly with managers and team leaders but also with union representatives. The employees were informed about the study by posters and circulars at the two ATCCs. The questionnaires were delivered to the en route center by a personal visit and to the arrival and departure center and the ANS office by mail. Each questionnaire was then distributed to the staff by the internal mail system. The subjects were asked to answer and return the questionnaires within three weeks. After that, reminders were sent out by e-mail to the employees until an acceptable response rate was achieved. The interviews were held at the respective employee's workplace.

Feedback meetings concerning the results of the first base line measurement round has been held at all three study locations. This gives the possibility for the staff to further discuss safety culture and psychosocial issues on a local basis. The idea is to have an interactive dialogue with the ATCCs and the ANS office concerning the issues measured during the study.

Material

The studies were conducted at the two main air traffic control centers in Sweden and at the ANS office. The questionnaires were distributed to 635 employees at the three workplaces. Of these 141 were filled out by employees at the en route center, 130 by employees at the arrival and departure center and 114 at the ANS office. The questionnaire survey received the following response rates: 66 % (en route), 61 % (the arrival and departure center) and 63 % (ANS office).

The distributions of operators and administrators, males and females, age and position of staff within the groups of respondents at the three study locations are given in Table 1.

Statistical analysis

The frequency distribution was calculated for each item in the safety culture questionnaire. Notation was made when at least 20 % of the participating subjects at the respective study location gave a response that fell in item categories that were defined to represent a negative safety culture. Examples of such categories are "being

Table 1. Distributions of operators/administrators, male/females, age and position of the staff within the groups of respondents at the three study locations.

Position	Manager	Non-manager	Op.	Adm.
En route	38	103	125	16
Arr./dep.	23	107	118	12
ANS-Hq.	25	94	0	119

Sex	Male	Female		
En route	74	67		
Arr./dep.	63	67		
ANS-Hq.	86	28		

Age	21-30 years	31-40 years	41-50 years	>50 years
En route	29	54	29	29
Arr./dep.	41	48	25	16
ANS-Hq.	10	26	34	49

barely or not at all encouraged to propose ideas and suggestions for improvements concerning the work" and "very often or often getting in a situation where it was unclear what to do as an individual".

To compare the two ATCCs the COPSOQ questionnaire data were analyzed by 2x2x2 factorial ANOVA. The three factors compared were "en route ATCC vs. arr./dep. ATCC", "administrative vs. operative personnel" and "managers vs. non-managers". When comparing the two ATCCs and the ANS office the "administrative vs. operative personnel" factor was excluded because all personnel at the ANS office were considered administrative. In this case, the questionnaire data were therefore analyzed by 3x2 factorial ANOVA with the factors "en route ATCC vs. arr./dep. ATCC vs. ANS office" and "managers vs. non-managers".

Results

Results of the safety culture study

Short summaries of the respective nine safety culture dimensions will be given here.

Working situation

The area Working situation received several positive components. The majority of the

respondents liked their work and their fellow workers. They experienced the collaboration within the respective study location as good. They seldom got in a situation where it was unclear what they should do as an individual. There were tendencies to more negative results concerning experienced mental exhaustion and stress during a normal working week (especially at the ANS office).

Flexibility

Flexibility as a safety culture dimension received somewhat lower mean scores compared to the other dimensions at the three study locations. It was found that the personnel experienced that the knowledge and experiences of all employees was to some extent not appreciated. This was not the fact at the ANS office. At the two control centers the result showed, for example, that if a task close to one's own hadn't been carried out, one told the person who should have done it and also often did it oneself.

Communication in normal work

This dimension received both positive and negative components. The result was parallel for both control centers. Positive components were that respondents said they got the information they needed and at the proper time in order to perform their work in a safe way.

A negative component was that large groups at all three study locations thought that they had not gotten enough training in how the communication should function in emergency situations. This was reported by 32 % of the respondents at the en route center, 53 % at the arrival and departure center and 49 % at the ANS office.

