DEVELOPMENT OF A GRID TO ASSESS RESILIENT PERFORMANCE OF OSH MANAGEMENT SYSTEMS: A CASE STUDY IN A METALWORKING INDUSTRY

J. Fernandes
Polytechnic Institute of Porto, Department of Environmental Health, Portugal;

C. Ferreira
University of Málaga, School of Industrial Engineering, Spain;

J.C. Rubio-Romero
University of Málaga, School of Industrial Engineering, Spain;

M.A. Rodrigues
Polytechnic Institute of Porto, Department of Environmental Health, Portugal;
Algoritmi Centre, University of Minho, Guimarães, Portugal.

Introduction

For several organizations, occupational risk management is focused on risk assessment, accident investigation and analysis, and implementation of control measures. However, this traditional safety management approach begin to show itself unable to cope with the changes in the working context and unable to fully explain the accidents occurred within organizations. Resilience Engineering emerges as a new safety management paradigm that seeks to focus on the daily performance of organizations (Wood, Hollnagel & Leveson, 2006). It seeks to ensure that the number of successful results is as high as possible under the most varied conditions (Hollnagel, 2012). With this new paradigm, new methods and instruments have emerged to support resilience assessment, such as the Resilience Assessment Grid (RAG). The RAG is an instrument that allows to measure the abilities of an organization to achieve resilient performance (Hollnagel, 2017). This research sought to adapt this new approach to safety to the metalworking industry, which is particularly interesting as the accident rate is still high and improvements in the safety management process are required.

Objective

Develop and validate of a grid for assessing resilience in the metalworking industry, to facilitate the improvement and monitoring of OSH performance.

Stydy area

Occupational Safety and Health.

Methodology

This research can be divided into 3 main steps:

Step 1: Development of the questionnaire based on RAG by a team of four researchers. The primary information resource was the book “Safety-II in Practice: Developing the Resilience Potentials” (Hollnagel, 2017). As suggested by Hollnagel (2011) a Likert scale from 1 to 5 (1: “Deficient”; 2: “Unacceptable”; 3: “Acceptable”; 4: “Satisfactory”; 5: “Excellent”) was applied;

Step 2: Questionnaire validation through Delphi methodology. The experts anonymously expressed the level of importance on each statements and the communication was done by e-mail. Consensus was reached when the sum of items 4 and 5 (Agree) reached at least 80%;

Step 3: Questionnaire pretest (*n = 15* workers from metalworking industry).

Results

The first version of the questionnaire is constituted by 57 items, 16 items in the first dimension (ability to respond), 11 in the second (ability to monitor), 16 in the third (ability to learn) and 14 in the fourth (ability to anticipate). The Cronbach's alpha in the first round was 0.96 for ability to respond, 0.94 for ability to monitor, 0.95 for ability to learn and 0.95 for ability to anticipate. In the round 2 the experts were given the median of the group responses within ± 1 interval and if their answers differed from those of the group they should indicate the reasons. Based on these comments at the end of the second round 4 items were deleted. At the end of round 3, 4 items were eliminated whose percentage of agreement was below 80%.
The 15 pretest participants reported a good understanding of the questionnaire items, with no difficulties in completing.
The final questionnaire contains 49 items.

	Dimensions	Items of Round 1	Cronbach’s Alpha Round 1	Items of Round 2	Cronbach’ s Alpha Round 2	Items of Round 3	Cronbach’s Alpha Round 3
Cornerstones of resilience	Respond	16	0,96	16	0.88	13	0.75
	Monitor	11	0,94	11	0.91	11	0.93
	Learn	16	0,95	16	0.88	15	0.88
	Antecipate	14	0,95	14	0.92	16	0.89

Figure 1 – Cronbach´s Alpha according to the dimensions of questionnaire.

Discussion

The internal consistency of the questionnaire remained high throughout the three rounds. According to the literature values of Cronbach´s α ≥ 0.9 is considered excellent (Hill & Hill, 2009). Throughout the three rounds of the Delphi methodology, the level of consensus has increased. In the second round, the level of consensus was 75.6% for a total of 57 items and in the second round obtained 92.5%. Based on this, we eliminated of the four items that did not reach consensus at the end of third round. Throughout the rounds, one could choose reformulate and rewrite the items or proceed with their elimination based on the established criteria, as occurred in the work developed by Ljungberg & Lundh (2013).
There was a decrease in the number of specialists over the three rounds, with 22 in the first, 19 in the second and 17 in the third and last. The decrease in the number of experts may have occurred due to their difficulties in responding in a timely to successive rounds. However, the decrease was not critical to the results obtained.

Conclusions

According to the obtained results, the designed and developed questionnaire is a reliable instrument that can be used to measure resilient performance in the metalworking industry and contribute to the improvement of the OSH management systems. The questionnaire is an essential and practical tool to insert the precepts of Resilience Engineering to organizations in the metalworking industry.

References

Hill, M.M., Hill, A. (2009). Investigação por Questionário. Lisboa: Edições Sílabo.
Hollnagel, E. (2012). A tale of two safeties. *Nuclear Safety and Simulation*, *4*(1), 1–9.
Hollnagel, E. (2017). *Safety-II in Practice: Developing the Resilience Potentials*. Routledge. https://doi.org/10.4324/9781315201023
Hollnagel, E., Woods, D. D., & Leveson, N. (2006). *Resilience Engineering: Concepts and Precepts*. Ashgate Publishing, Ltd.
Ljungberg, D., & Lundh, V. (2013). Resilience Engineering within ATM - Development, adaption, and application of the Resilience Analysis Grid (RAG) (No. LiU-ITNTEK-G--013/080--SE). Department of Science and Technology Linköping University. Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva104023