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Defining risk acceptance criteria in occupational settings: A case study in the furniture industrial sector

Matilde A. Rodrigues [a,b,*], Pedro M. Arezes [b], Celina P. Leão [b]

[a] Department of Environmental Health, Research Centre on Environment and Health, Allied Health Sciences School of Polytechnic Institute of Porto, Vila Nova de Gaia, Portugal
[b] R&D Centro Algoritmi, Engineering School, University of Minho, Guimarães, Portugal

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ABSTRACT

The use of appropriate acceptance criteria in the risk assessment process for occupational accidents is an important issue but often overlooked in the literature, particularly when new risk assessment methods are proposed and discussed. In most cases, there is no information on how or by whom they were defined, or even how companies can adapt them to their own circumstances. Bearing this in mind, this study analysed the problem of the definition of risk acceptance criteria for occupational settings, defining the quantitative acceptance criteria for the specific case study of the Portuguese furniture industrial sector. The key steps to be considered in formulating acceptance criteria were analysed in the literature review. By applying the identified steps, the acceptance criteria for the furniture industrial sector were then defined. The Cumulative Distribution Function (CDF) for the injury statistics of the industrial sector was identified as the maximum tolerable risk level. The acceptable threshold was defined by adjusting the CDF to the Occupational, Safety & Health (OSH) practitioners' risk acceptance judgement. Adjustments of acceptance criteria to the companies' safety cultures were exemplified by adjusting the Burr distribution parameters. An example of a risk matrix was also used to demonstrate the integration of the defined acceptance criteria into a risk metric. This work has provided substantial contributions to the issue of acceptance criteria for occupational accidents, which may be useful in overcoming the practical difficulties faced by authorities, companies and experts.

1. Introduction

Risk assessment is an important process for organizations' safety, allowing them to demonstrate that hazards have been identified, existing risks to worker health and safety have been assessed, and measures to reduce risks to a reasonably practicable level have been taken (van Duijne et al., 2008; CCPS, 2009). However, it is important to recognize that there exist various difficulties during the risk assessment process in the area of occupational accidents, which have been discussed in the literature, such as issues related to the availability of reliable data (Jacinto and Silva, 2010; Pinto et al., 2012) and the lack of practical tools (Fera and Macchiaroli, 2010; Pinto et al., 2012). In addition, the appropriateness of the criteria that are considered to support risk decisions is also a problematic question because the use of inappropriate acceptance criteria may result in poor and divergent decisions regarding risk control or mitigation. However, despite its importance, this issue is frequently overlooked when referring to occupational accidents.

Due to the difficulties identified in the risk assessment process, this topic has been the subject of particular attention in recent years. Some researchers have focused their efforts on developing new methodologies and procedures that are, according to the authors, more suitable for application in occupational settings (see e.g. Woodruff, 2005; Marhavilas and Koulouriotis, 2008; Fera and Macchiaroli, 2010; Jacinto and Silva, 2010; Marhavilas et al., 2011; Carrillo-Castrillo et al., 2014). However, although most of the proposed methods include quantitative criteria presented as acceptance risk limits, the problem of their definition has not been discussed.

In light of the foregoing factors and with the objective of contributing to the discussion regarding the problem of defining risk acceptance criteria for occupational settings, the present study aims to define quantitative acceptance criteria for the specific case of the Portuguese furniture industrial sector via a case study.

The approach and criteria presented in this study do not intend to be an answer to all of the questions related to the decision-making process. Instead, this study intends to address an

* Corresponding author at: Rua Valente Perfeito, no 322, 4400-330 Vila Nova de Gaia, Portugal. Tel.: +351 918043393; fax: +351 222 061 001.
E-mail address: mar@estsp.ipp.pt (M.A. Rodrigues).

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important problem for the risk assessment process by proposing quantitative criteria for a specific sector, which is useful when defining risk priorities and explaining how they can be defined. Therefore, throughout this study, there is an emphasis on the importance of considering other types of complementary criteria/approaches to support risk decisions.

1.1. Acceptance criteria as a problematic issue

Acceptance criteria are terms of reference by which the significance of risk is assessed (ISO Guide 73:2009). In the occupational safety field, different criteria can be used to support decision-making regarding the treatment of risk and setting priorities, as presented by Harms-Ringdahl (2013). However, despite the importance of other criteria, such as requirements of legislation, guidance and good practices (HSE, 2001; Abrahamsen and Aven, 2008; Harms-Ringdahl, 2013), this study is focused on quantitative acceptance criteria, which are materialized as risk limits. The main reason for this specific focus is because most Occupational Safety & Health (OSH) practitioners use semi-quantitative risk assessment methods to assess the risk of occupational accidents, in which the risk matrix is the principal metric used and the decisions regarding risk acceptance are supported by quantitative criteria (Rodrigues et al., 2012). However, when these types of methodology are used, explanations about the risk criteria used and about who has determined them are relatively scarce (Harms-Ringdahl, 2013). It is not clear whether the criteria used are appropriate or not for the companies' circumstances.

