

## Tools and techniques - what utilities need or what people think we want?

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### Introduction

Traditionally, water utilities have carried out risk assessments in a relatively small number of fields, addressing specific safety, health and environmental (SHE) risk concerns. In the last few years, however, the use of risk techniques has been extended as these companies increasingly seek to establish sound risk governance throughout all levels of their business to safeguard the interests of their customers and investors. Many new techniques have been imported from other process industries (offshore, energy supply, nuclear) and other businesses and financial institutions.

In many respects, risk management is a practitioner led discipline and as such, its development and implementation within water utilities can vary significantly according to their size, operations, ownership and leadership, as well as the political, economic, legislative and regulatory frameworks in which they operate. As part of the ongoing AwwaRF Project 2939 '*Risk analysis strategies for more credible and defensible decisions*', studies have been undertaken in order to better understand the current level of application of risk analysis within the sector and to identify sector-specific views on key implementation issues. This research has realised the development of a maturity model for assessing capabilities in risk management and has also included a series of structured interviews with utility risk managers and industry spokespeople. Between 13<sup>th</sup> May, 2004 and 25<sup>th</sup> January, a total of sixteen interviews were conducted with specialists from five different countries (Australia, Canada, New Zealand, the United Kingdom and the United States). Fifteen work primarily within the water sector; the sixteenth works for an energy company. A full summary of this research and its findings will be published in the AwwaRF Project Report. With regard to the topic of risk analysis tools and techniques in the sector, the following key issues emerged:

- Does anyone use the risk management frameworks in practice? Are they useful and practical?
- What are the practical limits of, and people views of quantitative risk analysis techniques?
- Should we and how do we make consistent the various tools and techniques for risk management across utility companies?

### Risk frameworks

Concurrent with the widening implementation of risk management tools and techniques within the water utility sector, is the need to formalise the process. This can be assisted by employing a framework or 'route map' within which the risk management process can be structured. These can comprise a simple task list although they are more often to be found in a diagrammatic form, usually outlining a continuous 'assess-plan-do-monitor-revise' management process.

The reputed benefits of different risk management frameworks are listed, for example, in Canadian Standards Association (1997) and the (Australian) National Health and Medical Research Council (NHMRC, 2001). Generally speaking, these can introduce extra rigour and consistency to the process of risk-based decision-making. They can also provide a standardisation of approach, wherein different methods for risk management can be compared, whilst still providing sufficient flexibility for users to adapt them to suit their own operations. This is especially important to regulators, for example, when benchmarking company performance. Frameworks also present a mechanism for more credible and defensible company decision-making, strengthening the case for a “due diligence” defense, and can help grow a risk culture within an organisation.

As highlighted in NHMRC (1999) risk management frameworks can additionally help foster a holistic approach to risk management - one where risk management is viewed in terms of an entire integrated system, greater than the sum of its individual parts. Some practitioners advocate using systems and procedures that allow for an integration of risk management practices across an organization, permitting a read-across of risk information from one part of the business to the other and a balancing of risks across an organization. Such approach is referred to as ‘integrated’, ‘holistic’ or, ‘enterprise’ risk management. Deloach (2000) reflects that that there is often a lack of consistency across enterprises in terms of the level of detail, reporting formats, management methods and guidelines for risk management. He advocates an enterprise (-wide) risk management approach that

- implements a common language that facilitates internal and external communication;
- provides a consistent reporting framework for aggregating risk measures and information;
- fosters increased management confidence through a systematic approach that identifies all of an enterprise’s risks;
- supports resource allocation through rigorous prioritisation of risk;
- reduces transfer costs due to offsetting or pooling of risk; and
- creates a disciplined, structured process for making vital decisions.

