Bayesian Belief Networks in business continuity management

By Patrick Roberts

Introduction

Bayesian Belief Networks (BBNs) have existed in the academic literature for many years but were of limited practical utility until the emergence of powerful PCs and specialist software such as *MSBN* and *Belief Net*. As the name suggests, they provide a method for integrating beliefs and hard facts in a logically consistent manner – a central theme in many areas of risk management. In recent years they have become widely used in operational risk management within the financial services sector and this short article explores the potential for applying BBNs in business continuity management.

Basic scenario

The use of BBNs will be illustrated by a simple scenario where the probability of a fire occurring in a warehouse over the course of a year is based on two factors:

- The proportion of time that flammable materials are stored in the warehouse; and
- Whether the sprinkler system is working or not.

We start with the following figures, based on actual data:

- Flammable materials are stored in the building 75% of the time;
- The sprinkler system is working 99% of the time (eg from the manufacturer's specification);

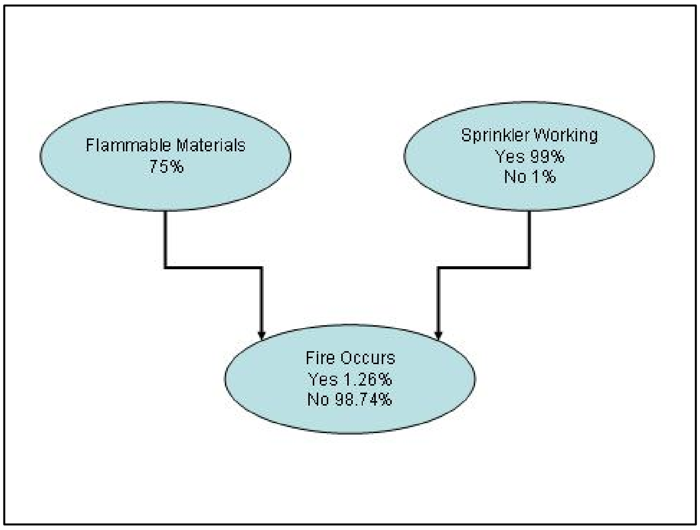
and combine these with the following beliefs:

- If the warehouse contains flammable materials we believe that there is:
    - A 1.5% chance of a fire each year if the sprinkler system is working
    - A 2.5% chance if the sprinkler system is not working
- Even if there are no flammable materials in the warehouse we believe there is still:
    - A 0.5% chance of a fire each year if the sprinkler system is working
    - A 1.5% chance if the sprinkler system is not working

In this simple scenario, the probability of a fire can be calculated as follows:

Flammable Materials	Sprinkler Working	Probability	Likelihood of Fire	Probability x Likelihood
Yes	Yes	74.25%	1.5%	1.114%
Yes	No	0.75%	2.5%	0.019%
No	Yes	24.75%	0.5%	0.124%
No	No	0.25%	1.5%	0.004%
Total				**1.261%**

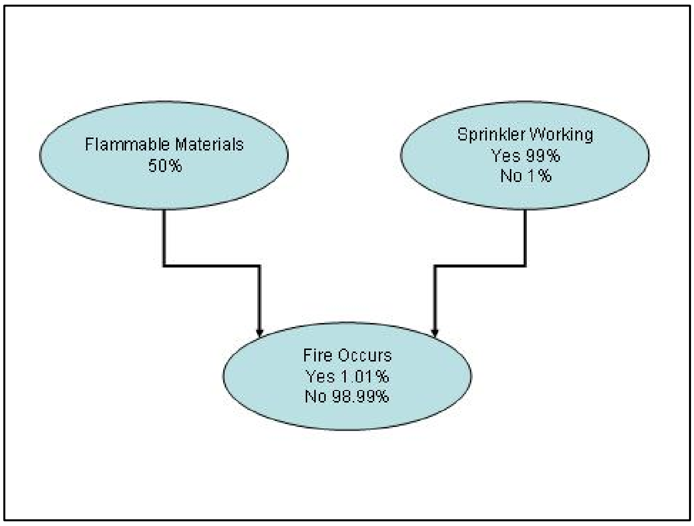
The same situation is represented below as a Bayesian Belief Network (BBN). It consists of a series of nodes representing random variables, connected by arrows which indicate dependencies between variables.

