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Operational Risk Modeling: Current Approaches and New Frontiers

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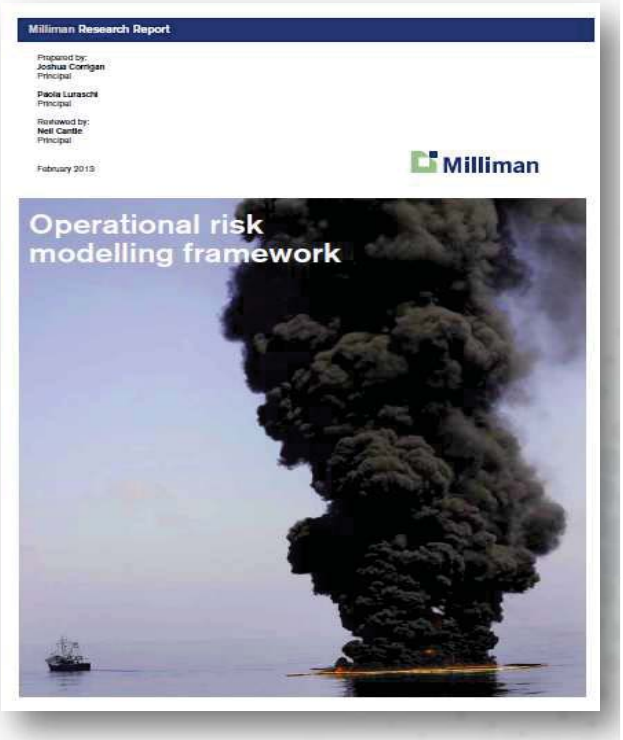
From the Ugly, through the Bad, to the Good

MODELLING APPROACHES

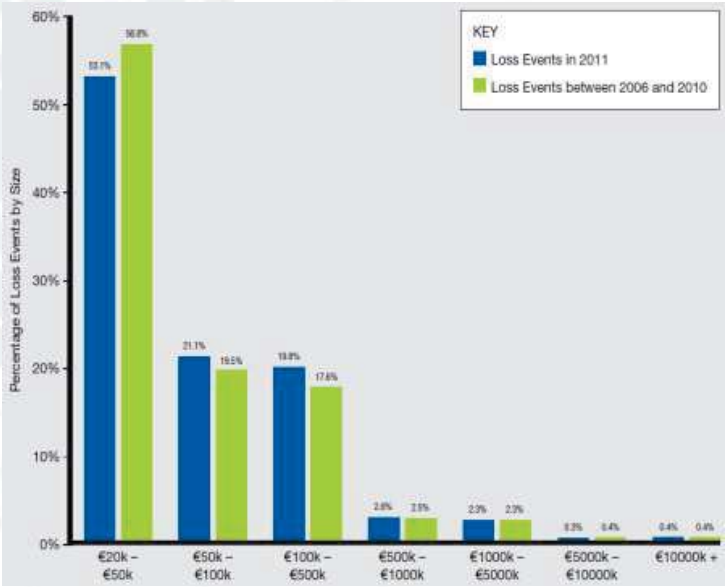
Milliman Research Report

- Recently published global research report,
  - Available for download at http://au.milliman.com/perspective/operational-risk-modelling-framework.php
- All developed markets
- Current and emerging techniques
- Operational risk assessment is a hot topic in the finance industry and coming under increasing stakeholder scrutiny

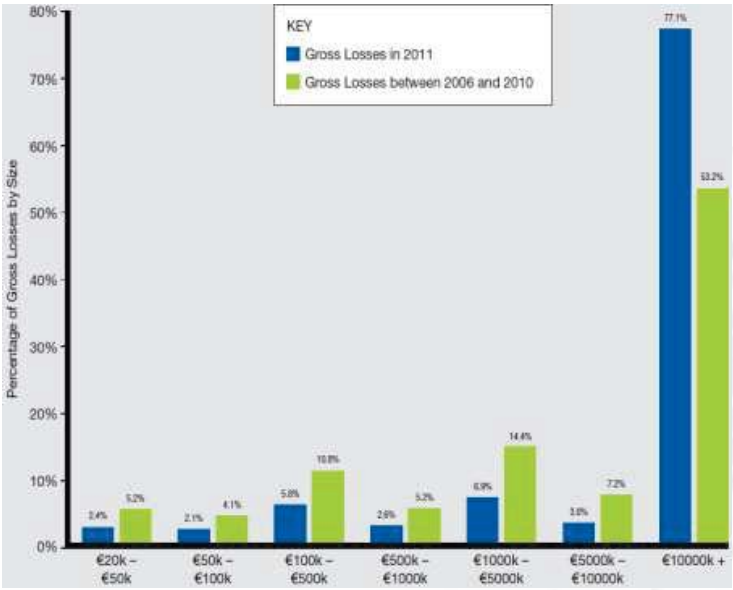


Nature of Operational Risk Events

Distribution of Number of Events by Size (ORX)