Within the water industry, this approach is gaining favour internationally. Leverett (2003) describes how Severn Trent Water (in the UK) is setting about managing its risks in a more holistic way:

*“The long-term philosophy behind holistic risk management is simple: assess and manage all aspects of risk associated with what we do in a consistent, structured way and to company standards, independent of how or where the risks are identified. In effect (it is) to provide a framework or umbrella to bring together all existing risk management approaches, whilst also driving them deeper into our culture.”*

In this context, the term ‘framework’ has a wider meaning and can be thought of as ‘the setting out of everything a company needs to do to enable it to define and implement a risk management strategy to meet the objectives of its stakeholders’. Broadly speaking, risk management frameworks available to water companies can therefore be categorized into four distinct groups (Figure 1). An in-depth review of these will be published separately. A summary of some key frameworks in each of these categories is shown (Table 1).

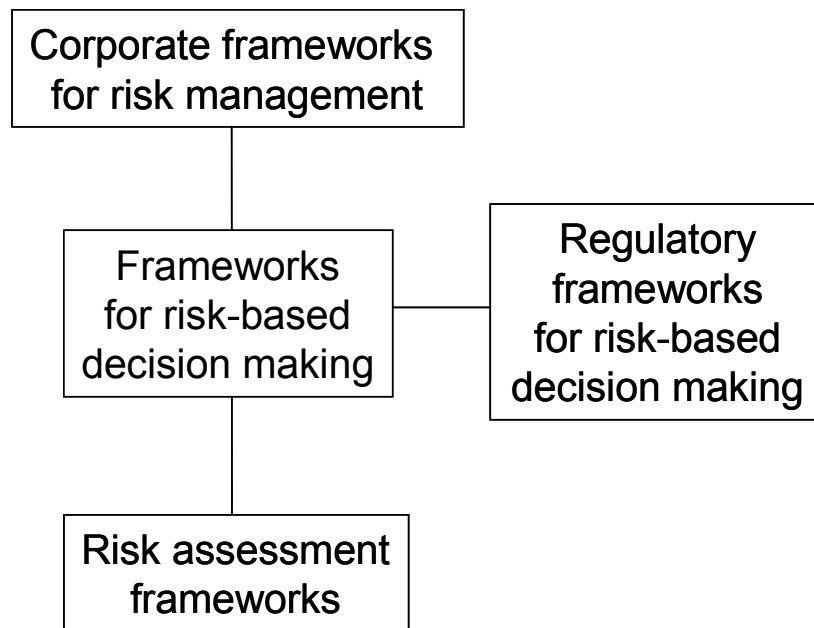


**Figure 1.** Different types of risk management frameworks

A key issue for discussion within the water sector and beyond is the extent to which frameworks for risk-based decision-making are actually being used by water utilities. A critical feature, perhaps, is the degree to which these frameworks have been embedded within organisations. A salutary lesson for risk managers can be learned from the failures in implementation from the international quality standard ISO9001. Hoyle (2001) argues that although some organizations did use ISO9001 wisely, that for many, the standard for many was merely a ‘badge on the wall’ and had nothing to do with improving performance. In some cases, new activities were bolted onto the industry without putting in place the necessary linkages to maintain system integrity leading no significant improvement in the organisation’s overall performance. Some believed the standard was largely a documentation exercise. In addition, the persistence of the auditors to require documentation led to situations where documentation only existed in case something went wrong.

As far as regulatory frameworks such as water safety plans are concerned, it is clear from the structured interviews that, internationally, many companies are either currently implementing these (this is especially true in Australia and New Zealand) or are at least contemplating doing so. Offered opinions on water safety plans were generally favourable. Those that had implemented water safety plans believed them to be useful in identifying hazards and reducing risks, especially at many of their smaller works which may have previously been overlooked, although one strong advocate of the plans highlighted that it was often necessary to “*cut the cloth to suit*” at some of these works, sacrificing sophistication for expediency. This is obviously a key point of debate for water companies and regulators alike, who need to find a workable balance between ensuring ‘due diligence’ without bureaucratising the decision-making process.

