Subjective Risk Assessment

- Assessing the Performance of Risk Matrix Under an Environmental Context

EVSC30003 Environmental Risk Assessment

Assessment 1

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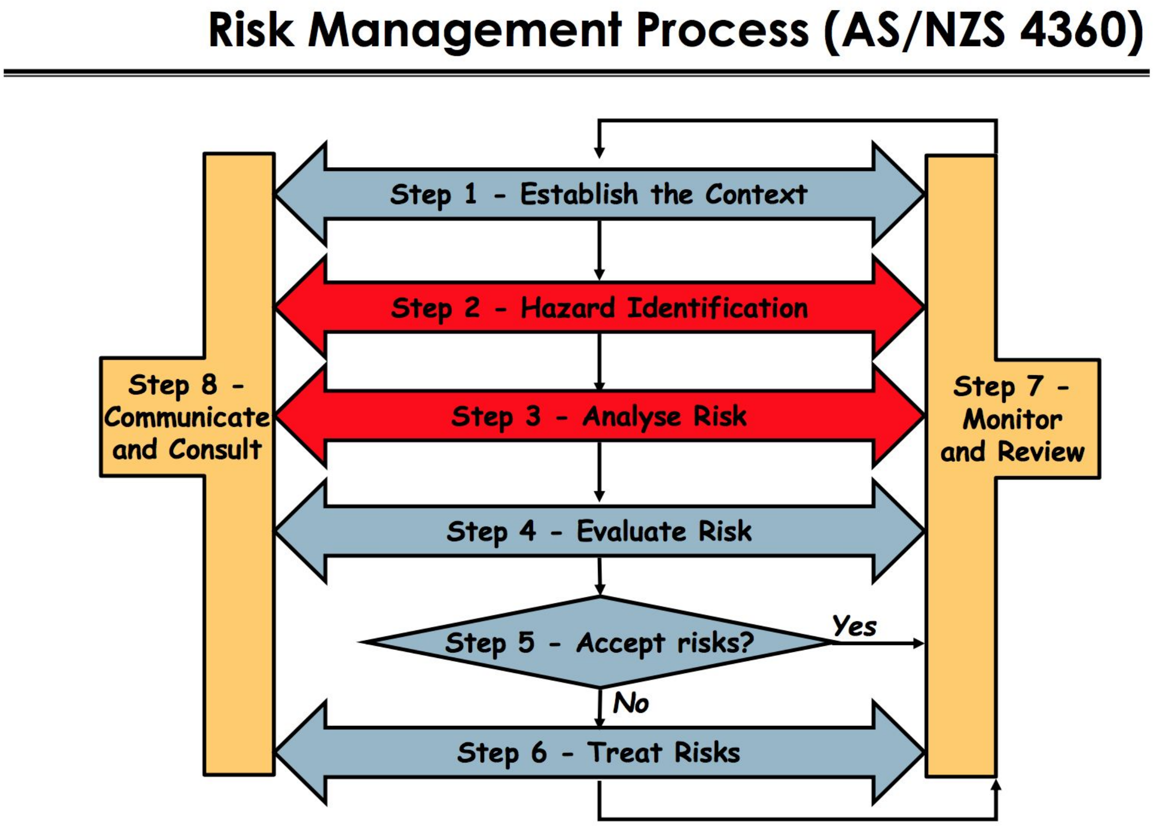
Introduction

With an increasing awareness of environmental protection and preservation, risk assessment and management is becoming increasingly necessary. Therefore, it is vital to have an effective assessment tool and understand its limitations to make better risk management decisions. The risk matrix is a widely recognised risk assessment method, which is often considered to be a simple and effective approach in doing risk management (Cox, 2008, p.498). However, few studies examine the performance of risk matrices in help to improve risk management decisions (Cox, 2008, p.497). As such, the purpose of this report is to examine the validity of the performance of this method in conducting subjective risk assessment for risk management, aiming to target specific strengths, limitations, and demonstrate its overall performance.

In this report, the application of risk matrix is based on a lab experiment that assessed major environmental hazards associated with a proposed expansion of coal port in the Great Barrier Reef (GBR) region, which is the world's largest coral reef system. (Moscardo, 2001) In overall, the lab focuses on major concepts and industry-standard protocols of environmental risk assessment, and explores differences in risk perceptions between independent assessor groups.

Methods

The main task of the lab is to conduct subjective risk assessment on the provided context, including the use of the risk matrix modified from ISO 31000 standard (International Organization for Standardization, Risk Management Guidelines), and the risk management process under AS/NZS 4360 standard (Australian and New Zealand Standard on risk management) (Flaus, 2013).