Defining acceptance criteria is not an easy process. According to the Center for Chemical Process Safety (CCPS), organizations have two great challenges when defining acceptance criteria: (i) to ensure appropriate technical accuracy and practical applicability and (ii) to ensure that the risk criteria can be considered credible and equitable (CCPS, 2009). However, some constraints can jeopardize these goals when referring to occupational risks, such as the relatively limited experience and lack of qualified personnel by some companies, as well as the lack of specific guidelines for occupational settings. In fact, the current available guidelines only present general requirements or are more oriented toward major industrial hazards.

1.2. Model to define risk acceptance criteria in occupational settings

According to the literature, various important points need to be considered when formulating acceptance criteria (see HSE, 2001; CCPS, 2009; ISO 31000:2009; ISO 31010:2009). The flowchart presented in Fig. 1 schematizes the key steps in defining acceptance criteria for the risk of occupational accidents, taking into account both the guidelines' instructions and the features of the occupational settings.

A description of each step included in Fig. 1 is given in the following points:

(i) Determine which criteria to develop: The first step is to determine which criteria are important to establish. Companies with major industrial hazards usually may need to define the acceptance criteria for both individual and societal risks (CCPS, 2009; HSE, 2001). Regarding occupational settings, companies usually need to determine the criteria for safety performance and individual risk.

(ii) Determine the principles/philosophy for establishing risk acceptance criteria: The use of fundamental principles is deeply significant when acceptance criteria are being defined because it can ensure that these criteria are based on rational logic and that they can be easily justified in a transparent manner (Vanem, 2012). Different principles and philosophies for setting risk acceptance criteria can be found in the literature, which can be used alone or together (see e.g. HSE, 2011; Vanem, 2012).

(iii) Analyse the historical accident data: According to ISO 31000:2009, defining risk criteria requires knowledge about the nature and type of causes and consequences of the accidents that can occur, how they will be measured and how the probability will be defined. This information can be based on the accident databases of the company and/or sector.

(iv) Analyse the stakeholders' views: It is important to include the stakeholders' judgement about the risk and consider their emotions (Renn, 1997; ISO 3100:2009) because of ethical concerns and because they can report useful information (Pidgeon, 1998; ISO 3100:2009). Although different stakeholders can be considered, the workers, employers, supervisors and OHS professionals are generally the people who are most interested in a company's safety.

(v) Select the risk metric to be used: Among many factors (Johansen and Rausand, 2014), the metrics used to estimate the risk level depend on the definition of consequences and likelihood because this selection is limited by the accident dataset available. They are also dependent on the intention of the analysis, i.e. the risk assessment of particular risks or safety performance. This is an important piece of information to consider because acceptance criteria and risk should be expressed on the same scale (Kjellén and Sklet, 1995).

(vi) Define the acceptance criteria and their adjustment to the company: Based on the outcome of the previous steps, the acceptance criteria can be specified. However, in accordance with ISO 31000:2009, acceptance criteria must be aligned with the organization's safety culture.

(vii) Periodically revalidate the risk criteria: It is important to consider that risk criteria are dynamic (CCPS, 2009). Therefore, they should be periodically and continuously revalidated because the stakeholders' judgement and the companies' goals may change over time.

(viii) Safety culture: The safety culture can be considered as "the collective ability to produce organizational and interorganizational work practices that protect both individual welfare and the environment" (Tharaldsen et al., 2008). According to this concept, companies with a greater safety culture are expected to demonstrate higher safety performance. Consequently, stricter risk acceptance criteria are required for companies with higher levels of safety culture.

2. Methodology

2.1. Procedures

Following the steps presented in Fig. 1, quantitative acceptance criteria to be used in assessing the risk of occupational accidents in the furniture industrial sector were developed. First, decisions were made regarding the acceptance criteria to be developed and the principles/philosophy to apply (steps (i) and (ii)). Subsequently, the dataset of work accidents in the furniture industrial sector was analysed (step (iii)). Afterwards, OSH practitioners' views regarding risk acceptance levels were analysed (step (iv)), and the risk metric to be used was selected (step (v)). Based on the results of the previous steps, the acceptance criteria for the furniture industrial sector were finally defined (step (vi)). After finding the acceptance criteria for the entire sector, examples were given of how they can be adjusted to companies' safety cultures and integrated with a risk metric.