As far as usage of more general (non-regulatory) high-level frameworks for risk-based decision making is concerned, such as those presented in Australian/New Zealand Standard (1999) or USPCRM (1997), for example, the picture is less clear. Although some companies have developed and claim to be using frameworks for decision-making, very few risk managers seemed enthusiastic to discussing, or in some cases knowledgeable about, the various high level frameworks that have been

developed to aid risk-based decision making. Instead many preferred to talk about specific risk management practices such as the scoring systems that they were using to evaluate risks across their business. The reasons why such frameworks do not have a higher profile within the industry is unclear although it is possible that, for many, the benefits are not readily apparent. A representative of smaller water utilities voiced complained that some frameworks can be too ‘high-level’ and lacking sufficient ‘hands-on’, practical information to be sufficiently useful. This suggests that there may be, as far as some water companies are concerned, a disparity between the academic and the practitioner view of risk frameworks.

**Table 1.** Examples of different types of frameworks available for utility risk management.

|                                                      | Area of use                  | Framework                                                                                                | Reference                                                                               |
|------------------------------------------------------|------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Risk assessment frameworks                           | Ecological risk              | Framework for ecological risk Assessment                                                                 | US Environmental Protection Agency (1992)                                               |
|                                                      |                              | Guidelines for ecological risk assessment                                                                | US Environmental Protection Agency (1998)                                               |
|                                                      | Microbiological risk         | Conceptual framework for human health (chemical) risk assessment                                         | National Academy of Sciences (1983) [US]                                                |
|                                                      |                              | Conceptual framework for assessing the risks of human disease following exposure to waterborne pathogens | International Life Sciences Institute (1996)                                            |
|                                                      |                              | Revised framework for microbial risk assessment                                                          | International Life Sciences Institute (2000)                                            |
| Frameworks for risk based decision-making            | Public health risk           | Framework for environmental health risk management                                                       | US Presidential/ Congressional Commission on Risk Assessment and Risk Management (1997) |
|                                                      | General                      | AS/NZS 4360:1999 Risk management overview                                                                | Australian/New Zealand Standard (1999)                                                  |
|                                                      |                              | AS/NZS 4360:1999 Risk management process                                                                 |                                                                                         |
|                                                      |                              | AS/NZS 4360:1999 Risk treatment process                                                                  |                                                                                         |
|                                                      |                              | CAN/CSA-Q850-97 Q850 Risk management decision making                                                     | Canadian Standards Association (1997)                                                   |
|                                                      |                              | Risk management process                                                                                  | Association of Insurance and Risk Management <i>et al.</i> (2002)                       |
| Regulatory frameworks for risk-based decision making | Water safety                 | Framework for the management of drinking water quality                                                   | National Health and Medical Research Council (2002) [Australia]                         |
|                                                      |                              | Guidelines for drinking water quality (Draft)                                                            | World Health Organization (2004)                                                        |
|                                                      |                              | Public health risk management plan for drinking water supplies                                           | New Zealand Ministry of Health (2001)                                                   |
|                                                      | Capital maintenance planning | Common Framework for capital maintenance                                                                 | UK Water Industry Research (2002)                                                       |
| Corporate frameworks for risk management             | Enterprise risk management   | Enterprise risk management framework (Draft)                                                             | Committee of the Sponsoring Organizations of the Treadway Committee (2004)              |
|                                                      |                              | ‘Stepping stones’ along the enterprise-wide risk management journey                                      | Deloach (2000)                                                                          |
|                                                      |                              | ‘Launch-pad’ to enterprise-wide risk management                                                          |                                                                                         |

That is not to say that high level frameworks may not be useful to these companies. One utility manager claimed how his company had not only developed their own high-level framework, establishing a consistent approach to risk-based decision-making, but had also produced sets of accompanying documentation, containing more specific, low-level information necessary for its implementation across different departments within its organisation.

Ultimately, therefore, for many water companies, there would appear to be at least some scope for expanding the role of risk-based decision-making frameworks within their business. For this to happen effectively the industry may first need to consider the following questions:

- what is the practical value of using frameworks in risk based decision-making, both in terms of making these decisions better and more credible?
- how should such frameworks be designed and used – do they provide a rigid procedure for decision-making or merely act as a guide?
- how these should be better embedded within organizations.

