



Risk assessments: is there a Goldilocks technique?

This working paper reviews findings from research being carried by Chris Peace towards a PhD at Victoria University. It looks at which techniques could be and are used as part of risk assessments.

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Background

Risk assessors should use techniques, relevant to the risk, applied in a recognised process (here, the ISO31000 (2009) process) to elicit the best available information by de-biasing their work (MacGillivray, 2013; Montibeller & von Winterfeldt, 2015) and inform decision makers of the best available information (Wiedemann et al, 2013).

Literature review

As part of continuing research to assess the effectiveness of risk assessments in informing decision makers a preliminary set of 160 articles identifying possible risk techniques was found in the academic databases.

An internet search using Google Scholar yielded a further 51 potential sources of techniques, two of which provided a further 27 techniques.

More than 140 standards include consideration of risk (Paris, 2014) but the following provided the most sources of risk techniques:

- IEC/ISO31010:2009 *Risk assessment techniques*
- ISO17776:2000 *Petroleum and Natural Gas Industries: Offshore Production Installations: Guidelines on Tools and Techniques for Hazard Identification and Risk Assessment.*

Both standards cross-reference to technique-specific standards.

Results of the literature search on risk techniques

Some articles reviewed single risk techniques but many identified or reviewed project risk management techniques (Ammar, Berman, & Sataporn, 2007; Baker, Ponniah, & Smith, 1998, 1999; Hillson, Grimaldi, & Rafele, 2006; Rafele, Hillson, & Grimaldi, 2004; Raz & Michael, 2001; Williams, T., 1995). Some techniques were found to be common to other areas of management such as strategic, quality or environmental management, and software development and engineering design and production (eg, Goldberg et al, 1994).

Six books provided corroboration for the techniques found in articles (Chapman, 2011; Cooper et al, 2005; Haines, 1998; Stewart & Melchers, 1997; Swallom, Lindberg, & Smith-Jackson, 2003; Turney & Pitblado, 1996). However, review of some standard texts on risk management (eg, Chance & Brooks, 2010) found no mention of risk assessment or risk techniques.

Risk techniques for further review

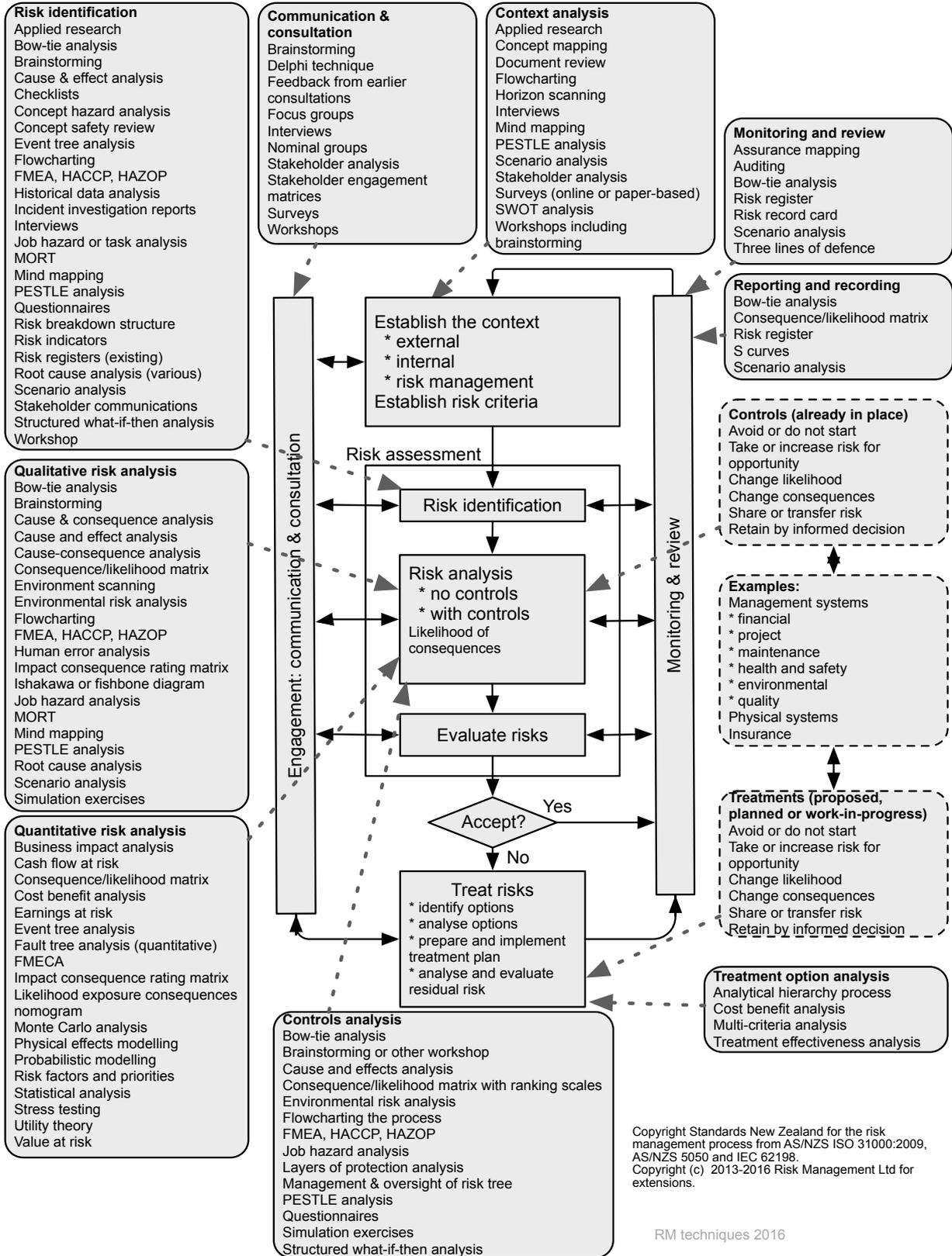
If a risk technique was named at least three times in the literature it was selected for further review and (using guidance in IEC/ISO31010 *Risk assessment techniques* (2009)) grouped under one or more of the seven main stages in the ISO31000 risk management process. The grouped techniques were discussed with two experienced risk practitioners and two focus groups of practitioners. As a result, some techniques were added to the groups and some were removed.

