Risky business: Can organizations define "acceptable risk" in an emergency?

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Abstract

Occupational Health and Safety legislation obliges organisations to consider "acceptable risk" to staff in the performance of their work. This is problematic for emergency service responders (police, fire) as there is no consensus as to how "acceptable risk" should be defined in an emergency. We argue that it is an inherently flawed enterprise to try to define and calculate "acceptable risk" in emergency response. We report results of a number of research projects into the risk perception of firefighters which show that judgements of risk vary enormously depending upon both individual characteristics and features of the situation. Any attempt to define "acceptable risk" within emergency services must acknowledge the contribution of individual influences on risk perception. The implications of these research findings for training of staff are also considered. A Dynamic Cognitive Risk Assessment Model is proposed as one solution to the assessment of risk in emergency situations.

"Acceptable risk" in the emergency environment

The notion of an "acceptable risk" to health and safety in the workplace is grappled with across many industries. Fischhoff, Lichtenstein, Slovic, Derby & Keeney (1981) define acceptable risk as the "risk associated with the most acceptable option in a particular decision problem" (p.3). Most models of acceptable risk are based on probabilistic calculations of the statistical likelihood of an occupational risk occurring, e.g. the likelihood that a nuclear reactor will meltdown would be calculated as low. The problem with attempting to define risk in terms of statistical probability is that when the odds are not beaten, results can be 100% disastrous, e.g. the Chernobyl disaster.

The dynamic nature of the emergency response environment (police, fire, paramedic, rescue) presents challenges to any effort to define "acceptable risk". Dealing with occupational risk is of fundamental importance to emergency service organisations (ESO's) given that these services operate in a high risk environment which may result in deaths of workers. Notorious examples of failure to adequately assess risk may be found in the South Canyon Fire in the USA where 13 firefighters died (McLean, 1999) and the Linton, Victoria fire (1998) which resulted in five firefighter fatalities (Johnstone, 2002). There is currently no consensus among emergency services, however, as to what constitutes an "acceptable risk" in dealing with emergency situations (Kipp & Lofin, 1996; Wilder, 1997).

Variability in risk perception

ESO's have traditionally managed occupational risk by relying on intensive training of their staff and strict adherence to Standard Operating Procedures. The greatest challenge to ESO's in defining acceptable risk in emergency response, however, is the fact that perception of risk has been found to vary enormously between individual ESO workers. This variation in risk perception between individuals is accounted for by both characteristics of the individual and also characteristics of the situation.

Factors affecting risk perception

Experience in emergency response is often seen as a measure of the competence of a worker; however, there are many variables that may affect the impact of experience on risk perception. For example, 2 people with 20 years experience are highly unlikely to have had the same experiences. Clancy (2005) found no significant differences in firefighter risk perception based on simple length of service. Clancy found that variety of experience, rather than simple frequency of experience, significantly broadened firefighter's perception of risk.

Prior experience of a 'near miss', where a person felt that their safety had been significantly compromised, has also been found to be associated with a significantly broader and increased perception of risk among firefighters (Clancy & Holgate, 2005). This provides both a warning and a lesson to ESO's as it suggests that the best way of training people to appreciate risk is actually to expose them to risk.

Education has also been found to be associated with increased risk perception (Williams & Narendan, 1992, Slovic, 2000). Clancy (2005) and Clancy and Holgate

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(2005) found that firefighters with a tertiary education identified significantly more categories of risk in firefighting scenarios than did those without a tertiary education.

The limitations of human information processing capacity have been well researched (Baddeley, 1972) and these limitations have important implications for risk perception. Information processing capacity is reduced when human beings are subjected to noise and radio traffic (Surprenant, 1999; Potter, 2000) and when subjected to stress (Crowe, Hale, Dean, El Hadj, MacDonell, Sarkissian & Wrigley, 2001) and all of these features are typical in the emergency service environment. Even the process of deciding which pieces of information in the environment are important, and which should be ignored, taxes the capacity of working memory (Conway, Tuholski, Shisler & Engle, 1999).