Distribution of Total Gross Loss by Size (ORX)



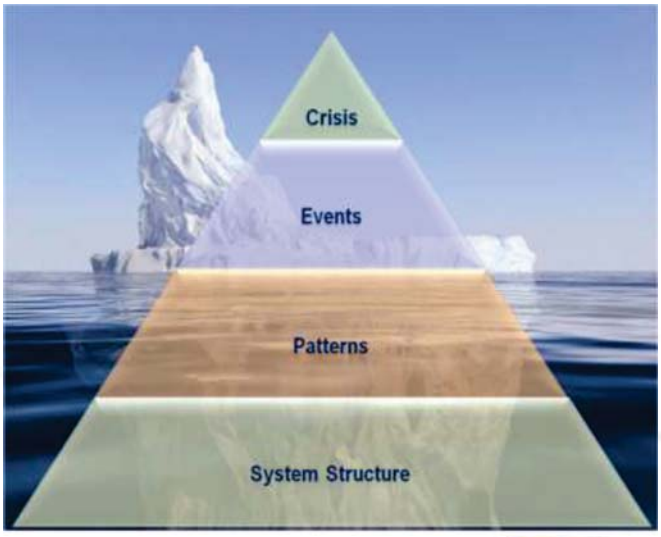
Model Framework Choices

Risk identification, assessment, monitoring, mitigation, appetite etc. all depend upon the perspective taken.

Traditional and statistical frameworks focus mainly on above the water line items, appropriate for stable systems.

New complex systems based frameworks focus on dynamic non-stable systems, embracing:

- Holism
- System drivers and dynamics
- Non-linearity
- Human bias
- Emergence



Basic Indicators

Standard Formulas

Scenario Analysis

LDA

Causal Models

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Basic Indicator and Standard Formula

Operational risk capital scales in line with broad business metrics such as:

- Gross income
- Premiums, claims, expenses
- Liabilities, Assets / AUM
- Capital

Assumes stable loss generation mechanisms (LGM)

Simple, transparent, cheap, but… main problem is that it isn't linked to the LGM itself !

- Rough proxy only
- No incentive to manage op risk
- Enables gaming of the system

Country / Sector	Indicator	Factor (indicative)
Global, Basle II	Gross income	12% to 18%
EU, Solvency II	BSCR, premiums, liabilities, expenses	Capped at 30% of BSCR + 25% UL expenses
Australia, LAGIC	Premium, liabilities, claims	Varies for Life vs General; function of size
Japan, SSR	"BSCR"	3% if P&L < 0 2% if P&L > 0
South Africa, SAaM	BSCR, premiums, liabilities, expenses	Varies for Life vs General; Floored at 30% of BSCR + 25% UL expenses
Taiwan, RBC	Premiums, AUM	0.5% life, 1% annuity, 1.5% other, 0.25% AUM
USA, Europe ex EU, Other Asia, Russia, NZ	None!	

Scenario Analysis

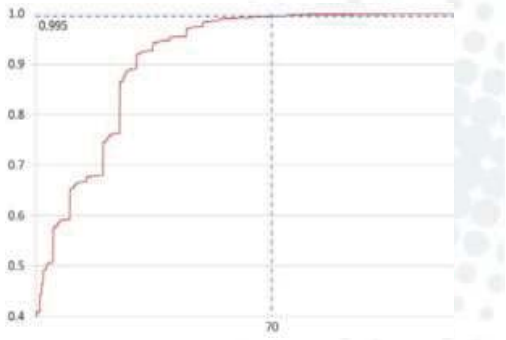
Common method used

Forward looking and transparent, but suffer from:

- selection bias
- Point estimates – no uncertainty
- the when to stop problem
- human bias (e.g. 1 in 1000 event?)
- rubbery inter-relationship assumptions
- lack of uncertainty
- allowance for complexity
- no ability to use inference
- dangerous as it feels like something has been done, but in reality it is not very meaningful

1. Hypothesize loss severity and likelihood of possible scenarios
2. Generally assume scenario independence, use generalized binomial distribution to estimate loss distribution and thus capital (VaR / CTE).
3. Or assume linear dependence, use correlations

SCENARIO	SEVERITY (M)	LIKELIHOOD (P.A.)
1	5	5.00%
2	10	1.00%
3	1	3.00%
4	10	1.00%
5	10	1.00%
6	10	5.00%
7	20	5.00%
8	5	5.00%
9	5	5.00%
10	30	0.50%
11	25	0.25%
12	75	0.10%
13	10	0.10%