“Professional judgement” was raised by one person in one of the focus groups who argued strongly it was widely used and should be included in the list of risk techniques. Subsequent informal consultation with other risk professionals suggested this was correct, despite difficulties with defining its meaning, and it was included in the survey.

The final selection was mapped against the ISO31000 risk management process to create Figure 1 and contributed to development of the online survey that forms part of this research.

Figure 1. Risk techniques in the risk management process

This graphic is based on the ISO 31000 risk management process diagram. The three right-hand boxes with dotted outlines have been added to show (1) when controls should be analysed and (2) where treatment options should be identified, assessed for likely effect, selected and implemented. The examples box suggests a few controls and treatment options that might be relevant. Possible risk techniques are shown in boxes with solid lines and curved corners to indicate where they might be used. Note that some techniques can be used in several stages of the process.



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Other findings from the literature search

Quality assurance and need for a risk technique selection process

Individual risk techniques often seem to have been developed on a standalone basis or in “silos” that reflected the developers’ professional or academic origins or interests rather than a generic approach to risk assessment. These differences may also have influenced what people were taught during formal or on-the-job training.

The hazard and operability technique (HAZOP) provides an example of a standalone technique. It was developed by ICI in the late 1960s and early 1970s as part of a response to several high-profile events and has become an industry-standard technique in the petrochemical industry (Swann & Preston, 1995). However, the language used in HAZOP studies is different from the language used in other techniques, giving rise to the potential mismatch of findings and responses to risk.

A theme found in several articles was the need for quality assurance in risk assessments (Arunraj & Maiti, 2007; Cantrell & Clemens, 2009; Chapman, 1998; Pinto, Ribeiro, & Nunes, 2013; Schrader et al, 2010; Suokas & Rouhiainen, 1993; Williams, J. C., 1985).

Risk techniques ought to be selected based on the likely characteristics of the risks and the needs of decision makers. Several authors discussed use of risk technique selection tools for specific applications through, for example:

- case-based reasoning to aid selection of project risk techniques (Forbes, Smith, & Horner, 2008, 2010)
- a methodology for assessing the effectiveness of IT-related techniques (Raspotnig & Opdahl, 2013)
- a methodology for assessing risk-based management techniques (Arunraj & Maiti, 2007)
- a methodology for selecting root cause analysis techniques (Doggett, 2005).

Further work on a process for selection of risk techniques is planned.

Qualitative and quantitative risk analyses

A risk may have qualitative or quantitative factors that should be drawn out in a risk assessment to enable decisions about the acceptability of the risk. Such an analysis should clearly state the qualitative nature of the risk, or quantitative level of risk, or both, and uncertainties in the risk assessment and selected techniques (Wiedemann et al, 2013).

March & Shapira (1987) found strong indications that people “do not trust, do not understand, or simply do not much use precise probability estimates” and quoted one respondent to their research as saying “You don’t quantify the risk, but you have to be able to feel it”, suggesting use of qualitative risk analysis techniques, supported by quantitative analysis.

Conversely, words alone as descriptors of consequences or their likelihood are prone to divergent interpretation (Budescu, Broomell, & Por, 2009; Evans, 2012), suggesting the need to quantify some characteristics of risk. This was reinforced by research into intelligence analyses in the USA that showed considerable misunderstandings of text-based analyses by decision makers (Tetlock, 2006).