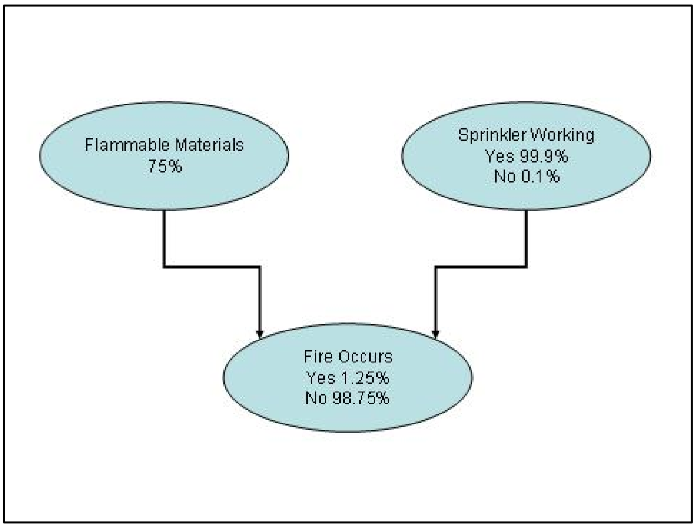


This may not seem very profound but already, by simply presenting the probabilistic data in a graphical format (instead of the complex list of data and beliefs given above); we have begun to facilitate a more rational discussion of risks and their drivers.

Scenario analysis

A more useful application of BBNs is for conducting scenario analysis eg to see what the effects of reducing the amount of time that flammable materials are stored on site, or improving the reliability of the sprinkler system, would be. Rather than simply quantifying risks, the BBN now becomes a tool for actively managing risk. As can be seen below, reducing the proportion of time that flammable materials are stored can significantly reduce the probability of a fire (from 1.26% to 1.01%), whereas improving the reliability of the sprinkler system has only a very marginal effect. We can immediately conclude that spending considerable sums on a top-of-the range sprinkler system does not represent great value for money.

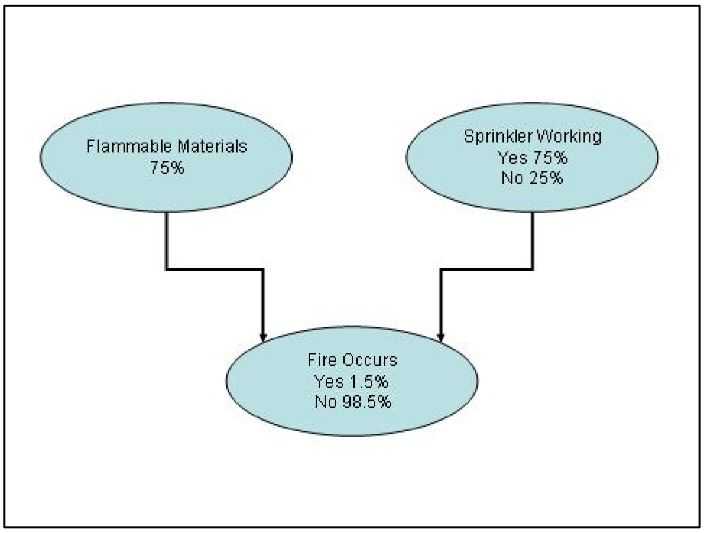




Uncovering the unseen

In fact this is still only the very tip of the iceberg: the real power of BBNs derives from the fact that information can be propagated 'backwards' as well as forwards. That is to say, one can incorporate the evidence of direct observations (incidence of fires) as they occur and use this data to update our knowledge of things that cannot be directly observed (whether the sprinkler system is working). This can be an extremely powerful tool to understand and actively manage risk drivers.

For instance, if an insurance company insured many clients similar to the one described in the basic scenario it could begin to compile statistics of the true incidence of fires in their warehouses. Suppose that over the course of a few years they discover that, whilst the proportion of time that flammable materials are stored remains at 75% as before, the actual incidence of fires is 1.5% per warehouse per year. One can then set the output of the BBN to 1.5% and work out the true reliability of the sprinkler systems as shown below. This modest increase in the incidence of fires actually represents a very significant deviation from the manufacturer's specification.



Conclusions

BBNs are a powerful and intuitive tool that can assist in the BCM process in a number of progressive stages:

- At their most basic, BBNs provide a straightforward way of presenting risks and risk drivers when conducting a risk assessment;
- BBNs can also be used to conduct scenario analysis in order to identify the most cost effective ways to manage risks; and
- Finally, as data is gathered on the real incidence of disruptions, BBNs can be used 'in reverse' to update our knowledge of things that cannot directly be observed.

Further Reading

"Operational Risk: Regulation, Analysis and Management", Carol Alexander (Ed), FT Prentice Hall, 2003.

"Financial Times Mastering Risk – Volume 1: Concepts", Carol Alexander (Ed), Prentice Hall 2001.

"Operational Risk with Excel and VBA", Nigel Lewis, Wiley 2004.

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