ORGANIZATIONAL ISSUES AND SAFETY CULTURE IN ATM PART 1 – STABILITY ANALYSIS

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Abstract

The Swedish Air Navigation Services Provider (LFV 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. 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 aim of the project is to study safety culture and related organizational issues in order to monitor these during the change processes. Study locations are the two main air traffic control centers and parts of the LFV ANS head office in Sweden. Using questionnaire assessments, three measurement rounds will be conducted during the course of about three years. Studies 1 and 2 are completed, where the first one has given baseline values. After 20 months, study 2 was completed in order to monitor the effect of spontaneously occurring organizational changes.

This paper presents results concerning the stability of the investigated organizational climate, leadership style of team managers, psychosocial work environment, and safety culture.

Introduction

Background

The overall strategic driver for the pragmatic research in the safety culture/organizational area is the anticipated impact of the implementation of the Single European Sky (SES). The approximately 50+ numbers of air traffic control (ATC) centers (responsible for the air traffic service) in Europe have to be significantly reduced and the operations have to be more efficient. Today a very fragmented service and sometimes cumbersome procedures must be in place due to the fragmentation of the airspace. One of the major consequences of a merger of air traffic control will be the following merger of workforce/staff and hence the organizational issues and safety culture are brought into focus.

The Swedish Air Navigation Service Provider (LFV ANS) is presently adapting to demands on efficiency and technical development and to the international standards of air traffic control mentioned above. However, the significance of cultural and social issues was recognized within LFV ANS in the mid 1990s and a motto was formulated with the objective to guide further efforts in this area:

"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 safely and efficiently. They have equipment and regulations they trust. The equipment or tasks 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" [1].

A joint research project called HUFA (Human Factors in ANS) was launched in year 2000. The stakeholders were the LFV ANS and Lund University. The aim is to study and monitor the organizational climate, work climate at a team level, leadership effectiveness, psychosocial work environment and safety culture during the course of the organizational and technical 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 studies are conducted at the two main air traffic control centers (ATCCs) in Sweden and at the LFV ANS head office. Studies 1 and 2 are accomplished, where the first one has given baseline values [2, 3, 4, 5, 6]. After 20 months, study 2 was accomplished in order to monitor the effect of spontaneously occurring organizational changes. Study 3 will be performed after the introduction of a new more computerized air traffic control system.

Aim of Paper

The aim of this paper is to 1) present results from a study of the stability of the organizational climate, the leadership style of team managers, the psychosocial work environment, and the safety culture; and 2) present future studies.

Theories of the Studied Concepts

Organizational climate is defined by Ekvall (1990) [7] as a conglomerate of attitudes, feelings and behaviours that characterise life in an organization. This definition of organizational climate is just one of many in the literature. Even if there is some disagreement as to the exact meaning of the term, most authors seem to assume that the organizational climate is rather stable over time with respect to attitudes and that it affects people's behaviour. The organizational climate is important due to its potential to influence different organizational and psychological processes. Communication, problem-solving, decision-making, learning and motivation can all be affected by the organizational climate. This in turn might have an impact on the effectiveness and productivity of the organization as well as the work environment and employee well-being in the work place [7]. In a high-risk environment such as the ATC industry, it might also have an effect on safety standards. Neal et al. (2000) [8], found that safety climate was related to the organizational climate. Their findings suggest that interventions to improve organizational climate also might have a positive impact on safety climate, and interventions aimed at improving safety climate would be more effective if the organizational climate is already positive.

The situational leadership model used in the study is based on a curvilinear relationship between task behaviour and relationship behaviour and maturity. Task behaviour is described as the extent to which leaders are likely to organize and define the roles of the members of their group, and to explain what activities each member has to do, and when, where, and how tasks are to be accomplished. Relationship behaviour is referring to the extent to which leaders are likely to maintain personal relationship between themselves and members of their group by opening up channels of communications, providing socio-emotional support and facilitating behaviour. Maturity refers to the willingness and ability to take responsibility, and experience of an individual or a group. This theory attempts to provide leaders with some understanding of the relationship between an effective leadership style and the level of maturity of their co-workers. Because abilities and motives among co-workers vary, the leader must have the sensitivity and diagnostic ability to be able to sense and appreciate the differences. Yet, even with good diagnostic skills, leaders may still not be effective unless they can adapt their leadership style to meet the demands of their environment [9]. This means that if the needs and motives among co-workers are different, they must be treated differently. Furthermore, as emphasized in many research studies on safety, the management has a key influence on the development and the maintaining of a good safety culture [10, 11].