### **Risk tools and techniques**

A comprehensive review of frameworks for the management of SHE risks was detailed in Jardine *et al.* (2003). Based on a study 12 frameworks, they identified seven key elements that should be included in a comprehensive framework for human health, ecological and occupational risk assessment and management:

- a problem formulation stage;
- stakeholder involvement;
- communication;
- quantitative risk assessment components;
- iteration and evaluation;
- informed decision-making;
- flexibility.

Perhaps the only one of these that is questionable, at least when considering these from a water utility perspective is the necessity for quantitative components in risk assessments. Although quantitative risk data can obviously be an asset when assessing public health risks, some of the most popular and most effective risk assessment tools used by water companies are qualitative in origin (such as the risk ranking systems used by Deere *et al.*, 2001, Leverett, 2003, and Lifton and Smeaton, 2003). These may be especially valuable where data may be limited, or if used a first step of a longer ‘tiered’ risk assessment process. An example of such an assessment as applied within the water industry is presented in Radovanovic and Marlin (2003). This was conducted to prioritise expenditure within Sydney Water’s programme of water mains rehabilitation and comprised three assessment tiers increasing in complexity and cost: (i) risk screening using a simple likelihood-consequence risk ranking process; (ii) a quantitative risk analysis using a generic probabilistic model (KANEW); and (iii) a more focused programme of site-specific monitoring and data analysis.

Many other examples of quantitative tool use in the water industry can be found in the literature. For example, Rothstein and Kiyosaki (2003) describe how the Honolulu Board of Water Supply uses both sensitivity analysis and scenario planning to evaluate different investment options in their ‘portfolio management’ system. Similarly, Monte Carlo simulation tools such as @RISK<sup>TM</sup> or Crystal Ball<sup>TM</sup> can be used in project risk evaluations (Pollard, 2001) or in predicting the levels of risk posed to communities by microbial pathogens in drinking water supplies (Haas *et al.*, 1999) A thorough review of these and other tools will be

published separately (Macgillivray *et al.*, 2005). The relative merits of quantitative and qualitative tools are summarized in Table 2.

**Table 2.** Comparison of quantitative and qualitative risk assessment tools

| <i>Quantitative</i>                       | <i>Qualitative</i>                        |
|-------------------------------------------|-------------------------------------------|
| Objective                                 | Subjective                                |
| More complex                              | Simpler                                   |
| Resource intensive                        | Less resources required                   |
| Use depends on data availability          | Useful when data is scarce or unavailable |
| Value depends on data quality             | Value depends on quality of judgement     |
| Provides more effective scenario analysis | More suited to single point analysis      |
| Can model interactions between risks      | Tends to view risks in isolation          |

Advocates of ‘good risk management practice’ such as Deloach (2000) and Jardine *et al.* (2003) point to the use of quantitative tools as indicative of a more sophisticated risk management programme (Table 3). This is also reflected in the Cranfield capability maturity model for risk management which stipulates that, for a company to achieve a high level of maturity (Level 4) in risk management, it should have “*a broad range of qualitative and quantitative tools that are available and applied*”.

**Table 3.** Quantitative and qualitative tools (adapted from Deloach, 2000)

| <i>Degree of sophistication</i> | <i>Risk measurement / analytical technique</i>                 |
|---------------------------------|----------------------------------------------------------------|
| High                            | Statistical analysis (probabilistic models)                    |
|                                 | Scenario analysis/simulation                                   |
|                                 | Sensitivity analysis                                           |
|                                 | Position reports (exposure measurement/volumetric measurement) |
|                                 | Risk rating and scoring                                        |
|                                 | Risk indicator analysis                                        |
|                                 | Group facilitated qualitative prioritization                   |
| Low                             | Individual qualitative self-assessment                         |

Interviews with risk managers highlighted that, for the most part, it is qualitative tools which form the mainstay of water companies’ risk assessment programmes. Concerns raised over the suitability of quantitative tools included

- perennial problems with data quality;
- the lack of skills and resources to dedicate to complex tools (especially in smaller water companies);
- the lack of available data (especially for distribution systems).