Above is the standard risk management; step1 to step 3 are conducted in this practical. First, all participated students read over development plan and other background information of the region, while the tutor guides students through the topic by explaining terminologies used and details of the region's existing decline in ecological condition.

Next, the class establishes context by establishing management objective, measurement, and time horizon. Decision makers also need to be identified in order to establish the objective. Management object is the goal that authority want to accomplish by doing this risk assessment. Measurement endpoint is "a measurement endpoint that is related to the valued characteristic chosen as an assessment point" (2006). Time horizon is the expected length of time in future that the risk management takes place. Establishing these three things leads to the second step, hazard identification.

In hazard identification stage, students discuss potential hazards in the class. Then the class together analyse students' suggestions and synthesise all listed potential hazards. Ultimately they come up with 12 different hazards of different impacts, and students list these hazard in their own risk rating table.

In the third step, the class is divided into accessor groups each of 5 to 6 students. Within each group, students analyse the risk together. A legend is provided for groups to check definition of terms used in the risk matrix, and to ensure that each group member shares the same understanding of all terminologies used. After that, group members assign subjective ratings to each hazard's likelihood and consequence, then calculate risk scores. Every member has the same risk score for the same hazard.

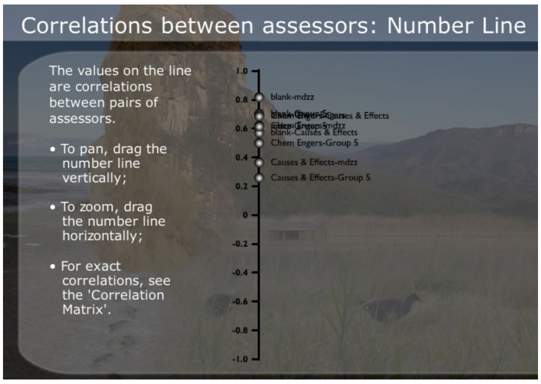
Risk Analysis Matrix (modified from ISO31000).

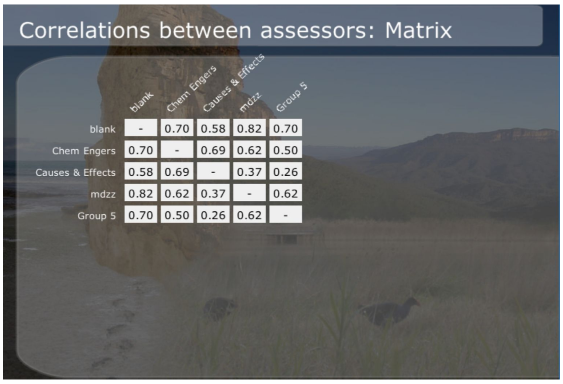
Likelihood		**Consequence**				
		Insignificant **(1)**	Minor **(2)**	Moderate **(3)**	Major **(4)**	Catastrophic **(5)**
Almost certain	**(5)**	5	10	15	20	25
Likely	**(4)**	4	8	12	16	20
Moderately likely	**(3)**	3	6	9	12	15
Unlikely	**(2)**	2	4	6	8	10
Rare	**(1)**	1	2	3	4	5

The risk matrix displays criteria for evaluating a risk event. It has five discrete scales for both likelihood and consequence of a risk over the established time horizon. Likelihood is the frequency, potential and probability for the risk to occur over the set time horizon;

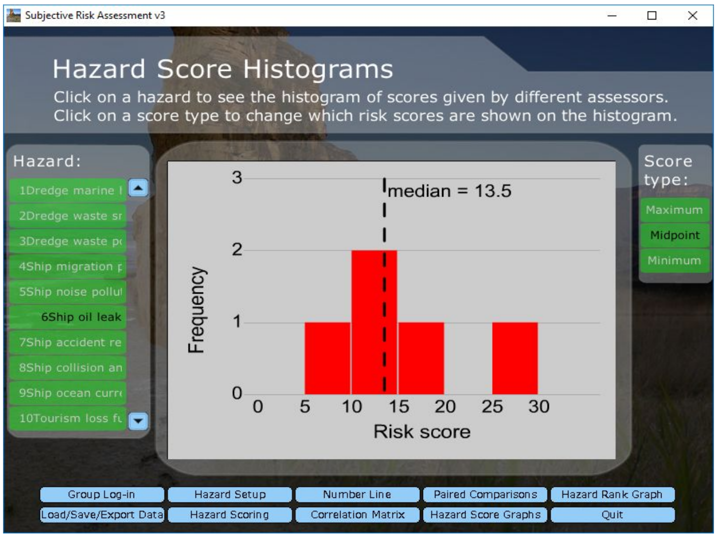
consequence is the severity in terms of the management objective if the risk event occurs (Lough, 2006). The two scores multiply together to produce a risk score, which is the number shown in each grid of the matrix. Risk scores are categorised into three scales, and the scales are in turn used as risk priority indicators of a risk event (Lough, 2006).