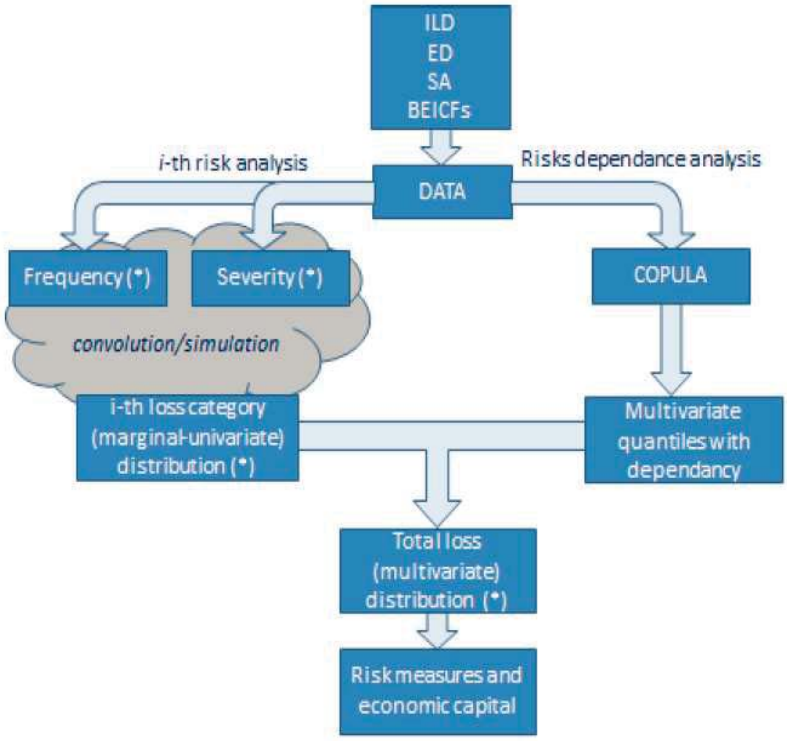
Loss Distribution Approach

Basle II allows for the use of an Advanced Measurement Approach (AMA) with regulatory approval.

Current common practice in leading AMA banks

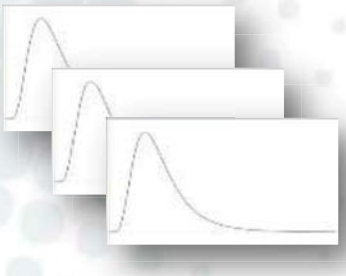
Distribution calibration leverages multiple data sources:

- Internal loss data (ex-post)
- External loss data (ex-post)
- Scenario analysis (ex-ante)
- Business environment and internal control factors (ex-post, current, ex-ante)



Aggregation Issues

- Typically simulate the compounding effect of variation and uncertainty through statistical models with dependency structures (correlations, copulas)
- "Thing" being modelled is a complex adaptive system, exhibiting emergence, which means that historical data therefore irrelevant for many behaviours



$$\rho = \begin{pmatrix} 1 & \cdots & \rho_{1n} \\ \vdots & \ddots & \vdots \\ \rho_{n1} & \cdots & 1 \end{pmatrix}$$

Models are not often used to understand "modal" behaviours…they are used to understand extremes. But the mechanisms of these behaviours are likely to be different to those seen often and are likely to adapt over time. Emergent behaviour requires us to focus on interactions, but these modelling methods artificially set these.

Unravelling Operational Risk

Bridging the gap between "modelling" and "managing"

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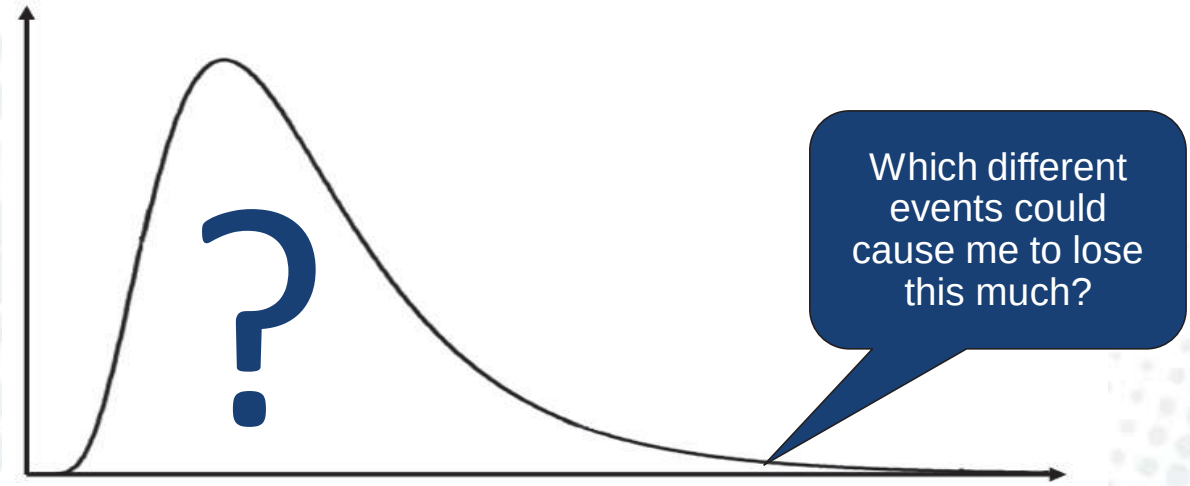
Prediction ≠ Explanation