Results from the online survey

The anonymous online survey was run in late 2013 and contained questions related to risk assessment techniques. Respondents were asked to select three techniques from lists used to develop Figure 1 above. Respondents could also answer “other” and type in one other technique.

Questions at the end of the survey asked about the background of respondents and found that about half of the 223 respondents lived in New Zealand with the others predominantly from the UK and Ireland. About half of the respondents worked in risk management with many of the others working in health and safety; most respondents were well qualified and experienced and often members of professional bodies.

Preliminary results from the online survey are appended with detailed statistical analysis in progress and some of the interesting results are discussed below.



Professional judgement

As noted earlier, professional judgement was included in the survey despite not being a documented technique. It was ranked as the most popular technique for establishing the context and judging the effectiveness of controls and risk treatment options but was also highly ranked for identification of stakeholders, risk identification, qualitative risk analysis and risk evaluation.

More detailed analysis is planned to help understand the levels of experience and education of respondents who selected professional judgement. A review of the literature on professional judgement is also in hand.

Consequence/ likelihood matrix

The matrix with ranking scales was selected by 87 respondents as one of their three qualitative risk analysis techniques. The matrix with numerical scales was selected by 103 respondents as one of their quantitative techniques.

The matrix can also be used to help judge the effectiveness of controls and 77 respondents chose it. Similarly, the matrix can be used to help choose the best options for risk treatment and was selected by 70 respondents.

Overall, the matrix seems to be a frequently chosen risk analysis technique, closely followed by professional judgement. It has, however, been criticised by a number of authors and a summary literature review is in hand.

Qualitative and quantitative techniques

The majority of respondents reported using qualitative techniques but 14 selected "I don't use qualitative techniques". Somewhat more respondents (31) selected "I don't use quantitative techniques".

ALARP and SFAIRP

The survey was designed and run before the New Zealand Health and Safety Reform Bill 2014 was published, containing the "so far as is reasonably practicable" test. Respondents were offered number of risk evaluation techniques or options including "as low as is reasonably practicable" and this was selected by 110 people suggesting many had a health and safety background.

Respondent responsibilities

Most questions offered an option such as "it's not my job to analyse risks". This was the least selected option in many questions suggesting that most respondents carry out almost all stages in the risk management process.

Conclusions

The results suggest respondents frequently use professional judgement in combination with qualitative risk assessment techniques that may lead to poor or misleading results.

Elsewhere in the online survey respondents were asked about uncertainty and the extent to which it formed part of risk assessments. Results from those questions suggest that uncertainty may often be inadequately discussed. This, in combination with optimistic professional judgement and use of the matrix, suggest that at least some risk assessments may be highly ineffective in informing decision makers.

A detailed analysis of the data and further literature reviews are, as noted, in hand.

Is there a Goldilocks technique?

The short answer is "No", but many people use the consequence/likelihood matrix and professional judgement as their preferred, perhaps only, risk assessment techniques. Personal biases in these techniques may result in an incomplete understanding of a risk and misleading analysis of the level of risk.

Further research is planned to look at the conduct of risk assessments in a series of case study organisations.

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Appendix: Summary results from the online survey

Table 1. Risk techniques used in establishing the context

Name of technique	Number of respondents choosing this technique
Professional judgement	108
Workshops including brainstorming	105
Scenario analysis	64
SWOT analysis	64
Document review or analysis	62
Applied research	42
Flowcharting	36
PESTLE or PEST analysis	34
Mind mapping	28
Surveys (online or paper-based)	21
Concept mapping	15
Horizon scanning	11
I rely on another person or group in my organisation to do this	6

Table 2. Risk techniques used to identify stakeholders in a risk assessment

Name of technique	Number of respondents choosing this technique
Personal knowledge of stakeholders	153
Professional judgement	148
Brainstorming	107
Interviews with other stakeholders	86
Workshops with other stakeholders	67
Existing database of stakeholders	59
I rely on another person or group in my organisation to do this	7

Table 3. Risk techniques used to decide how and how much to consult or communicate

Name of technique	Number of respondents choosing this technique
Professional judgement	187
Feedback from earlier consultation	147
Brainstorming	98
Stakeholder importance/influence matrix or similar	84
I rely on another person or group in my organisation to do this	11
Legal requirements or guidance	3

Table 4. Risk techniques used in risk identification

Name of technique	Number of respondents choosing this technique
Workshops, brainstorming and similar	81
Professional judgement	70
Risk registers (existing)	63
Job hazard analysis or task analysis	60
Incident investigation reports	54
Root cause analysis	48
Cause and effect analysis	47
Interviews	43
Scenario analysis	38
Risk indicators	31
Applied research	27
HAZOP	25
Failure modes and effects analysis	22
Stakeholder communication to you or your organisation	21
SWOT analysis	18
Risk breakdown structure	16
Questionnaires	14
HACCP	9
Mind mapping	9
PESTLE or PEST analysis	9
Flowcharting	8
It's not my job to identify risks	2
Bow-tie analysis	1
Checklists or trigger lists	1
Event tree analysis	1
MORT	1
Structured What-If Then analysis	1