No simple and uniform definition of the term psychosocial work environment seems to exist. According to Westlander (1980) [12] three concepts can be crystallized: one dealing with psychosocial factors as causal conditions in the work environment, one concerning the effects on experiences and behaviours, and one that treats psychosocial factors as the effect of the interaction between the individual and the environment. Despite the differences between them, these concepts still indicate a close relationship between the individual and the environment. Westlander (1980) [12] also suggested a distinction

between psychosocial factors and psychosocial consequences. The first concept refers to environmental conditions that have a significant psychosocial meaning for the individual. Psychosocial consequences, however, refer to experiences and behaviours that are reactions to environmental conditions in the workplace.

Past research [13] shows that the risk for stress and health problems increases when the psychosocial work environment is characterised by:

few resources: low control over work, low skill discretion, low decision authority.

unsuitable demands: too high or too low demands, monotonous work.

few social resources: limited social support from colleagues and management, role conflicts, limited social community.

low predictability: job insecurity, little feedback from supervisors, lack of information.

Past research also indicates that air traffic control is stressful, taking into account high demands, low control and shift work. This is troublesome since stress not only can cause emotional and physiological reactions, it can also influence people's behaviours. Research has repeatedly demonstrated that people underperform, make mistakes and are careless in their routine work behaviour when they experience stress [14]. An air traffic controller under stress could thus be more inclined to take unnecessary risks at work. Hence, 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. The stability of the psychosocial work environment and possible influence from forthcoming changes are therefore of importance to monitor and study.

The safety culture within an organization reflects the attitudes, beliefs, perceptions, and values that employees share in relation to safety [15]. The leadership within the activity is often said to be of central importance for safety in that it shapes the fundament of the safety culture. The existing safety culture has a significant impact on how proactive the approach to safety management will be. A proactive approach is supported by a well-developed learning culture in the organization, which concerns having updated knowledge about how the work and safety are functioning and having the willingness to introduce changes when needed. A combination of good organizational learning, reporting, justness, as well as flexibility, is emphasized [16]. In a just culture there are just consequences following the reporting of an incident or anomaly. Flexibility in an organization concerns the ability to transform the work organization in order to manage changing demands, for example, in periods of high workload. The air traffic control sector is very much under organizational stress due to factors such as organizational changes, demands for increased efficiency, and technological development. These changes can have effect on the safety work and introduce changes in the existing safety cultures. This in turn, can have effect on aviation safety. Efficient and successful safety management depends largely on the attitudes and the commitment to safety that exist in the organization [17, 18].

Methods

Questionnaires Used in the Data Collection

Organizational Climate

The GEFA questionnaire [7] was used to study the organizational climate. It consists of 50 statements formulated in the following manner: "People usually feel welcome when presenting new ideas here." The statements are answered using a four-point scale: do not agree at all (0), agree to some extent (1), agree to a great extent (2) fully agree (3). The 50 statements are grouped into 10 different organizational climate dimensions with five statements in each dimension [7]. The dimensions mainly focus on innovation and change within an organization, but other aspects are covered as well. The 10 dimensions, extracted by factor analysis, are as follows [7]: Challenge/Motivation, Freedom, Support for ideas, Trust, Liveliness, Playfulness/Humour, Debate, Conflicts, Risk taking and Idea time.

Situational Leadership

The situational leadership was measured using the Leader Effectiveness and Adaptability Description (LEAD) questionnaire [19] in a modified version [20]. This questionnaire consists of 32 items, reflecting different leadership situations, which are described to the respondent. Each item is answered by one of four alternatives. The respondent is asked to choose the alternative that best describes the respondent's expected behaviour of his or her team leader in each situation. Each item concerns the leadership in *group* or *individual* situations. The situations are in addition described in terms of *development* or as reflecting *difficulties*. The method is therefore assessing four types of situations: group or individual situations, and situations characterized by development or difficulties.