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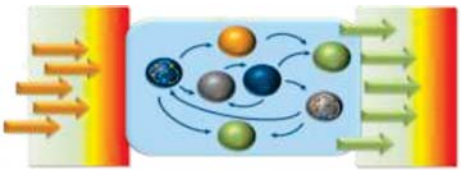
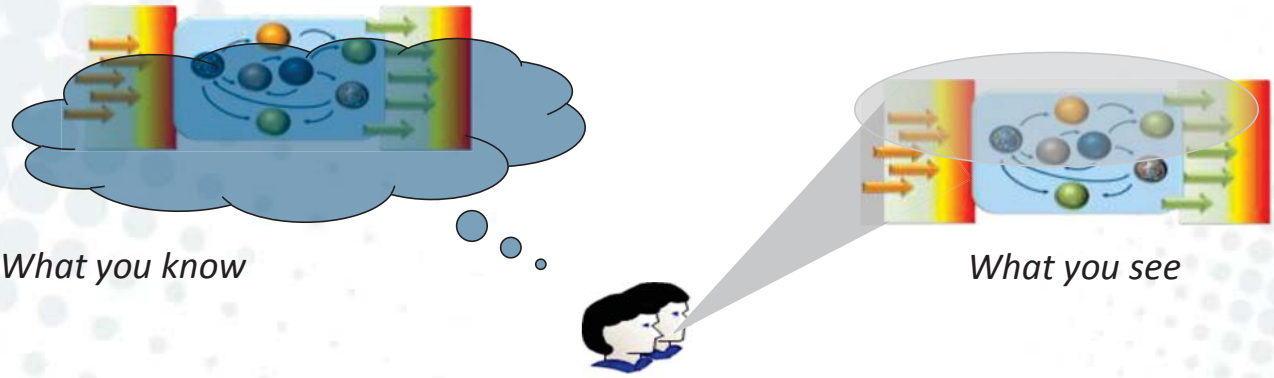
Paths to Enlightenment



The Operational System



What you know

What you see

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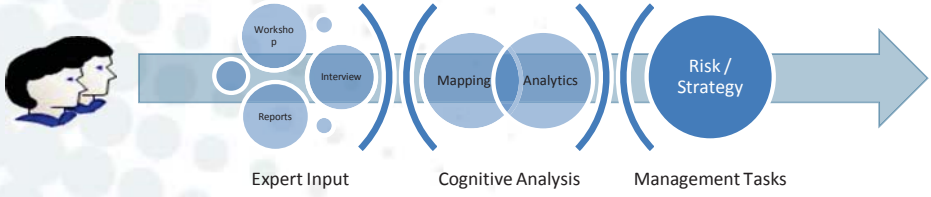
Cognitive Analysis

Capturing What People Know

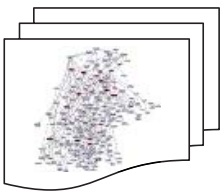
Input is captured through discussion with experts and key stakeholders.

Workshops or interviews permit them to explain their understanding of complex business dynamics.



Logical and structured nature of analysis provides input to a wide range of risk management tasks.

Information is structured as a cognitive map and analysed using a combination of mathematical and psychology techniques.



Key features and dynamics objectively and rapidly determined.

Analysis is particularly helpful for describing "hard" risks which involve many factors and complex adaptive behaviours.

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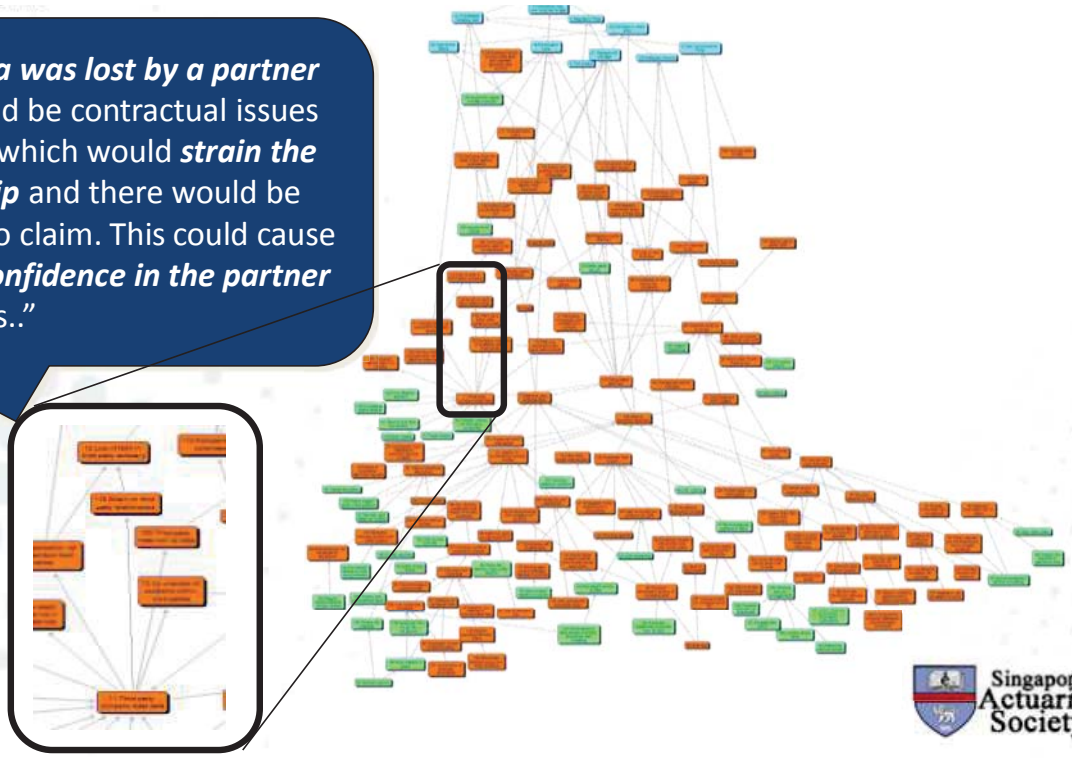
Describing the Operational Risk System

