Safety Science 73 (2015) 23–33

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Application of new human factors tool in an air traffic management organization

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ARTICLE INFO

Article history:
Received 22 July 2013
Accepted 7 November 2014

Keywords:
HF model
Incident report
Air traffic control
HF classification
Incident investigation

ABSTRACT

Aim: An easy-to-use human factors (HF) tool for air traffic control (ATC) operators was applied in an air traffic management (ATM) organization to ensure ATC operators' learning and commitment to HF, which is seen as a critical factor in improving safety.
Methods: ATC operators analyzed the positive and negative causal factors of 3163 incident reports in 2008–2010 using the HF tool in 27 ATC units. We studied the active usage of the HF tool and causal factors of incidents. Users' experiences of the HF tool were assessed using questionnaires with open questions.
Results: Although the usage of the tool varied from year to year and across units, it helped ATC units analyze both positive and negative HF-related causal factors of incidents. It also enabled ATC operators to learn about the new field of HF.
Discussion: The target ATM organization accepted the new HF tool. The benefits of the tool were its visuality, user-friendliness and the congruence of its contents with existing HF tools. The lessons learnt revealed the need for more extensive training, clearer instructions for the users of the HF tool, and publicizing the actions based on the findings.
Conclusions: The application of a new HF tool in the target ATM organization was supported by the fact that it could be included as one of the core processes of ATC work (reporting system). Improving HF competence in the organization is recommended, to further improve ATC work and the safety of ATC operations. The HF tool would support this.

1. Introduction

Awareness of human factors (HF[4]) in complex systems such as air traffic management (ATM) and control (ATC) is crucial in order to maintain the system's efficiency and safety and the wellbeing of those working within it (Kirwan, 2001; Hollnagel et al., 2006; Reason, 2008). The core function of ATC is to prevent collisions between aircrafts, but as in other complex sociotechnical systems, there is always a risk of disturbances in the system (Vicente, 1999; Chang and Yeh, 2010; Cox et al., 2007). Human error is a contributor to more than 70% of commercial aviation accidents, making HF the final frontier in improving aviation safety (e.g. Wiegmann and Shappell, 2003). This study describes how a new HF tool was applied in one ATM organization, with the aim to support safety.

1.1. Why a new HF tool?

In order to improve the level of safety in a safety critical environment, a method for analyzing incidents is essential. Traditionally, in incident analyses, the focus has been on factors causing problems. However, to motivate the ATC operators (personnel and managers) of the target ATM organization in this study (hereafter referred to only as "the organization"), it was considered

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[4] To make the article more concise, we have used the abbreviation HF, to denote both "human factors", (the knowledge of human needs, abilities and limitations) as well as a multidisciplinary study known as "Human Factors" which applies the information to e.g. equipment, systems, procedures, jobs, environments, and training), to entail safe, comfortable, and effective human performance (definitions of FAA, 2005 and Wilson, 2000, applied here).

http://dx.doi.org/10.1016/j.ssci.2014.11.005
0925-7535/

important to highlight the positive role of human activity in coping with unexpected events, and the strengths and capabilities of human operators, rather than focus on human errors and risks. Such a pro-active approach to safety management emerged within the HF community during the 2000s, and even marked an actual paradigm shift in safety management. This approach, resilience engineering, stresses the organizations' mechanisms via which people continuously cope with unexpected events and create abilities within the organization to adaptively solve problems (e.g. Hollnagel, 2004; Hollnagel et al., 2006). In natural settings, it has been found that even when confronted by pressure, people can make reasonable sense of their worlds (Klein, 1998; Vicente, 1997).

Managers in particular play a crucial role in developing safety culture (Flin, 2006; Johnson et al., 2009). Thus we considered it an important aim to develop not only personnels', but also managers' understanding of human risks, strengths and opportunities, in this way improving the safety culture of the organization. The HF tool was applied to support the improvement of HF awareness and safety culture in the organization.

1.2. Applying existing HF models and frameworks

The scope of active HF research orientations, as well as event analysis methods, have varied historically, moving from a technical and mechanistic picture of humans to a more dynamic one in which social, organizational and system factors have become the focus (Amalberti, 2001; Hollnagel, 2004; Leveson, 2011). Some known HF models and techniques (e.g. the model of human errors by Reason, 1990, 1997; HERA-Janus by Schorrock and Kirwan, 2002) had already been used in the organization. Several other HF tools and methods for assessing the background factors of incidents were also recognized (these methods introduced by e.g. Stanton et al., 2005, cannot be dealt with in detail in this article). The reasons for not applying the existing HF models and frameworks are discussed as follows.