Although not just the preserve of quantitative risk assessment techniques, several managers also highlighted their mistrust of numerical systems where “*the numbers are only useful if you knew what’s driving them*”. Such systems may also give rise to credibility and transparency problems: “*...People are very adept at manipulating numbers to give them the answers they want, to push their own*

*projects forward*". On a similar theme, several practitioners also expressed dissatisfaction with some 'off-the-shelf' software packages which *"gives them the answers before they have the questions"* and which also *"relieves people of their obligation to really analyse what they're doing"*.

A key issue for water companies is to examine where the role of quantitative tools can be expanded both in terms of their development and their transfer across into new business areas. Or conversely, if there remain significant and lasting barriers to the implementation of these tools, then these need to be highlighted and, where possible, addressed.

### **Promoting an integrated approach to risk management**

As highlighted earlier, a key challenge for many utilities is to develop risk tools, techniques and framework that can be consistently applied across different departments of their business, allowing for a read-across of information in an 'integrated' approach.

In England and Wales, for example, water companies are being encouraged to adopt a risk-based approach in different areas of their regulated business, notably in the development and implementation of water safety plans (UK Water Industry Research, 2003) and Distribution Operation and Maintenance Strategies (Drinking Water Inspectorate, 2002). Risk analysis is also being advocated by the financial regulator, Ofwat as a means to prioritise future capital maintenance (Office of Water Services, 2001). Because of the similarity of the risk scoring systems used in these initiatives, it would be sensible for a company to standardize its approach as much as possible.

To this end, many companies are developing their own multi-attribute asset-scoring systems. One potentially very useful system developed by Scottish Water to more effectively manage its assets is presented in Lifton and Smeaton (2003). Here, an inter-related asset risk and criticality scoring mechanism aims to assess the 'total business impact' of asset failures across the company in relation to its core business objectives. This is in essence a source-to-tap FMECA (Failure Mode and Effects Criticality Analysis) approach but with the addition of a business impact scoring system that assigns a points' score to different asset failure scenarios according to criteria such as loss of service, environmental impact, and loss of reputation. In this system one point is approximately equal to £1000 of adverse business impact. This provides what the authors refer to as a 'common currency of risk' that allows a consistent approach to risk scoring to be taken across the business. The result is an integrated system that extends across strategic, programme and operational levels of the business, with the same tools used to prioritise capital investment, plan capital maintenance, as well as develop plant maintenance schedules to minimise the risk of electrical and mechanical failure.

In interviews, when asked about what improvements risk managers would most like to make to their risk management programme, many stressed the need for a greater business-wide integration in their approach, especially across the water and wastewater parts of their business. At least one manager interviewed believed that they were succeeding in this task:

*"We have a standard severity scale which allows us to compare any asset in a system with any other in the system. So we actually compare risks straight across the board now, within clean water and likewise on the wastewater side....And where we're trying to move towards is trying to balance and calibrate between the two...so that we can switch resources either from clean to waste or vice versa....Aligning the scales is something we've spent quite a lot of work on..."*

Other factors highlighted by interviewees that can also be important in integrating risk management practice include

- using a common ‘language of risk’;
- using frameworks to standardize risk management procedures and methodologies;
- appointing trained staff to coordinate risk activities;
- adopting an integrated approach when setting risk acceptance criteria or ‘thresholds’.

The strongest critics believe risk management to have become a resource-intensive ‘cottage industry’ within certain organizations. In terms of developing and implementing asset scoring systems such as those described, it is evident that this can place a heavy demand on resources. One risk manager commented how setting up of such a system required much time and effort initially but reaped rewards in the end. Obviously this may still create challenges for water companies, especially smaller ones.

Ultimately, as with risk analysis tools and frameworks before, there are practical issues to tackle such as

- the practical value of asset scoring systems in making decisions better and more credible.
- how best to design such as system
- how and where risk information can be read-across to other parts of a utility’s business.

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