"If the ***data was lost by a partner*** there would be contractual issues to resolve which would ***strain the relationship*** and there would be damages to claim. This could cause a ***loss of confidence in the partner*** themselves.."



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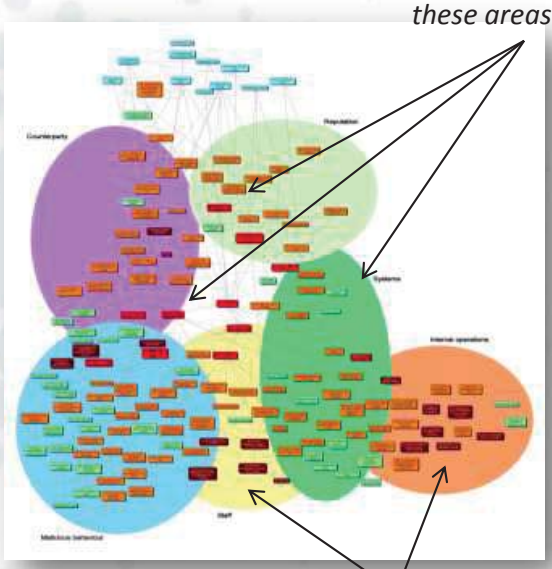
Describing Real Uncertainties

Scenarios must move through these areas



Scenarios must start in these areas

Winner of Award for "Practical Risk Management Applications" at ERM Symposium 2013

- Scenarios derived from an understanding of the actual mechanisms producing risk in company
  - Extreme dynamics
  - Causal flows
  - Build up of factors

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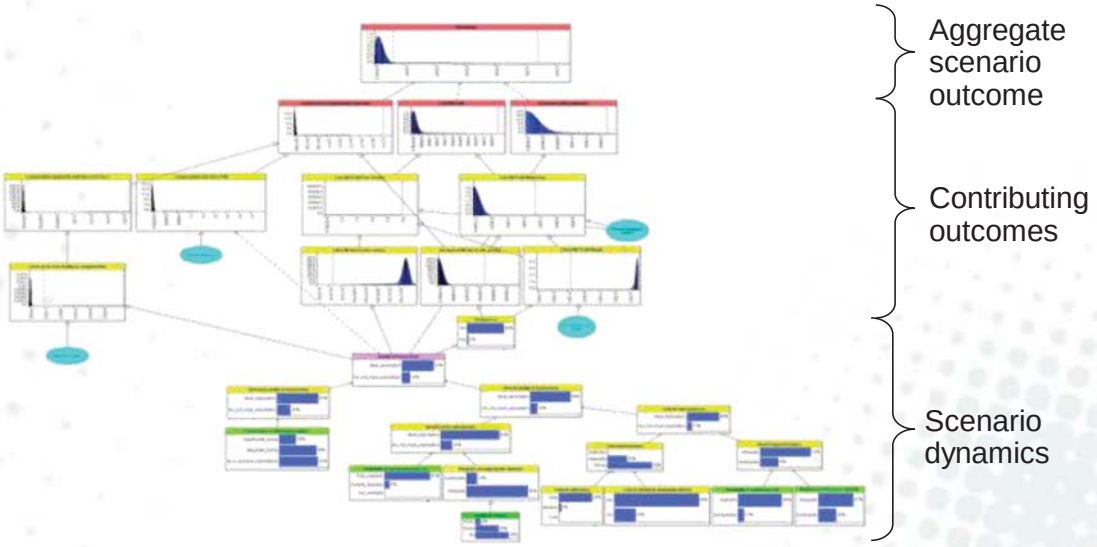
Bayesian Network Models