Psychosocial Work Environment

The psychosocial work environment was measured using the COPSOQ questionnaire [21]. This instrument consists of 141 questions. With a few exceptions, each question is answered using a five-point scale. Based on factor analysis, the 141 questions are grouped in 30 different dimensions. In the current study, 22 of these dimensions were included for the comparisons between the two measurement rounds. They cover a wide range of aspects concerning the psychosocial work environment. The dimensions included were: Quantitative demands, Emotional demands, Demands for hiding emotions, Sensorial demands, Influence at work, Possibilities for development, Degree of freedom at work, Meaning of work, Commitment to the workplace, Predictability, Quality of leadership, Social support, Feedback at work, Sense of community, Insecurity at work, Job satisfaction, General health, Mental health, Vitality, Behavioural stress, Somatic stress, and Cognitive stress.

Safety Culture

The safety culture was studied using a standardized questionnaire comprising nine safety culture dimensions. The questionnaire contained 95 items in study 1 and 57 in study 2. The 57 items that were used in both studies form the base of the comparisons of the results. The majority of the items were answered using a five-point scale (1-5) (e.g. 'Not at all, Barely, A little, Much, Very much,' or 'Never, Seldom, Sometimes, Often, Very often'), where a higher value on the scale indicated a better safety culture. The nine dimensions included in the questionnaire are: Working situation, Communication, Learning, Reporting, Justness, Flexibility, Attitudes towards safety, Safety-related behaviours, and Risk perception.

Feedback Meetings

Feedback meetings concerning the measurement results have been held at the three study locations. This gives the possibility for the staffs to further discuss safety culture/organizational aspects on a local basis. The idea is to have an interactive dialogue between researchers and the ATCCs and the LFV ANS head office concerning the issues measured during the studies.

Material

The studies were conducted at the two main ATCCs in Sweden referred to as the *en route center* and *the arrival and departure center,* respectively, because of different prevailing operating conditions.

The studies also concern the Swedish LFV ANS head office. The team-based organization at the en route center consists of 16 teams with 10-15 persons in each team. At the arrival and departure center, the organization consists of eight teams with approximately 20-25 persons in each team. The organization at the LFV ANS head office consists of 13 teams with 3-30 persons in each team.

The questionnaire surveys received the following response rates in the first and the second measurement rounds, respectively: en route center: 66% and 61%, arrival and departure center: 61% and 55%, and LFV ANS head office: 63% and 35%.

Statistical Analysis

For each studied unit and for the data from the two measurement rounds, respectively, the average scores for each dimension included in the GEFA, COPSOQ, and safety culture questionnaires were calculated. Differences in the average scores for the individuals responding in both studies were investigated using Paired samples t-test, p < .05.

For each leadership situation (group/individual and development/difficulties) the LEAD data was calculated as sums of the frequency for each of four possible leadership styles S1-S4 where S1 indicated high task/low relationship behaviour, S2 high task/high relationship behaviour, S3 high relationship/low task behaviour and S4 low relationship/low task behaviour [19].

Results

Organizational Climate

For the LFV ANS head office, the average scores for the organizational climate dimensions from studies 1 and 2 are given in Figure 1.

For the three studied units, the organizational dimensions that showed stability and the dimensions that had statistically significant differences in average scores between the two studies were as follows:

En Route Center

No differences in average scores were found for: Challenge, Support for ideas, Trust, Liveliness, Playfulness, and Risk taking.

The average score increased between study 1 and 2 for Conflicts (which is a negative result).