Reporting

Reporting received very positive results. A majority of the respondents at the three study locations experienced that they could express their opinion about the safety at work and that the respective managements were listening to employees regarding safety issues. The most common answer from the respondents was that they were satisfied with the information they got concerning air safety issues that affected them. They also thought they got enough information about occurring incidents and near-misses. The

predominant opinion was that there was a sufficient collection of information concerning the functionality of both technical equipment and work routines.

Justness

The result concerning Justness contained both positive and negative components. Positive components were that the majority of the respondents experienced that the organization to a very low degree wanted to find a scapegoat when something went wrong at work. Furthermore, the majority did not hesitate in taking initiatives in their work, because of anxiety of what would happen if it would turn out wrong.

However, approximately one third of the respondents at the respective control center were of the opinion that those who *did not* perform their work in a safe way seldom were made aware of this fact. When the question was asked from an alternative point of view, i.e. if those who performed their work in a safe way got acknowledged for this, a more negative result was found. About half of the respondents were of the opinion that they very seldom got acknowledgement for this.

Learning

The safety culture dimension Learning was consistently positive. An important component regarding learning in an organization concerns the willingness to act upon experiences and implement improvements concerning safety when needed. The majority of the respondents at the two control centers meant that this was the case concerning detected deficiencies in the work that could affect the air safety.

However, many respondents were of the opinion that improvements in safety were usually made first when something negative had happened, i.e. the organization had a more reactive approach to improvements.

Furthermore, the respondents had the opinion that they often used to talk about near-misses that could have affected air safety in order to learn from them.

Safety related behaviors

Another area that received many positive results concerned Safety related behaviors. Most respondents experienced that the safety rules and routines to be followed during work most often were functioning in reality. They thought the managers encouraged orderliness in the work as well as they experienced that fellow workers encouraged each other to work safely. However, about half of the respondents at the respective three study locations did not think they got sufficient practice in what to do in emergency situations.

Attitudes to safety

Three questions in the questionnaire concerned how much they thought different levels in the organization were “working for good safety” (i.e. air safety and work injuries, respectively). The three levels were the ANS office, the management within the respective ATCC and the operators. The results from the two centers showed that the respondents consistently thought that all three levels were working for good air safety. Concerning work injuries the result showed for the arrival and departure center that 20 % to 35 % of the respondents to a lesser degree thought that any of the three levels were working for good safety. At the en route center the respondents thought that they were working with this matter locally, but about one third thought the ANS office was working with this to a lesser degree.

The three levels asked for at the ANS office were management at ANS, management at the business area the respondent belonged to, and the personnel within the same business area. The results consistently showed that respondents thought that all three levels were working for good air safety and good safety concerning work injuries.

Risk perception

The respondents' perception of the air safety showed very positive results for all three study locations.

Results of the psychosocial working environment study

The overall results from the study show that the psychosocial working environment was

favorable at the two ATCCs and at the ANS office. Of 30 dimensions measured, only the dimensions “Sensorial demands”, “Degree of freedom at work” and “Feedback at work” could be considered less favorable. These results were true for the en route centre as well as for the arrival and departure centre. At the ANS office all dimensions but “Feedback at work” showed a very good or fully acceptable psychosocial working environment.

2x2x2 factorial ANOVA

The arrival and departure center versus the en route center

MAIN EFFECTS

Just one statistically significant main-effect appeared for the two ATC-centres. At the en route center the psychosocial working environment was experienced to be better in the dimension “Predictability” compared with the arrival and departure center.

INTERACTION EFFECTS

The psychosocial working environment was perceived as better concerning the dimensions “Role conflicts” and “Job satisfaction” for non-managers at the arrival and departure center compared with the same group at the en route center.

The operative managers and the operative non-managers at the en route center rated the working environment to be better in the dimension “Job satisfaction” than the same groups at the arrival and departure center.