Emerging Best Practice for Quantification

- Describing outcomes (e.g. capital) in terms of drivers means you can "explain" different outcomes in a real way
- No need for correlation (it is an output)



Source: Milliman, using AgenaRisk™

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Linking Outcomes to Business Drivers

STRUCTURED MODELLING CASE STUDY

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A Case Study

- We will illustrate the use of a structured approach to operational risk using a real case study based upon a Taiwanese life insurer
- Scope is with respect to sales risk
- The process involves the following steps:
  - Defining the scope
  - Workshop preparation
  - Conducting workshops
  - Constructing the cognitive map and analysis
  - Constructing the Bayesian Network model
  - Assessment and refinement

Scope and Preparation

Scope

- The client decides to tackle the sales risk of the agency and bank channel as it is a traditional focus of internal risk management yet there is no holistic measure process to assess and quantify the risk.

Workshop Preparation

- Functions invited – agency channel, bank channel, compliance and legal.
- In advance of the workshops, we collect and review the existing material associated with sales risk. This includes department KPI / KRI, risk registration, business plan, regulations and news.

Conducting Workshops

Conducting the workshops

- The workshops are scheduled for individual functions, and a summary session for these function heads.
- The attendees of the workshops covers middle and senior management so as to cover all relevant perspectives.
- All participants are encouraged to speak freely and explore the risk scenarios and factors which they think important.
- Facilitated discussion, capturing the causal drivers of the dynamics governing the current and potentially future risk issues

Workshop Structure

The workshop is structured below:

Identify Strategic Objectives

- Target sales level
- Company's vision and mission statement
- Brand profile and reputation

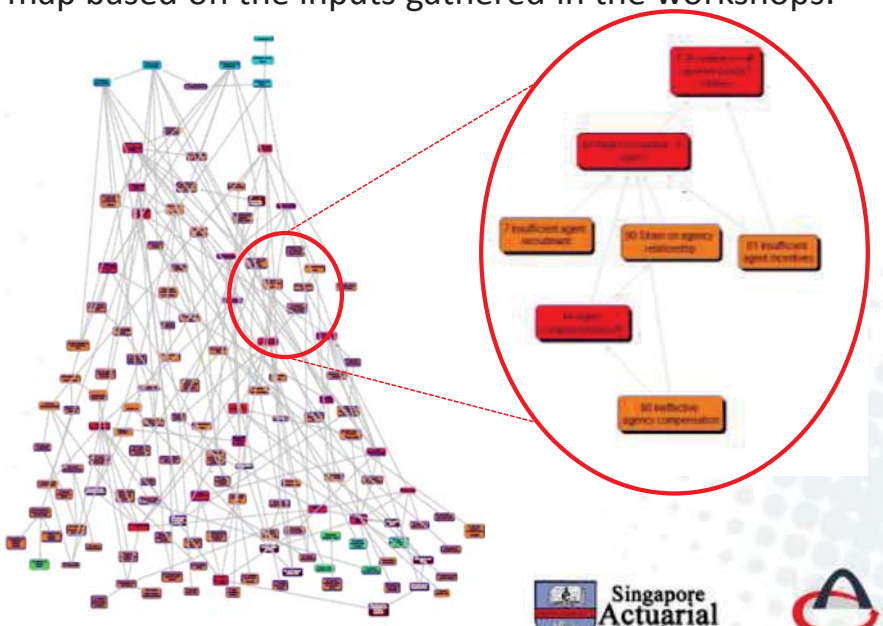
Discuss the risk factors / risk events which may cause the client failing to achieve the strategic objectives

- Agent fraud
- Market competition
- Sales force remuneration
- Control process
- Sales training
- Compliance checks

Cognitive Map

Next we construct the cognitive map based on the inputs gathered in the workshops:

- It's a visual representation of the complex interconnected narratives discussed by the business, built upon causal concepts (nodes) and causal links.
- The map is structured to show the risk drivers, controls and impacts.