It is well established that, in dangerous environments, our risk perception becomes more prone to errors (Baddeley, 1972). Under conditions of high stress and physiological arousal attentional capacity is likely to focus only on a few salient features of the environment (Crowe et al, 2001; Al'Absi, Hugdahl & Lovallo, 2002) thus potentially compromising our ability to assess risk.

Because human information processing capacity is limited humans seek to reduce cognitive load and complexity by relying on heuristics (Kahneman, Slovic & Tversky, 1982). If an emergency service worker has a great deal of experience dealing with a domain these heuristics will contribute to rapid information processing and effective performance (Ericsson & Lehmann, 1996). However humans tend to be prone to a number of cognitive biases and even experts have been found to be subject to these biases (Cleaves, 1987).

An important factor found to influence risk perception is the way in which the situation is framed. For example, expert firefighters have been shown to make inaccurate predictions about likely fire behaviour depending upon whether the fire is framed as a wildfire or a prescribed burn (Lewandowsky & Kirsner, 2000).

Upon arrival on scene firefighters are typically briefed as to whether a fire is "going" (spreading beyond its perimeter) or "contained" (not spreading beyond its perimeter). Sadler, Holgate and Clancy (in press) found that volunteer firefighters perceived a fire described as contained to be significantly less risky than a fire described as going. They also found that career firefighters were not subject to the same framing effect and perceived a contained fire as equally risky as a going fire.

Numerous cognitive biases have been identified in the literature and a number of these are particularly relevant to the assessment of risk. Emergency responders, as much as anyone else, are likely to be subject to optimistic biases (Metcalfe, 1998) which are likely to lead to over confidence in planning and obliviousness to risk. The planning fallacy (Sanna, Parks, Change & Carter, 2005) (that is, the tendency for people to underestimate the amount of time a task will take) will also leave the emergency service operator vulnerable to unanticipated risks. Operators may also be subject to confirmation biases (Klayman, 1995) which, again, may result in obliviousness to risk.

Another bias found in emergency situations is an "overutilisation of resources" bias whereby operators reduce the effectiveness of their performance by seeking to utilise all resources and information available rather than making appropriate judgements about resource and information utility (McLennan, Omodei, Holgate and Wearing, 2007).

One of the most pernicious biases in any emergency activity is that of sunk costs (Karlsson, Garling & Bonini, 2005) whereby operators persist in pursuing a course of action despite clear indications that the situation is deteriorating. The South Canyon, USA fire where 13 firefighters died provides a practical example of a situation where operators decided to pursue the firefight despite having explicitly identified that they were operating under unsafe conditions (McLean, 1999).

In large scale emergencies which require a co-ordinated multi-agency response (such as that experienced in Victoria, Australia during the 2006/2007 fire season) performance failures of any one part of the response effort tend to have a dominoe effect on the functioning of other parts of the system which may compromise the entire response to the emergency (McLennan, Holgate, Omodei & Wearing, 2006).

Dynamic Risk Assessment

Traditionally ESO's have managed risk through highly trained, procedure-based approaches that rely on standardised performance by the emergency responder. Examples of these are the 10 Standard Fire Orders and 18 watchouts that have been adopted internationally to guide risk assessment in wildfires. However, even these exceed the limits of working memory capacity (Braun, Gage, Booth & Rowe, 2001) and did not help in the South Canyon fire, where firefighters pursued the firefight despite having discussed the fact that they had broken 13 of the 18 watchouts (McLean, 1999).

Due to the problematic nature of defining acceptable risk for ESO's some efforts have been made (particularly by fire services, both in Australia and internationally) to institute dynamic risk assessment procedures whereby individuals are trained to perform risk assessments that balance the likelihood of a risk occurring against the consequences of pursuing a particular course of action. Increasing attention is also

being paid by ESO's to the concept of situation awareness (Endlsey, Holder, Leibrecht, Garland, Wampler, & Matthews, 2000). However, simply telling ESO workers that they need to have situation awareness is unlikely to result in improved risk assessment when the maintenance of situation awareness is subject to the same cognitive limitations and biases to which risk perception is prone.