Administrative versus operative personnel

MAIN EFFECTS

Statistically significant main effects appeared for administrative and operative personnel in seven dimensions. In the dimensions “Sensorial demands”, “Influences at work”, “Possibilities for development”, “Degree of freedom at work”, “Quality of leadership” and “Feedback at work” the administrative personnel experienced the psychosocial working environment as better than the operative personnel. The operative personnel considered only the psychosocial environment to be better than the administrative personnel concerning the dimension “Social Relations”.

INTERACTION EFFECTS

The operative personnel at the en route center experienced the psychosocial working environment to be better compared with the administrative personnel at the same workplace in the dimensions “Quantitative demands” and “Cognitive stress”.

The administrative personnel compared with the operative personnel at the arrival and departure center experienced the dimension “Resigning coping” to be better.

The dimensions “Commitment to the workplace”, “Predictability” and “Role-clarity” were experienced to be better among the administrative managers compared with the operative managers regardless of workplace.

The operative non-managers experienced the psychosocial working environment to be better in the dimensions “Meaning of work” and “Role-clarity” compared with the administrative non-managers regardless of workplace.

The administrative non-managers judged the working environment as better in the dimension “Demands for hiding emotions” compared with the operative non-managers regardless of workplace.

The operative managers rated the psychosocial environment more favorable compared with the administrative managers in the dimension “Role conflicts” at the en route center.

The operative non-managers at the en route center experienced the psychosocial working environment to be better in the dimensions “Cognitive demands”, “Role-conflicts” and “Job satisfaction” compared with the administrative non-managers.

The administrative non-managers compared with the group of operative non-managers considered the psychosocial environment to be better in the dimension “Job satisfaction” at the arrival and departure center.

Managers versus non-managers

MAIN EFFECTS

Statistically significant main effects implying that managers experienced the psychosocial working environment to be better than non-managers appeared in eight dimensions: “Influence at work”, “Possibilities for development”, “Degree

of freedom at work”, “Quality of leadership”, “Feedback at work”, “Social relations”, “Problem focused coping” and “Resigning coping”.

INTERACTION EFFECTS

The managers at the en route center experienced the working environment to be better in the dimension “Sense of coherence” than the non-managers.

The administrative managers at the en route center rated the psychosocial environment more favorable in the dimensions “Cognitive demands” and “Job satisfaction” than the administrative non-managers.

The administrative non-managers at the arrival and departure center experienced the working environment to be better in the dimension “Role conflicts” compared with the administrative managers.

The operative managers at the arrival and departure center experienced the working environment to be better in the dimension “Cognitive demands” compared with the operative non-managers.

3x2 factorial ANOVA

ATCCs versus ANS office

MAIN EFFECTS

Statistically significant main effects appeared only in two dimensions when comparing the two ATCCs and the ANS office: “Role-conflicts” and “Resigning coping” were rated more favorable at the arrival and departure center than at the ANS office.

INTERACTION EFFECTS

The psychosocial working environment was experienced as better by non-managers at the arrival and departure center in the dimension “Job satisfaction” compared with the same group at the ANS office.

Management vs. non-management

MAIN EFFECTS

When comparing managers with non-managers at the two ATCCs and the ANS office, a total of 13 statistically significant main-effects appeared. The managers considered the psychosocial working

environment to be better on 11 of these 13 dimensions: “Cognitive demands”, “Influence at work”, “Possibilities for development”, “Meaning of work”, “Commitment to the workplace”, “Predictability”, “Role-clarity”, “Quality of leadership”, “General health”, “Sense of coherence” and “Problem focused coping”. Non-managers only consider the psychosocial working environment to be better on two dimensions: “Emotional demands” and “Role-conflicts”.

INTERACTION EFFECTS

Managers at the ANS office experienced the psychosocial working environment to be better in the dimension “Job satisfaction” compared with non-managers at the same workplace.