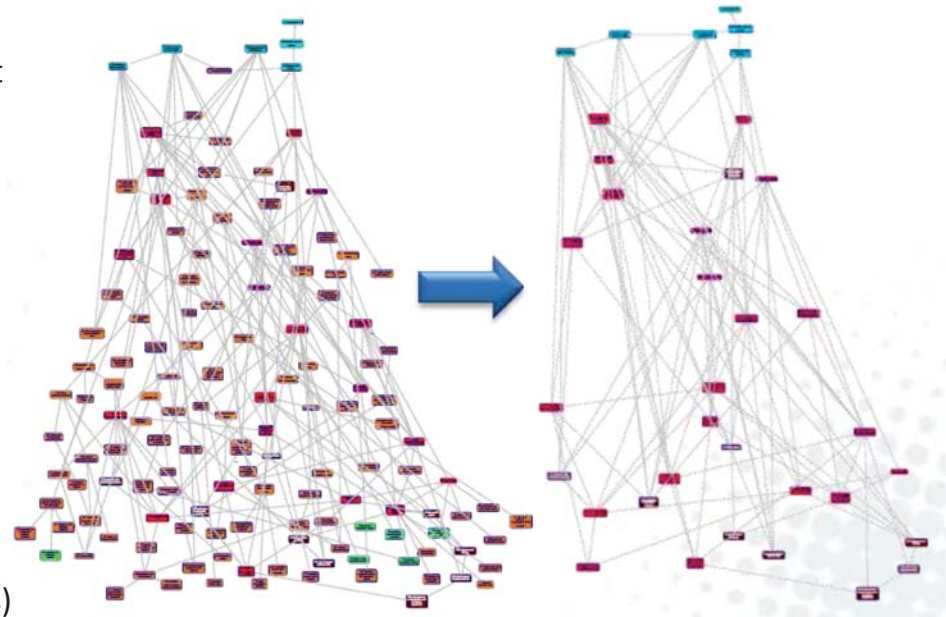
Cognitive Mapping Expertise

- In constructing the cognitive map, it is important to capture the complex inter-dependencies between the various narratives
- Some causal drivers may trigger several events or risks which should be explored during the workshops and described in the map.
- Sometimes there may be "gaps" in the narratives or between the concepts. It is necessary for review and refinement to fill the gaps.

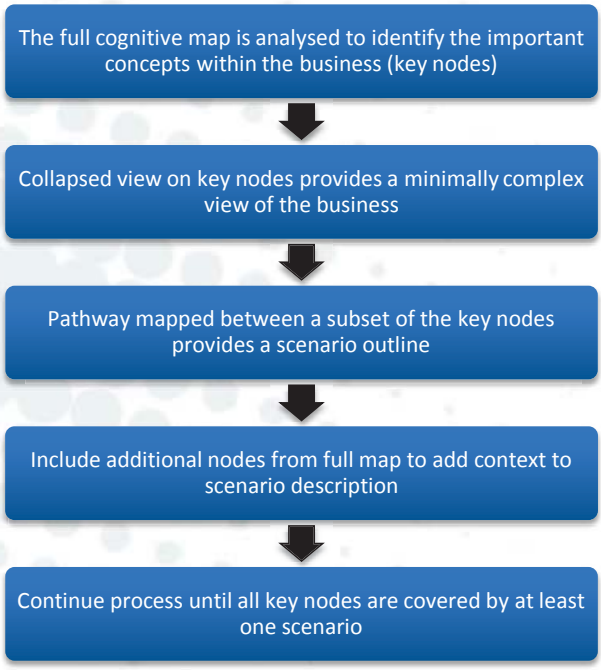
Network Analysis

Once the cognitive map has been built it is analysed to identify the key components

- Critical nodes:
  - Agent fraud
  - Mis-selling
  - …
- Potent nodes
  - Agent employment basis
  - Remuneration
  - …
- Impact nodes (strategic objectives)



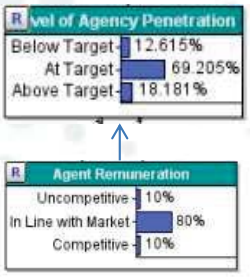
Constructing Structured Inter-related Scenarios



- We have identified around 5 scenarios to cover all the key nodes in sales risk assessment, which are:
  - Sales force training
  - Remuneration
  - Legal resources
  - Agent fraud
  - Product design
- These are the candidates for risk quantification in Bayesian networks.