Most models of dynamic risk assessment rely on emergency responders retrieving experience-based mental models and assessing risks cognitively, rather than applying a reliable technical formula. The dynamic nature of emergency situations necessarily means that unique variables need to be factored into calculations on a situation-by-situation basis. For example the risk that a sniper will shoot (presumably governed by psychological factors) is different to the risk of an explosion of a gas tank (governed by the laws of physics), which is different to the risk of being overrun by wildfire (governed by multiple factors). This means that it is not possible to develop heuristics for risk calculation that will cover all possible emergency scenarios.

Individual variations in risk perception also mean that the typically utilized models of dynamic risk assessment are unreliable in practice. For example, Clancy & Holgate (2005) asked 110 firefighters to provide a risk rating for a firefighting scenario using a 4 x 4 risk rating matrix commonly employed by fire services and found that of the 16 possible categories of response respondents endorsed 11. Risk ratings of firefighters for the same scenario varied between extreme, high, medium and low risk.

Findings such as these suggest that ESO's cannot rely on training in the use of existing risk-rating matrices to improve operators risk perception and ensure consistency between individuals in the perception of risk in any given scenario.

Any attempt to model the risk perception process needs to take account of the influence of human factors, such as the limitations of human information processing capacity and the tendency to be prone to biases in perception and decision making rather than ignoring the effect of human factors in the vain hope that everything will be all right on the day.

Dynamic Cognitive Risk Assessment Model

We propose the following model which: 1. illustrates the cognitive steps involved in the risk perception process; 2. identifies the cognitive biases that are most likely to impact on the human operator at each step; 3. identifies the strategies which are likely to contribute to effective risk assessment; and 4. provides a simplified 2 x 2 likelihood/consequences matrix to aid decision-making (not shown).

We suggest that training in the application of the D-CRAM model is likely to improve the risk perception of emergency service operators (regardless of factors such as individual experience) and result in greater consistency between individuals in their assessment of risk. Strengths of the model are that it is research evidence based rather than theoretical and it improves on previous models of risk assessment by explicitly identifying the cognitive contribution of the human operator at each step of the risk assessment process. The application of this model by ESO's may contribute to greater consensus on when a risk is "acceptable". The authors are currently developing a training package to complement the model and intend to further research its efficacy.

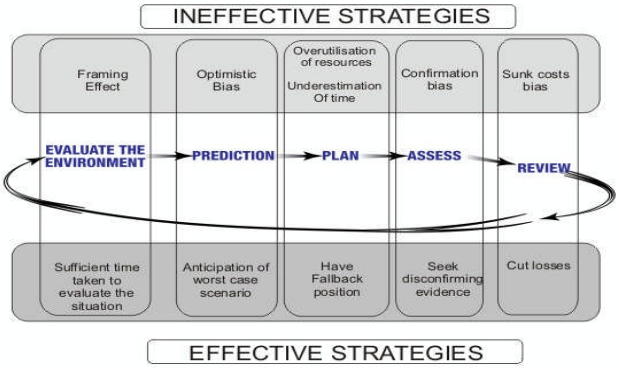

Figure 1: Clancy and Holgate (2007) Dynamic Cognitive Risk Assessment Model (D-CRAM)©

Conclusion

Due to the dynamic and unpredictable nature of emergencies, ESO's are faced with a difficult task when trying to manage and reduce the impact of risks. As discussed by Fischhoff et al (1981) it is unlikely that an "acceptable risk" can be determined, rather we are left with "accepting options" that are perceived to have the least amount of risk.

ESO's are likely to be able to improve staff training in risk assessment by including training in the human factors that affect performance in an emergency situation. The proposed D-CRAM model distils a large amount of conceptual and research knowledge into a simple five step process that may be easily communicated to ESO workers. Future research efforts by the authors will concentrate on establishing whether training in the D-CRAM model results in improved risk perception and greater consensus in risk assessment among emergency workers.

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