Discussion

Safety culture study

The results obtained from the first measurement round suggest that most dimensions in the safety culture model used in the study can be described as predominantly positive at all three study locations (e.g. Attitudes to safety, Safety related behaviors and Risk perception).

The results to date also show that safety culture varies both across different locations and across different personnel categories at the same location [15].

The results concerning the Working situation contained generally positive components. Nevertheless, it was found from group analyses that air traffic control assistants at the en route center (compared to air traffic controllers) reported that they experienced a less positive view of their Working situation [15]. This could be due to differences in work organization for this group. At the arrival and departure center the assistants group had another work organization and experienced a more positive view of their working situation.

The dimension Flexibility received somewhat lower mean scores compared to the other dimensions at the three study locations [15]. The mean scores were calculated from the respective total samples. At the ATCCs the result can be explained by the fact that the total samples contained large proportions of operators. Due to

innate factors in the operative work situation a perceived less Flexibility might not be so surprising. Further analysis must be done to determine the exact causes and why the same result was found at the ANS office.

Concerning Communication in normal work the results revealed that large groups at all three study locations thought that they had not gotten enough training in how the communication should function in emergency situations. This result can be interpreted in different ways. The reason could be that the training is clearly insufficient, that the ambition concerning safety among the respondents is very high or a combination. In any case an analysis should be performed and actions taken.

Furthermore, at the two control centers it also appeared that individuals at higher age perceived a poorer communication in normal work. At the ANS office the result was the opposite [15].

Managers were very positive in their reports of safety culture. The results showed that at both ATCCs the top management group reported a better perception of Attitudes to safety compared to non-managers. At the en route center the comparisons also showed that individuals with leadership positions perceived more positive views on Attitudes to safety compared to individuals with no leadership positions. Interestingly, no differences were found on this dimension when the same analyses were made at the arrival and departure center [15].

The existing differences in safety culture between different organizational levels could be due to different prerequisites at each level that will affect the answers even if the culture is the same. Although, it could motivate a continued study of the co-ordinations for safety between the levels. Strong connections between the levels in the form of goal orientation with feedback, learning and action both within and across levels are important for maintaining safety.

The overall results concerning the organizational climate (with application of the GEFA-questionnaire [16]) showed that the two ATCCs differ from each other on some dimensions [17]. For example the dimension “Trust” indicated that the emotional security and trust in the relations within the organization was better at the en route center compared to the arrival and departure center.

Another example was the dimension “Conflict” which indicated that the presence of personal and emotional tensions was lower at the arrival and departure center.

Further analysis must be made in order to determine the exact causes behind the differences in results between the three study locations.

Psychosocial working environment study

The arrival and departure center vs. the en route center

The COPSOQ questionnaire data show that in general only small differences existed between the two air traffic control centers. This seems to indicate that the psychosocial working environment was not affected by the different working conditions to any great extent. This also indicates that the psychosocial working conditions at the main ATCCs in Sweden are rather similar probably due to the strict regulation and routine character of ATC work.

However, two patterns can be seen in the findings concerning the comparison between the two ATCCs. The first pattern refers to differences between managers and non-managers. In eight psychosocial dimensions statistically significant main effects existed. All these main effects were in favor of the managers. The results indicated that managers enjoy greater “Influence at work”, greater “Possibilities for development” and greater “Degree of freedom at work” compared with non-managers. Managers also judged the “Quality of leadership”, the “Feedback at work” and the “Social relations” to be better than the non-managers, and “Problem focused coping” and “Resigning coping” were also in favor of the managers. These results clearly indicated that managers assessed the psychosocial working environment more favorable than non-managers did. This was probably a consequence of differences in organizational position, work tasks and forms of co-operation.

The second pattern refers to differences between the administrative and operative personnel. In six of seven psychosocial dimensions with statistically significant main effects, the administrative personnel scored higher than the operative personnel. Five of these dimensions were in fact the same ones showing statistically

significant main effects between managers and non-managers. Statistically significant interaction effects in favor of the administrative personnel occurred in six dimensions.

