MANAGING THE RESILIENCE OF PILOTS IN THE COCKPIT

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2 SUMMARY OF THE PROPOSAL

In aviation, several accidents, incidents and near-misses happened in 2014. These made obvious that the high safety standards and successful operation in the past cannot guarantee future successful operation. Therefore, assuring safety is an ongoing process, especially in high risk industries like aviation.

The aim of this study was to operationalize Hollnagel's (2011) four essential capabilities of resilience (subsequently referred to as "fecor", i.e. the abilities to monitor, to anticipate, to respond, and to learn) with regard to pilots in the cockpit of Swiss International Air Lines. Based on this operationalization an instrument was developed, allowing for measuring the pilots' resilience and hence for a proactive trend monitoring. In accordance with core assumptions of Resilience Engineering and Safety-II this study focused on "things that go right" (Hollnagel, 2012, 2014), on "normal functioning" (Hollnagel et al., 2013, 2014), and on "work as done" (Dekker, 2006).

The study was carried out in two phases. The aim of the first phase was to operationalize the fecor and thus to understand how pilots create and sustain resilience, i.e. how they adapt to potential and actual changes during a flight to sustain normal functioning. Phase one had the following three steps:
In step one a systematic qualitative content analysis of literature was conducted. The results show, that the fecor can be differentiated per ability with several main- and subcategories. In the core there is the main category "activity" consisting of the subcategories intended "outcome", resilience specific "behavior", and "method". Prerequisites, which are critical for executing ability-specific activities, represent another main category. To give an example: The subcategory "behavior" of the ability to monitor contains specific monitoring behavior like "updating of beliefs" or "recalibrating risk models", the subcategory "method" contains behavior-supporting methods like "cross-checking" or "information gathering", and the subcategory "outcome" contains e.g. "recognize changed situation" or "noticing critical disruptions".
The aim of step two was to concretize these theory-based categories with reference to the pilots' task. To do so, five semi-structured expert interviews with pilots were conducted and analyzed with qualitative content analyses. The interviews aimed at identifying dimensions with variability, i.e. dimensions that could change in a system-relevant manner and thus require adaptation from the pilots. Subsequently, the fecor-specific adaptation activities as well as the respective prerequisites were identified. The results show that there are several dimensions with variability, e.g. "technical aspects", "human aspects" or "weather". Furthermore, first leading indicators could be defined which refer to the pilots' adaptive behavior to potential or actual changes in order to sustain normal functioning. In the study it was decided to focus the subsequent steps on resilience related to potential or actual changes in the dimension "weather". This focus has been chosen because of the fact that weather is to a certain amount unpredictable for a system. Furthermore, the technical systems on board often do not automatically provide information about possible weather changes, especially not regarding the more distant future, which may become system-relevant. Therefore, the pilots' anticipation and monitoring concerning weather are crucial.

In step three a semi-structured group interview with five pilots was conducted in order to deepen and to verify the previous results. Final results of this step are four fecor-specific models of leading indicators. These models describe the pilots' resilient activities (behavior, methods and outcomes) as well as the related prerequisites required to successfully cope with variability in the dimension "weather". For the ability to monitor, behavior-specific leading indicators are e.g. "communicative information exchange" or "assessment of recognized changes". A Related method-specific leading indicator is e.g. "active acquisition of information". The subcategory "outcome" then contains e.g. the indicator "recognition of system relevant changes in the weather". Indicators for prerequisites are e.g. "knowledge about current main focus" and "situation awareness".

The aim of phase two was to develop an instrument for measuring the fecor. For that purpose a questionnaire was developed referring to the behavior of pilots in the cockpit. An item analysis as well as a reliability analysis with regard to the internal consistency (Cronbach's Alpha) were conducted on the basis of a online survey completed by 134 pilots. The results showed that the fecor can be measured with 93 psychometrically suitable items in 17 reliable scales (Cronbach's Alpha between α=.66 and α=.89). These reliable scales thus enable a proactive trend monitoring of pilots' resilient adaption to potential or actual changes in the weather.

3 RELEVANCE FOR SYMPOSIUM

An operationalization of the fecor with leading indicators classified in theoretically sound main- and subcategories allows for developing theory based models. When these models reflect the normal functioning of a system at the sharp end, they describe in a comprehensible manner which activities and prerequisites are critical for creating and sustaining resilience and hence for being proactive. Furthermore, a questionnaire for reliable measurement of the fecor facilitates resilience management by monitoring resilience specific activities (behavior, methods, outcomes) and critical prerequisites.

Using the tested questionnaire on a regular basis (e.g. twice a year) supports the identification of resilience-relevant trends in the measured scales. These trends need to be discussed and interpreted by representatives from the pilot corps and the Flight Safety Department. Such, problematical or undesirable developments can be recognized and appropriate, proactive measures can be taken. At a later stage the intended impact of the measures taken can statistically and qualitatively be evaluated. This proactive management of resilience helps an organization to sustain and to promote resilience. Furthermore, more practical experiences with this way of managing resilience supports the resilience community in developing and implementing target-oriented processes of resilience management in a complex, high-risk organization.

4 SIGNIFICANCE/TAKEAWAY:

The contribution of this study to creating resilience is twofold. First it provides a detailed description of pilots' resilient activities and its prerequisites at the sharp end. This description is both, soundly theory-based and elaborately referred to what pilots really do. This provides detailed insight into what weather-related resilience in the cockpit really is. These insights formed the basis for the development of the tested questionnaire, which allows for a detailed measuring and monitoring of the respective adaptive capabilities. Such, the basis of managing resilience in this domain is created.

Second, this prototypical study provides a process for the elaboration of the knowledge base required for resilience management and for a target oriented and proactive trend monitoring of key resilience abilities. The steps of this process are the first and hence very important ones when implementing a proactive management of resilience, because they decisively determine what will be focused. This shapes from what a system will learn when aiming to become more adaptive and proactive in the future. Consequently, the quality of managing resilience depends heavily on the developed knowledge base and the instruments which enable managing resilience. The process developed in this study contributes to increase this quality.

5 REFERENCES

Dekker, S., Hollnagel, E., Woods, D. & Cook, R. (2008). *Resilience Engineering: New directions for measuring and maintaining safety in complex systems.* retrieved from https://www.msb.se/Upload/Kunskapsbank/Forskningsrapporter/Slutrapporter/2009%20Resilience%20Engineering%20New%20directions%20for%20measuring%20and%20maintaining%20safety%20in%20complex%20systems.pdf [04.01.2015].

Hollnagel, E. (2012). A Tale of Two Safeties. *The Resilient Health Care Net*. retrieved from http://www.resilienthealthcare.net/A_tale_of_two_safeties.pdf [04.01.2015].

Hollnagel, E. (2014). Resilience engineering and the built environment. *Building Research & Information, 42*, (2), 221 - 228.

Hollnagel, E., Pariès, J., Woods, D. D. & Wreathall, J. (2011). *Resilience Engineering in Practice - A Guidebook.* Farnham, UK: Ashgate.