Table 5. Risk techniques used in qualitative risk analysis

Name of technique	Number of respondents choosing this technique
Consequence likelihood matrix with ranking scales	87
Professional judgement	70
Brainstorming or other workshop	59
Job hazard analysis	52
Bow-tie analysis	47
Root cause analysis	44
Cause and effect analysis	37
Scenario analysis	37
Impact consequence rating matrix with ranking scales	26
HAZOP	24
Failure modes and effects analysis	21
Risk mapping	21
Fault tree analysis (qualitative)	19
I don't use qualitative techniques	14
SWOT analysis	14
Flowcharting	13
Questionnaires	13
Environmental risk analysis	12
HACCP	7
Mind mapping	7
PESTLE or PEST analysis	6
Environment scanning	5
Simulation exercises	5
MORT	2
It's not my job to analyse risks	1

Table 6. Risk techniques used in judging the effectiveness of controls

Name of technique	Number of respondents choosing this technique
Professional judgement	112
Brainstorming or other workshop	86
Consequence likelihood matrix with ranking scales	77
Job hazard analysis	55
Bow-tie analysis	47
Root cause analysis	38
Failure modes and effects analysis	33
Cause and effect analysis	31
Questionnaires	21
Flowcharting or mapping the recommended process	20
HAZOP	20
Simulation exercises	18
Layers of protection analysis	17
SWOT analysis	12
Environmental risk analysis	10
MORT	3
PESTLE or PEST analysis	3
HACCP	2

Table 7. Risk techniques used in quantitative risk analysis

Name of technique	Number of respondents choosing this technique
Consequence likelihood matrix with numerical scales	103
Business impact analysis	55
Risk factors and priorities	51
Cost benefit analysis	48
Impact consequence rating matrix with numerical scales	35
Statistical analysis	32
I don't use quantitative techniques	31
Likelihood exposure consequences nomogram	25
Failure modes, effects and consequences analysis	22
Probabilistic modelling	22
Monte Carlo analysis	20
Fault tree analysis (quantitative)	19
Event tree analysis	17
Value at risk	12
Cash-flow at risk	8
Earnings at risk	7
Physical effects modelling	7
Stress testing	5
Utility theory	3

Table 8. Risk techniques used in risk evaluation

Name of technique	Number of respondents choosing this technique
Risk criteria developed by my organisation	119
As low as is reasonably practicable	110
Professional judgement	109
Benchmarking against internal or external standards	94
Risk appetite statement developed by my organisation	49
Heat mapping	33
Best available technology not entailing excessive cost	33
Precautionary principle	21
It's not my job to do this	6
Cost benefit analysis	3

Table 9. Risk techniques used in identifying and evaluating risk treatments

Name of technique	Number of respondents choosing this technique
Professional judgement	99
Brainstorming or other workshop	92
Cause and consequence analysis	52
Root cause analysis	38
External advice	37
Bow tie analysis	31
Job hazard analysis	31
Similar risks	25
Checklists	23
Risk Mapping	23
HAZOP	21
Simulation exercises or scenario development	19
Causal analysis	17
Failure modes and effects analysis	14
Risk breakdown structure	13
Fault tree analysis	10
Environment scanning	8
Flowcharting	7
I rely on another person or group in my organisation	7
It's not my job to do this	5
HACCP	3

Table 10. Risk techniques to help choose the best options for risk treatment

Name of technique	Number of respondents choosing this technique
Professional judgement	89
As low as is reasonably practicable	84
Cost benefit analysis	71
Consequence likelihood matrix	70
Risk criteria developed by the organisation	57
Benchmarking	38
Best available technology not entailing excessive cost	34
Impact consequence rating matrix with ranking scales	30
Analytical hierarchy process	19
Legal advice	18
External advice	17
Heat mapping	11
Capacity for change analysis	10
Treatment effectiveness analysis	10
Precautionary principle	9
I rely on another person or group in my organisation	8
Constraints analysis	5

Table 11. Risk techniques used in monitoring and reviewing

Name of technique	Number of respondents choosing this technique
Planned reviews (eg, annual; after a major change)	124
Post-event investigations	75
I rely on internal audit	64
Indicators (eg, performance, cost of materials)	60
Controls self-assessment	54
Professional judgement	54
Focus groups	31
Benchmarking	24
I rely on external audit	19
Complaints analysis	17
Variance monitoring	17
Questionnaires	14
It's not my job to do this	12