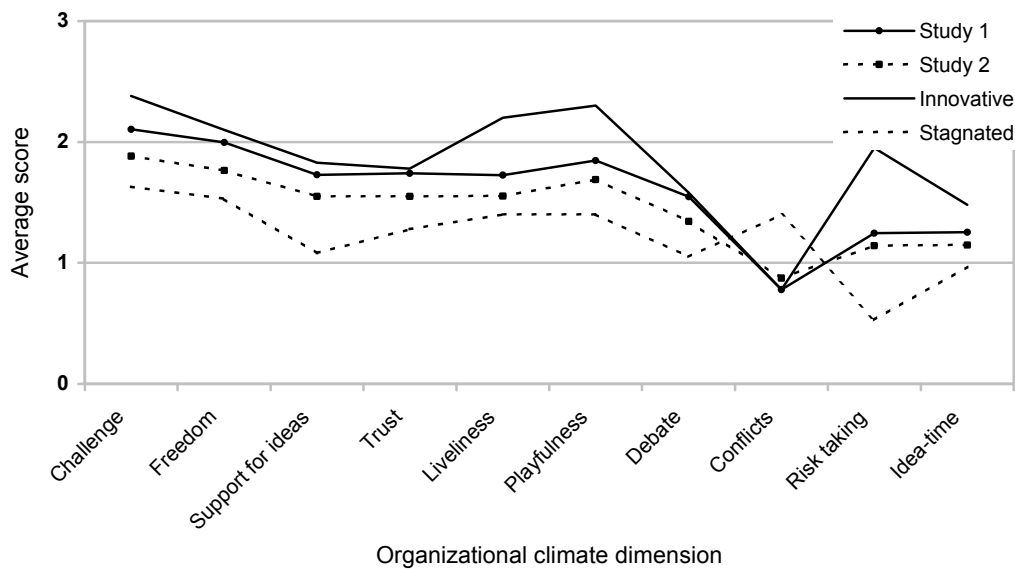The average scores decreased between study 1 and 2 for Freedom, Debate, and Idea-time.

Figure 1. Average Scores for the Organizational Climate Dimensions (GEFA) for Study 1 and Study 2 at the LFV ANS Head Office. For Comparison, Average Reference Scores for Innovative and Stagnating Organizations Are Included in the Figure. Note: High Scores Are Considered Positive for All Dimensions Apart From the Conflict Dimension Where Low Scores Are Considered Positive.

Arrival and Departure Center

No differences in average scores were found for Support for ideas, Trust, Liveliness, Playfulness, Debate, Conflicts, Risk taking, and Idea-time.

The average scores decreased between study 1 and 2 for Challenge, and Freedom.

LFV ANS Head Office

No differences in average score were found for Conflicts.

The average scores decreased between study 1 and 2 for Challenge, Freedom, Support for ideas, Trust, Liveliness, Playfulness, Debate, Risk taking, and Idea-time.

Situational Leadership

Study 1

The results concerning the situational leadership showed similar patterns concerning the leadership styles at all three units. The overall picture from study 1 indicated the leadership as being character-ized by relationship behaviour rather than task behaviour in development situations and group situations. In situations of difficulty and in individual situations the leadership was, on the other hand, characterized by task behaviour rather than relation-ship behaviour.

Study 2

In study 2, the results once again showed a similar pattern concerning the leadership styles at all three units. However, some differences have occurred between study 1 and 2. In individual situations and in situations of difficulty the task behaviour has increased. In development situations the relationship behaviour has increased. In group situations an almost reverse pattern occurs between study 1 and study 2. The task (S1) and the relationship (S4) behaviour have increased while high task/high relationship behaviour (S2), and high relation-ship/low task behaviour (S3) have decreased.

Psychosocial Work Environment

For the en route center, the average scores for the psychosocial work environment dimensions from studies 1 and 2 are given in Figure 2.