To summarize, 12 statistically significant main and interaction effect differences were in favor of the administrative personnel. The main effect differences indicated that the administrative personnel had greater “Influence at work”, greater “Possibilities for development” and more “Degree of freedom at work” than the operative personnel. These differences were what to expect in view of the fact that when the air traffic controller is in position, working behind the radar screen the controller has to follow prescribed routines and cannot leave this position to talk with colleagues or influence the working situation in any tangible way.

The differences in the dimensions “Influence at work” and “Possibilities for development” were probably due to the differences in the working conditions between the two personnel categories. The operative personnel mainly work in the control room with operative tasks interacting with other operative personnel. They experience less contact with the top management than the administrative personnel. This situation may have impact on the “Influence at work” and “Possibilities for development”. The administrative personnel also judged the “Quality of leadership” and the “Feedback at work” as better than the operative personnel. “Feedback at work” seemed to be a problem not only for the operative personnel but for the administrative personnel as well. Of all 30 psychosocial dimensions the “Feedback at work” dimension acquired the lowest average score. The working conditions for an air traffic controller may not always allow feedback to be delivered because the work is performed on a momentary basis and the air traffic situation is constantly changing. When the air traffic controller leaves the radar position at the end of a shift nobody knows how well the work has been performed apart from the pilots and the air traffic controller him-/herself.

ATCCs vs. ANS office

In the comparison between the ANS office and the two ATCCs only small differences appeared. Only two of 30 COPSOQ dimensions, “Role conflicts” and “Resigning coping”, showed a statistically significant main effect for the three

units indicating that more favorable psychosocial working conditions were assessed at the arrival and departure center. Also in the dimension “Job satisfaction” two statistically significant interaction effects appeared for non-managers at the arrival and departure center.

However, when comparing the ANS office with the two ATCCs one pattern became clear. This pattern refers to differences between managers and non-managers. The managers judged the psychosocial working environment to be better on 11 COPSOQ dimensions compared with the non-managers. As in the formal comparison between the two ATCCs the results indicate that the managers enjoyed greater “Influence at work” and higher “Possibilities for development”. In addition, the managers also enjoyed greater “Meaning of work”, higher “Commitment to the workplace” and more “Predictability” concerning future events. Once again, these results are what can be expected because managers usually have greater influence and perhaps a stronger ambition to improve in their profession. This may in turn create an environment in which they enjoy greater commitment and experience the work as more meaningful. The managers also indicated better “General health” and more “Sense of coherence” compared with the non-managers.

The non-managers experienced the psychosocial working environment to be better only in two dimensions: “Role conflicts” and “Emotional demands”. This means that non-managers considered their work situation as less emotionally demanding than the managers and they also experienced less conflict than the managers.

System for reporting and analyzing near-incidents

As a part in the implementation strategy for safety management routines, a project within the HUFAs sphere (mentioned in the Introduction), has been performed at one of the ATCCs where all the air traffic controllers were involved in reporting and analyzing occurrences (near-misses) [5]. Many occurrences were reported. After some training the controllers made good analyses when working in group. They were able to identify system weaknesses behind the occurrences. An interesting finding was that delayed conflict detection was

closely related to relieve situations and cognitive overload situations for the controllers. The project has resulted in some safety improvements and thus in an improved learning process/safety culture.

Tool for improvements

One purpose of the safety culture measurement tool is that it should yield results which can be used in discussions at the ATC centers and ANS office in order to find out what measures are needed in the improvements of safety culture and for safety. This will be a step in the continuous improvement processes.

Feedback meetings concerning the results of the first base line measurement round have been held at all three study locations. At one location discussions have started concerning improvements of some individual topics, which were brought forward by the researchers. We therefore think that the results to some extent have been useful to the study locations.

