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Risk assessment of safety and health (RASH) for building construction

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ABSTRACT

In this research Risk Assessment of Safety and Health RASH method for building construction has been developed with risks classified into Safety Risks and Health Risks. 11 factors representing safety risks and 8 factors representing health risks were identified based on field survey in Oman. 40 Safety and Health specialists were involved in carrying out risk assessment using the existing method of risk analysis RA and the proposed RASH method. It was found that RASH method resulted in superior accuracy for assessment of risk zones than the existing RA method. The accuracy by RASH was almost twice the accuracy by RA. The overall percentages of the correct answers for the four scenarios using the RASH method and the RA method were 72.5 percent and 40 percent respectively. The proposed RASH method gave fewer errors than the existing RA method for all scenarios. Two scenarios were found to be the most problematic ones with largest overestimation of risks occur when using the existing RA method. Wilcoxon Ranked Test showed that the two methods are significantly different ($z = -3.357$, $p > 0.01$). The new method RASH is statistically acceptable and it resulted in better response in terms of estimating the risk than the RA method.

1. Introduction

Assessment of Occupational Safety and Health risks at construction sites is currently carried out using risk assessment matrices. Most of these matrices are designed based on brain storming sessions which make them risky to use since they are based on experience and knowledge in taking decision. Quantitative statistical analysis is rarely used. They lack specifications of carefully studied variables and inter-relations between them to aid the decision makers. Wall (2011) criticized the risk matrices as being producing less than useful portrayal of risk management information without probabilistic models for uncertainties. Ho (2010) stated that the most popular risk assessment methods are/may be the least effective. There is a strong "placebo effect" in analysis – even a completely ineffective method would feel like it worked,

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particular when it is easy to master. Even in organizations with extensive performance metrics, one of the most important measures is almost always ignored – the effectiveness of its risk management process. He suggested that users of risk matrix to be careful due to many limitations. Cox (2008) described the existing risk matrices as experiencing several problematic mathematical features making them harder to assess risks, including poor resolutions, errors, suboptimal resources allocation, and ambiguous inputs and outputs. He suggested that risk matrices should be used with caution, and only with careful explanations of embedded judgments. Pinto (2014) criticized the existing probabilistic occupational safety risk assessment OSRA models as require analysts to make harsh estimates based on their experience and perceptions. This is reflected in the analyst-to-analyst variability of results. He developed a fuzzy Qualitative Risk Assessment Model QRAM that can assess occupational safety risks in a better way than the OSRA models. Fung et al. (2010) used a set of historical accident data to develop a Risk Assessment Model (RAM) for assessing risk levels at various project stages. They found that RAM is beneficial in predicting high-risk related to construction activities and thus preventing occurrence of accidents. Risk in the AS/NZS 4360:04 (2006) is defined as the chance of something happening that will have an impact on Objectives and is measured in terms of a combination of the consequences of an event and their likelihood. Likelihood, as defined in ISO 31000 (2009) is the chance of something happening and can be expressed qualitatively or quantitatively. Consequences are defined as outcome or impact of an event. Johar and Mohayiddin (2011) calculated the risk by multiplying probability by Consequences. They divided the Consequences into Damage Consequences and Health Consequences. Safety is defined by Hughes and Ferrett (2008) as the protection of people from physical injury. Health is defined by the World Health Organization WHO (2006) as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. The International Council on Mining and Metals ICMM (2010) identified the Occupational Health hazard and carried out risk assessment for health and called it Health Risk Assessment (HRA). HRA is primarily concerned with managing the occupational health and safety of a workforce, likelihood and consequences. From the above literature the Overall Risk for both Health and Safety is calculated as given in Eq.1 without clear distinction between safety and health in both likelihood and consequences. This existing Risk Assessment (RA) method is well known and can be found in many references (i.e. Cox (2008), Fung et al. (2010), Ho (2010), Hughes and Ferrett (2008), Wall (2011), Marhavilas and Koulouriotis (2008)).

$$\text{Risk} = \text{Likelihood} \times \text{Consequences} \quad (1)$$

Sousa et al. (2014) emphasized the importance of a methodology to quantify occupational safety and health risk in construction projects following the guidelines set by the International standard ISO 31000:2009.

In this research, a Risk Assessment for Safety and Health, RASH, is developed. RASH assess the safety and health separately in the likelihood and consequences. The method was developed based on statistical quantitative analysis of data collected via a field survey and statistically validated.

2. Methodology

Here, the existing method of assessing Occupational Risk Assessment of Safety and Health in Building Construction projects is discussed and the new method of Risk Assessment for Safety and Health, RASH, is presented.

2.1. Data collection

Key risks in Safety and Health in building construction in Oman were identified using three main sources: data from local authorities including governmental authorities and Oil and Gas companies, Hazard Identification, HAZID, reports, and from a field survey that was conducted via a questionnaire on safety and health experts and risk management staff in the field of construction industry. As a result, 11 factors representing safety risks and 8 factors representing health risks were identified in Oman. This study followed a previous research work carried out to identify and categorize the occupational safety and health key risks in building construction in Oman (Al-Anbari et al. (2014)). A workshop was conducted to study HAZID reports and compares them with international reports. Strengths and weaknesses of the local HAZID were identified. It was found that professionals prone to heavily rely on their own experiences and knowledge on decision making on occupational Safety and Health risk assessment, which lack of a systematic approach and ways to check the reliability of the decisions.

2.2. RASH assumptions

The proposed Risk Assessment for Safety and Health, RASH, evaluates the Safety and Health separately in the Likelihood and Consequences as show in Eq. (2). The resulting matrix of the overall risks is a combination of both health and safety.

$$R = (L_S + L_H)(C_S + C_H) \quad (2)$$

Where;
R = Risk
L_S = Likelihood for Safety
L_H = Likelihood for Health
C_S = Consequences for Safety
C_H = Consequences for Health

In order to use the Risk Matrix, the equation should be in a format of: Likelihood × Consequences. Thus Eq. (1) is rewritten as shown in Eq. (3) to suit the RASH assumptions.

$$R = L_S C_S + L_S C_H + L_H C_S + L_H C_H \quad (3)$$

The components (Key risks) of Eq. (3) are defined as follows:

$$R_{SS} = L_S C_S \quad (4)$$

$$R_{SH} = L_S C_H \quad (5)$$

$$R_{HS} = L_H C_S \quad (6)$$

$$R_{HH} = L_H C_H \quad (7)$$

Then:

$$R = R_{SS} + R_{SH} + R_{HS} + R_{HH} \quad (8)$$