Results

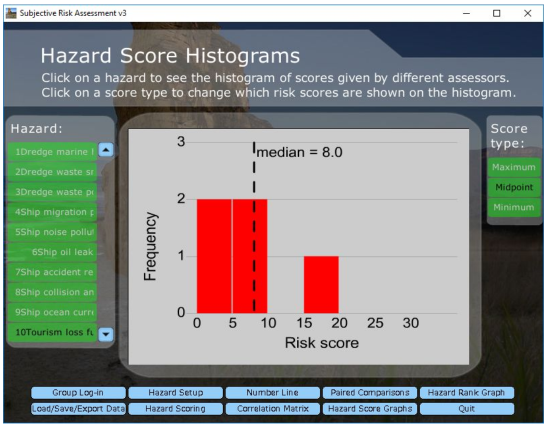


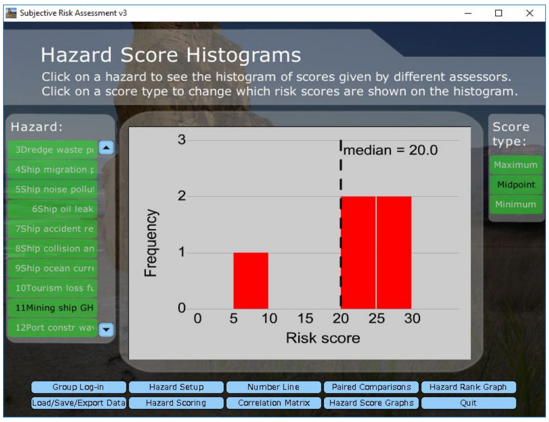


The gathered data are analysed in Subjective Risk Assessment software. In overall, across all hazards, “ship oil leak” has the most divergent risk score across all accessor groups, as shown in the hazard ranking graph. This is further supported by the risk score histogram, which shows four of the five groups rated different risk scores.



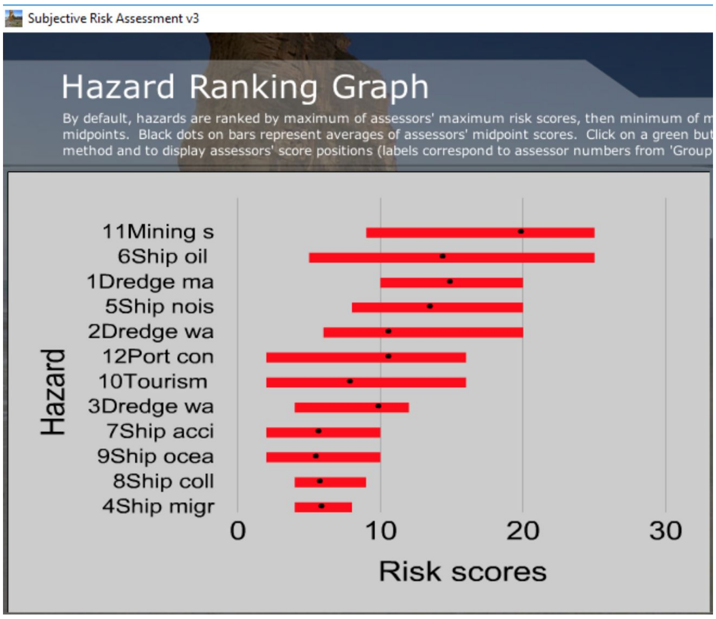
Furthermore, there is a significant divergence in risk scores for the risk "greenhouse gas emissions produced by mining ships". One group rated far lower that the others. The same scenario also shows on histograms of the risks "ship oil leak" and "tourism lost".