For all units, the dimensions that showed stability and the dimensions that had statistically significant differences in average scores between the two studies were as follows:
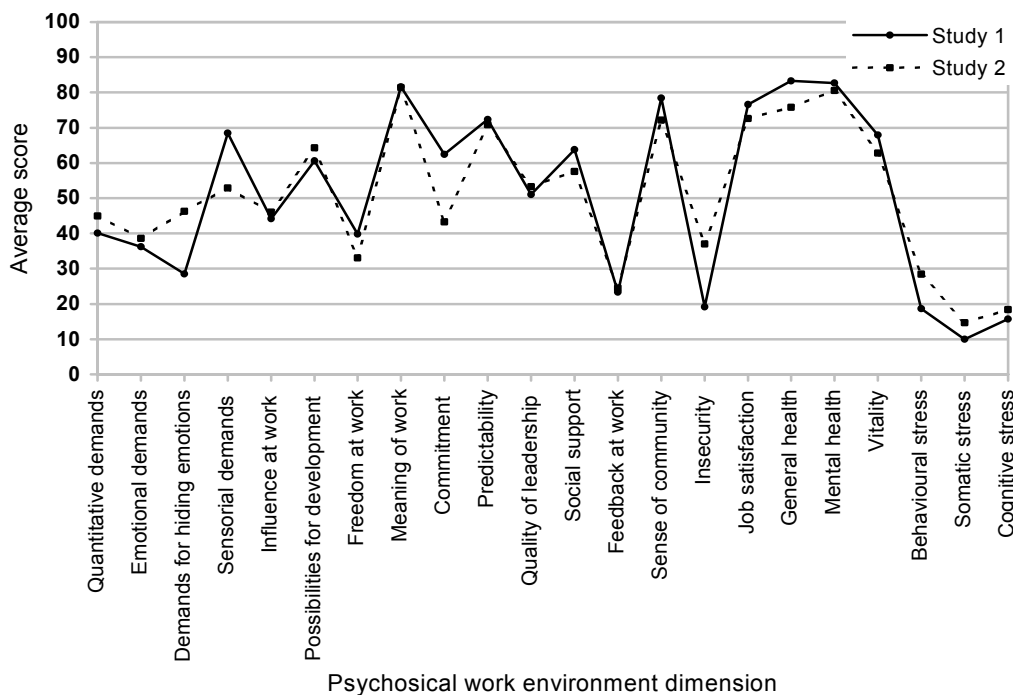
Figure 2. Average Scores for the Psychosocial Work Environment Dimensions (COPSOQ) for Study 1 and Study 2 at the En Route Center. Note: High Scores Are Considered as Positive for All Dimensions Apart From the Following Dimensions Where Low Scores Are Considered Positive: Quantitative Demands, Emotional Demands, Demands for Hiding Emotions, Sensorial Demands, Insecurity, Behavioral Stress, Somatic Stress, and Cognitive Stress.

No differences in average scores were found for Influence at work, Freedom at work, Meaning of work, Predictability, and Quality of leadership.

The average scores increased between study 1 and 2 for Sensorial demands (which is a change for the worse).

The average scores decreased between study 1 and 2 for Quantitative demands, Demands for hiding emotions, Behavioural stress and Somatic stress. For these dimensions this means a change for the better. The average scores decreased between study 1 and 2 also for Commitment, Social support, Job satisfaction, and General health, which are changes for the worse.

In addition, the dimensions that showed stability and the dimensions that had statistically significant differences in average scores between the two studies were as follows:

En Route Center

No differences in average scores were found for Feedback, Mental health, and Cognitive stress.

The average scores increased between study 1 and 2 for Possibilities for development.

The average scores decreased between study 1 and 2 for Sense of community, Vitality, Emotional demands, and Insecurity. For the latter two dimensions this means a negative result.

Arrival and Departure Center

No differences in average scores were found for Possibilities for development, Sense of community, and Insecurity.

The average score increased between study 1 and 2 for Feedback at work.

The average scores decreased between study 1 and 2 for Emotional demands and Cognitive stress (changes for the better), and for Mental health and Vitality (changes for the worse).
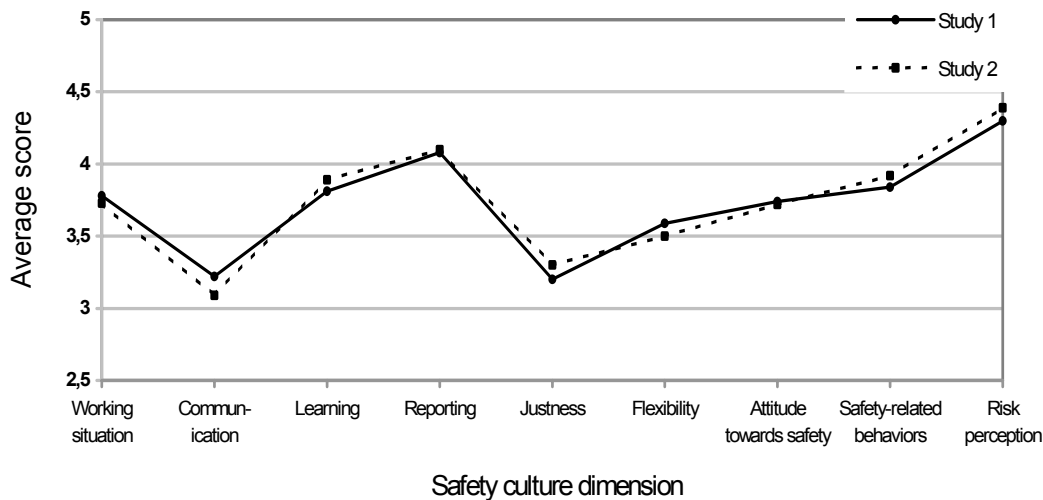
Figure 3. Average Scores for Safety Culture Dimensions for Study 1 and Study 2 at the En Route Center.