In the organization, a newly recruited HF expert started to use the SHEL-L model (Chang and Yeh, 2010; also included in international aviation guidelines by ICAO, 1989) as a first tool to classify incidents from the HF perspective. The HF expert observed, however, that the rather generic classification of the HF that the method provided was not sufficient for helping the ATC personnel improve their understanding of the more concrete contents of HF. Another method, the HERA-Janus framework and technique for analyzing human errors in ATM (originally designed for the nuclear power industry by Kirwan, 1998a,b; see also Schorrock and Kirwan, 2002; HERA-Janus, 2003), was the second method to be tried out in the organization. It was used by the HF expert in the organization's incident investigation process in a few cases per year, but it was considered too time-consuming to apply this method to masses of incident data or to train the ATC operators in the use of the tool for analyzing their incidents.

The Human Factors Analysis and Classification System, HFACS (Wiegmann and Shappell, 2003) which is based on Reason's systemic model of human error, was also considered one possible method for use in the organization (Reason, 1990, 1997). However, HFACS was originally designed for naval aviation safety as an accident analysis tool, and its focus was on unsafe acts (e.g. unsafe supervision, unsafe acts of operators) (Wiegmann and Shappell, 2003, 71, 76), rather than on human resources or the positive causal factors that could maintain or enhance safety (Klein, 1998). Other aspects of the HFACS that were criticized also included 'simplifying the incident analysis as labels', i.e. limiting the scope of the investigation (Wiegmann and Shappell, 2003, 151). The HFACS was rejected for its inability to consider the positive contribution of human operators in coping with demanding situations.

Another option was the functional resonance model, FRAM, which describes system failure as a resonance of the normal variability of functions (Hollnagel, 2004). This method has been applied in several case analyses in ATM (e.g. Eurocontrol, 2009). It corresponds to the requirements that were regarded as important in the organization, but unfortunately, at the time HF work started in the organization, the FRAM technique was still very new and only very few scientific publications concerning the model were available.

To conclude, the main disadvantages of the existing tools and methods were their complexity of use and long training times, to be applied within a relatively small organization with limited time and resources.

Consequently, the HF expert designed a quick and easy-to-use HF tool for the use of ATC operators (ATC managers and personnel) with the following aims: Firstly, the method had to meet the local and practical demands of the organization in collecting causal HF factors. Secondly, it had to commit the ATC operators to HF by involving them as experts of their own everyday work and encouraging them to participate in the safety analyses of the organization (the HF tool was to be used by ATC operators to obtain incident data in a bottom-up approach). As the ATC operators did not have deep professional knowledge regarding HF, the tool would, thirdly, improve their competence in HF, while at the same time enabling them to analyze HF incidents.

The problem in the development of the method was that although the new HF tool was easy to use, would it still provide the same information compared to other known HF tools, techniques and methods? Empirical testing of different HF tools, techniques and methods is not possible within the scope of this paper, but some characteristic differences and similarities concerning the contents and usability of the above mentioned HF tools are summarized in Table 1 (except FRAM, which was a new method at the time of planning the tool's application).

According to the findings above (Table 1), we (the researchers of this study) can presume that the new HF tool introduced in this paper included similar contents (e.g. individual and organizational factors) to some other HF tools (e.g. SHEL, HERA) that were available before this new tool. The new dimension it offered was the focus on the positive causal factors of incidents.

A further question to be asked was whether – although user-friendly and including all relevant contents – the HF tool would be accepted by the ATC operators in their every day work. Organizational contingencies and uncertainties may hinder the adoption of new ergonomic tools and practices (Owen, 2009; Broberg, 1997). Users' acceptance of tools developed by scholars or experts is crucial in the improvement of safety and well-being at work. Even the environment of the organization appears to affect the adoption of new practices. (e.g. Jokisaari and Vuori, 2010).

1.3. Description of the HF tool

The HF tool was developed in several phases during 2002–2009 by the HF expert of the ATM organization (starting with the prototype designed in 2002; Runway Safety Report, 2002) and it was used in safety and HF training sessions, incident investigations and safety audits. Visual depiction of the HF tool can be seen in Section 2.3.1, Fig. 1.

The HF tool consisted of four parts (I–IV) which aimed to describe the individual (I), work (II), group (III) and organizational (IV) factors or characteristics that may contribute to the safety and efficiency of ATM operations. The method sees ATM as a sociotechnical system that is composed of psychological, technical and social elements (Vicente, 1999) (e.g. controllers, equipment and pilots as 'external partners'), which are in continuous relation with each other (Roske-Hofstrand and Murphy, 1998; Leveson, 2011).