The correlation between different accessor groups is shown in the number line graph. Across all pairs of accessor groups, it is noticeable that goup Blank and group Mdzz have a significantly high correlation coefficient value exceeding 0.8; the correlation matrix further shows the value to be 0.82. Around the bottom of the line graph, it is clear that group Causes&Effect have very low correlation with two other groups - 0.26 and 0.37 respectively, making the minimum correlation value among all group pairs. All other correlation values are clustered between 0.5 to 0.7, and there are no negative correlations, indicating that in general there is no dramatic contradiction between the risk score produced by each group.

While it is expected that groups give different judgements, there are some interesting results that need to be addressed specifically. Detailed discussion of results is presented in Discussion section.



Discussion

As illustrated above, interesting results are produced, and reflects different risk perceptions across assessor groups, which worths further investigation in this section. Furthermore, the validity and performance of the risk matrix is examined.

Causes of differences in risk perceptions could be arised from linguistic uncertainty, different causal judgement and value judgement of different individual. Unfortunately, these uncertainties are not eliminated by using the risk matrix approach.

Regan states that linguistic uncertainties can be classified into "vagueness, context dependence, ambiguity… and underspecificity… with vagueness being the most important for practical purposes" (Regan et al, 2002, p.621-622). Vagueness occurs in borderline cases (Burgman, 2007, p.35). For example, in the legend of the risk matrix, the term "temporary ecological impact" is not specified, which is vague because there is no specific numerical ordering, and different individual interprets this differently. This could be solved by assigning a specific time frame for mutual interpretation. However, “many vague terms have a nonnumerical character” (Regan et al, 2002, p.623); the term “substantial ecological change” is an example that could only be solved by constructing multidimensional measurements (Regan et al, 2002, p.623).

In addition, language ambiguity exists in hazard identification. The hazard “oil leak” is ambiguous since how much oil leakage accounts for a oil leak is not specified. Language ambiguity as such leads to significantly divergent risk scores.

Moreover, differences in causal judgements generally could be resolved by group discussion to come to a shared understanding, whereas it is hard for people to adjust to the same value judgement (Knobe et al, 2008). Value judgement arises from education, culture background, social status as well as other underlying factors; different value judgement leads to motivational bias (Strech et al, 2008). Different individuals consider global warming differently, for example. As a result, it is nearly impossible for all accessors to share the same value judgement and give unbiased results.

Other cognitive biases may also affect the validity of risk score. Group thinking bias is an example; one group member’s own idea might be different to other member’s idea, but they take the majority idea in order to achieve unanimity while neglecting realisticity (Bénabou,2009).

In overall, risk matrix is not capable of eliminating nor presenting the above uncertainties, which leads to biased and untrustable risk scores and priority rankings. However, certain actions can be taken for more trustable results. First, form accessor groups in a diverse way that members have different gender, age, culture, career discipline, worldview, and cognitive style to eliminate overconfidence and motivational bias (Regan et al, 2002). Second, individuals should think independently before group discussion, and use structured group interactions to avoid group thinking bias. Third, the process of analysing risk should be iterated for several times, with discussion between all groups conducted each time.

Yet, the above actions may still be not effective enough to produce trustable results, a number of biases still remain unsolved. For example, “categorization of uncertain consequences is inherently subjective” (Tonycox, 2008, p.508). Some risks have no definite consequences. As a result, risk perception of people who perform risk analysis affects the result. While psychological biases could be eliminated, there is “no unique way to interpret the comparisons in a risk matrix… and the unstated risk attitudes of consequence severity classifications makes changes to be impossible when someone else uses the matrix” (Tonycox, 2008, p.508).

Most surprisingly, even the risk matrix itself often does not provide qualitatively useful information for ranking risk priorities. It is possibly useful under circumstances that consequence and likelihood are strongly positively correlated, but provide useless information when they are negatively correlated (Tonycox, 2008, p.501).

On the other hand, the pros of risk matrices is clear. It disaggregates risk likelihood and consequence severity (Burgman, 2007), and it requires no knowledge in quantitative assessment methods, making it simple for any individual to conduct subjective risk assessments. Its straightforward templates and data visualisation makes it easy for stakeholders to read (Tonycox, 2008). Yet, those data may not be trustable.

In conclusion, the risk matrix does not provide valid and trustable results. The fact that the use of this method is too widespread is a bad thing, for untrustable results leads to false management decisions. “Risk matrices do not necessarily support better-than-random risk management decisions and effective allocations of limited management attention and resources” (Tonycox, 2008). One way to avoid those limitations is to use alternative methods such as building a risk model using Monte Carlo simulation, or use risk matrix together with other tools. Yet, the risk matrix method needs urgent amendment and improvement, and researchers should be aware of specific limitations while using this method.

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