LFV ANS Head Office

No differences in average scores were found for Emotional demands, Mental health, Vitality, and Cognitive stress.

The average scores increased between study 1 and 2 for Possibilities for development and Feedback at work.

The average scores decreased between study 1 and 2 for Sense of community (a change for the worse) and Insecurity (a change for the better).

Safety Culture

For the en route center, the average scores for safety culture dimensions from studies 1 and 2 are given in Figure 3.

The safety culture dimensions that showed stability between the two studies for all investigated units, were Flexibility, Justness, Learning, Attitude towards safety, and Risk perception.

In addition, the safety culture dimensions that showed stability and the dimensions that had statistically significant differences in average scores between the two studies for the respective unit were as follows:

En Route Center

No differences in average scores were found for Working situation and Reporting.

The average score increased between study 1 and 2 for Safety-related behaviours.

The average score decreased between study 1 and 2 for Communication.

Arrival and Departure Center

The average scores increased between study 1 and 2 for Reporting and Safety-related behaviours.

The average scores decreased between study 1 and 2 for Working situation and Communication.

LFV ANS Head Office

No differences in average scores were found for Communication, Reporting, and Safety-related behaviours.

The average score decreased between study 1 and 2 for Working situation.

Feedback Sessions and Lessons Learnt

A general lesson learnt is that feedback sessions with the participants are of utmost importance. The collected data needs to be put into context; therefore the feedback meetings were performed at the locations where the data had its origin. Remember that the HUFA study includes the complete ANS organization including the CEO ANS. Concerning feedback, the high-level management and the staff were the first ones to endorse and acknowledge the results. The middle managers were found to be a bit slower in responding according to the HUFA results.

LFV ANS's Human Resources Director points out the complimentary values that the HUFA project brings to the organization. Awareness of differences within the organization and identification of weak areas are useful.

Operational management at the en route center has had great use of the results from the study on organizational climate. In spring 2003, the en route center reorganized the management of operational staff by assigning team leaders to every 12-15 operational air traffic controllers/flight data officers. One reason behind this reorganization was to make managers more accessible to each individual. Previously, managers have had so many employees to manage that appraisals and other necessary interactions were suffering. The en route center also saw a need for more direct and frequent communication between management and workforce to manage the change projects that were envisioned within, among others, the Single Sky concept. When the reorganization of management of staff was evaluated a year after the implementation, the en route center could use results from the organizational climate studies and link them to experienced and factual effects the organizational change had on the staff. Improvement of the organizational structure was further developed in conversations with the researchers who were also allowed time to present the results to the staff.

In order to facilitate the dissemination and access to HUFA papers a website was launched at the end of 2004, www.lfv.se/HUFA [22].

Discussion

This paper reports on assessments in the form of questionnaires of human and organizational factors in relation to safety at the two main ATCCs and the LFV ANS head office in Sweden.

In the organizational climate assessment at the LFV ANS head office, the only dimension that showed stability between the two studies concerned the Conflicts dimension. All other organizational climate dimensions became statistically significantly less positive in the second study. This decrease in average organizational climate scores could very much be due to LFV ANS's transition and division into commercialized spheres. By this, there is a new distinction between the functional activity and the financial control that could have a negative effect on the organizational climate.

At the two ATCCs, the changes in the organizational climate were less dramatically compared to the LFV ANS head office. Dimensions that showed stability between the first and the second studies were for example Support for Ideas, Trust, Liveliness, Playfulness, and Risk taking. However, some negative changes have occurred, for example concerning Challenge/Motivation (which concern the organizational members' commitment to and feelings for the activity and its goals) and Debate (the extent to which different views, ideas and experiences exist in the organization).

Concerning the psychosocial work environment, the following dimensions showed stability between the two studies at all three study locations: Influence at work, Freedom at work, Meaning of work, Predictability, and Quality of leadership. This is an indication that employees' possibilities to have an influence on their working environment, breaks, and working hours are the same. The perceived quality of leadership was also the same as in study 1.