The feedback meetings may also induce new issues to be handled in relation to safety. The interactions allow the research to meet and adjust to the concrete needs in a realistic manner. At the same time as the usability of the tool can be increased the researchers can give usable knowledge to the organizations and provide a tool to make the production safer and more transparent.

Visions for the future

Josefsson [18] give some of the visions of the SCAA-organization concerning their work for increased safety and in creating a safety culture. It says that “In the best of ATC worlds there is a mix of open-minded people with good intentions. These people are given the knowledge to face changes in the surrounding world safe and efficiently. They have equipment and regulations they trust. The equipment or task do not harm them during long-term use sometimes combined with stress. There is a dialogue within the organization and the rules and norms are clear and visible. This should create a just culture whereby the service can be monitored and any deficiencies picked up can be dealt with. Such a culture also enables an efficient and true report and follow-up system to function thereby giving clear and concise feedback to the staff and

enables the management to be proactive and then exclude many non-wished situations” [18].

What do we measure?

There are difficulties in measuring safety culture. What we measure is central, but all cannot be measured directly. We can find out – ‘what is said’, ‘what is written’ and ‘what is being done’ concerning safety. ‘What is said and written’ do not have to be acted upon and alone they are poor measures. ‘What is being done’ is a better measure but is time consuming if one wants to get a complete picture.

‘What has been done’ reflect the safety culture and the conditions that have existed in an organization for a longer period in the past. The measure reflects how mature the safety culture is and should have a close relation to safety. ‘What has been done’ is therefore an important component in the concept of safety culture.

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Key words

Safety culture, psychosocial working environment, organizational change, human factors, air navigation service, air traffic control, air safety.

Biographies

Åsa Ek has a MSc in computer science and engineering and is a PhD student at the Department of Design Sciences/Ergonomics, Lund Institute of Technology, Lund University, Sweden. Her research area is safety culture applied in areas related to transport. She also belongs to the Lund HOFRIM group (Human and Organizational Factors in Risk Management) and to the Lund University Centre for Risk Analysis and Risk Management (LUCRAM). Home site: <http://www.eat.lth.se>.

Marcus Arvidsson has a masters degree in psychology and is a postgraduate student at Work and Organizational Psychology division, Department of Psychology, Lund University Sweden. He is conducting full time research within the HUFA-project since May 2001. The research focus is mainly directed towards different organizational aspects and their relation to change processes and safety culture.

Roland Akselsson, PhD and MB, is professor in Ergonomics and Aerosol Technology at the Department of Design Sciences, Lund University, Sweden. He is member of Change@Work (director), LUCRAM (deputy director), Flygforsk (HF director) and Decision Training Academy (Campus Helsingborg) – four multi-disciplinary centers at Lund University with focus on change processes, risk management, aviation and decision training respectively. He is also a leader in the Lund HOFRIM group (Human and Organizational Factors in Risk Management). Among current projects are: Safety culture for a safer society, Human factors in aviation, Maritime safety, Safety in airport ground handling, Learning from near accidents in small and medium sized enterprises, Design of car drivers environment.

Curt R Johansson, PhD, is professor in Work and Organizational Psychology and director of that division at the Department of Psychology, Lund University, Sweden and director of the Innovation & Development @ Work unit at the University Institute Univa AB. He is member of the multidisciplinary research centre Change@Work at Lund University and member of the Swedish National Committee for Psychological Sciences at the Royal Swedish Academy of Sciences. His main research interests are technological and organizational change processes, team and crew resource management, risk analysis and incident reporting, and women's work and management.

Billy Josefsson is a fully licensed Air Traffic Controller since 1984. In 1994 he moved to the SCAA Headquarters in Norrköping and now holds the position of Senior Air Traffic Controller ATM Expert Concept & Strategies. The initial responsibility was HMI (human-machine-interface design) and HCI (human-computer-interaction) activities. Now the main responsibilities comprise the coordination of R&D in general and the management of national and regional strategies including Human Factors strategies. Since 1988 he is also a part-time student at Linköping University.