At the two ATCCs a less positive assessment has occurred in study 2 compared to study 1, concerning the psychosocial work environment dimensions Quantitative demands, Emotional demands, Demands for hiding emotions, Commitment, Social support, Job satisfaction, General health, Vitality, Behavioural stress, and Somatic stress. Eight of these negative changes were also present at the LFV ANS head office. Since many of these changes were present at all three study locations it seems to be a common effect in the entire organization.

The found changes in the organizational climate and psychosocial work environment could be explained by being an effect of the repeated delays in the introduction of the new air traffic control system. This has created frustration and emotional tensions among the staff. In addition, uncertainty among staff has also existed due to ongoing plans of dividing the en route centre, where one part will be connected to the Copenhagen airport.

The result of the safety culture assessment at the three studied locations revealed generally good safety cultures with strong indications of stability over time. No great changes in average safety culture scores could be found in the second study compared to the first. For all three study locations stability was found concerning for example the dimensions Learning and Risk perception. Learning is associated with having a proactive approach to safety, which means collecting, monitoring, and analyzing relevant information and thus having updated knowledge about how the work and safety are functioning. The level of ambition concerning this proactive approach can probably be said to be closely connected to how risks are

perceived in the organization. Nevertheless, some statistically significant differences were found, for example for the safety culture dimensions Communication (negative change) and Safety-related behaviours (positive change) for the two ATCCs. Concerning Communication the results, for example, showed that there existed some unclarity whom to contact to discuss safety issues. The unclarity could be due to the operators having both an operative and an administrative manager, and when to contact whom is perhaps not always straightforward. At the LFV ANS head office, the general perception of the Working situation was somewhat less positive compared to the results in the first study. This decrease could be due to LFV ANS's transition and division into commercialized spheres, which for example, have led to increased stress among the staff and individuals searching for new roles in the new work organization.

In study 1, the leadership assessment indicated that the leadership was characterized by relationship behaviour rather than task behaviour in development situations and group situations. In situations of difficulty and in individual situations, the leadership was, on the other hand, characterized by task behaviour rather than relationship behaviour. The differences in leadership styles between the second and the first study indicate that the task behaviour has increased even more in individual situations and in situations of difficulty. This might be a reflection of the general results concerning the psychosocial work environment and the organizational climate. A less positive work environment could perhaps have an effect on the leadership in which the management requires a more controlled leadership style. The opposite could be true as well, since a more task-related leadership style could cause a less positive work environment.

A reversed pattern occurs from the first to the second study in group situations, in which task and relationship behaviour mutually has increased and represents the two most common leadership styles. This could possibly be due to the forthcoming introduction of the new air traffic control system. Even though the new system is not yet operational, some training and simulation is running. This could affect the leadership style in which a task-related behaviour is more suitable for operations in the new system. Since some of the work procedures are new and unfamiliar to the air traffic controllers when operating this environment, there is a need for clear instructions. In the old system, on the other hand, the work procedures are almost routine and a relationship behaviour is the most appropriate leadership style.

Future research

The next step in this longitudinal study will be measurement round three, i.e. study 3 that will be performed about six months after the introduction of the new air traffic control system. The new system has recently been implemented successfully. However, the system demands more manpower resulting in increased working hours among the current staff. This has given some negative organizational effects concerning air traffic controllers' satisfaction with their work. It will be interesting to see in the coming study how this (and perhaps other things) will affect the four concepts that are being monitored.

A missing piece for the HUFA project was the TWR and Approach ATS. The next phase of the HUFA project will therefore apply its methodology on the TWR and Approach business area. With this expansion of the project, the full range of ATS services for LFV ANS will be covered. The objective is further to include the main customer for the TWR and Approach services namely the airport directors and the operational managers in order to enrich the picture.

The next phase of the HUFA project will also be used as a matter of raising awareness to the importance of cultural issues. The HUFA methodology will be applied on a regional basis in the Nordic Area. The objective is primarily to raise the awareness of the need to include cultural aspects in any change or modernization process in ATM.

It is also interesting to investigate commonalities with the other actors within the air transport business i.e. Airlines, Airports and other ANS organizations. Feasibility studies addressing airports' and to some extent aircraft operators' needs are ongoing.

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Key words

Organizational climate, leadership, psychosocial work environment, safety culture, organizational change, human factors, air traffic control, air safety.

Acknowledgements

Biographies

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