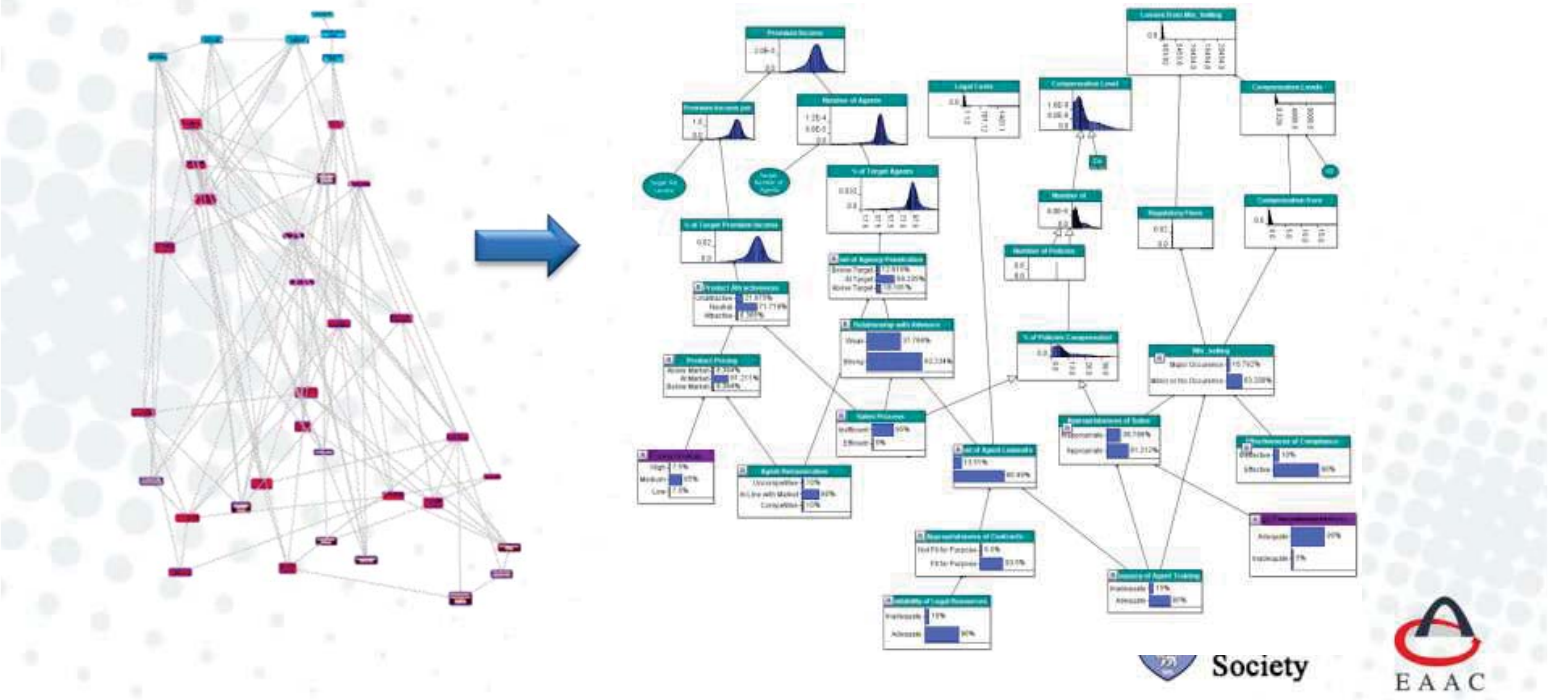
Quantification using Bayesian Networks

- The map indicates the key relationships (causal links) that need to be included in the model.
- Build the Bayesian Network with input from the business experts, supported by analytics wherever necessary.
  - Experts decide the states of each node. For simplicity, the number of states is ideally limited to 2 to 3.
  - Experts provide view on the distribution of the states in each node.
  - For example, agent remuneration has an impact on the number of sales force.



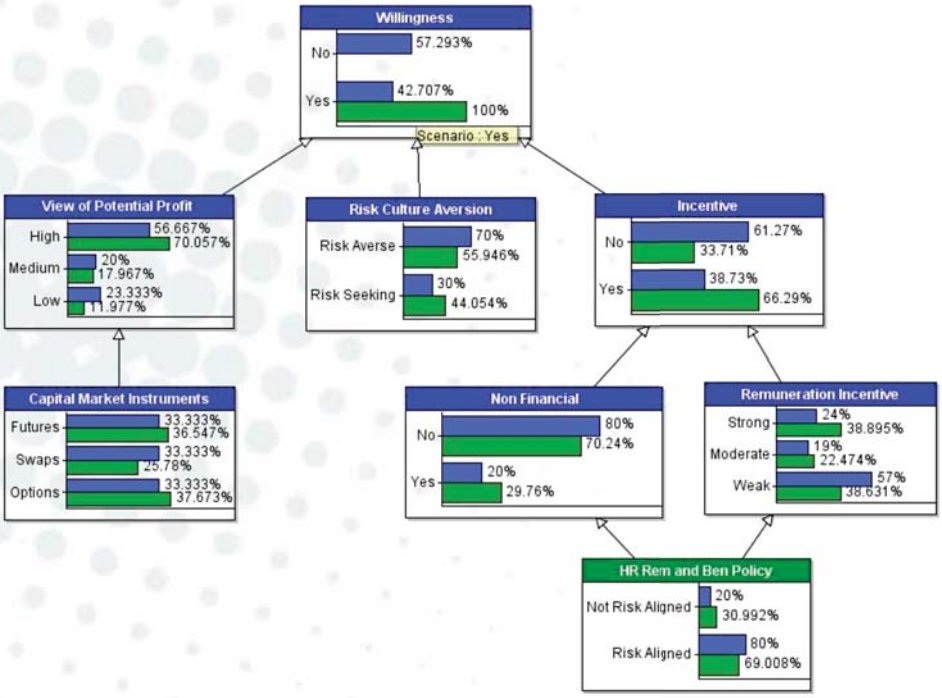
		Agent remuneration		
		Uncompetitive	In line with market	Competitive
		10%	80%	10%
Number of sales force	Below target	60%	30%	15%
	At target	30%	55%	65%
	Above target	10%	15%	20%

BN: Connecting Drivers to Outcomes



BN: Drivers of Rogue Trader Behaviour

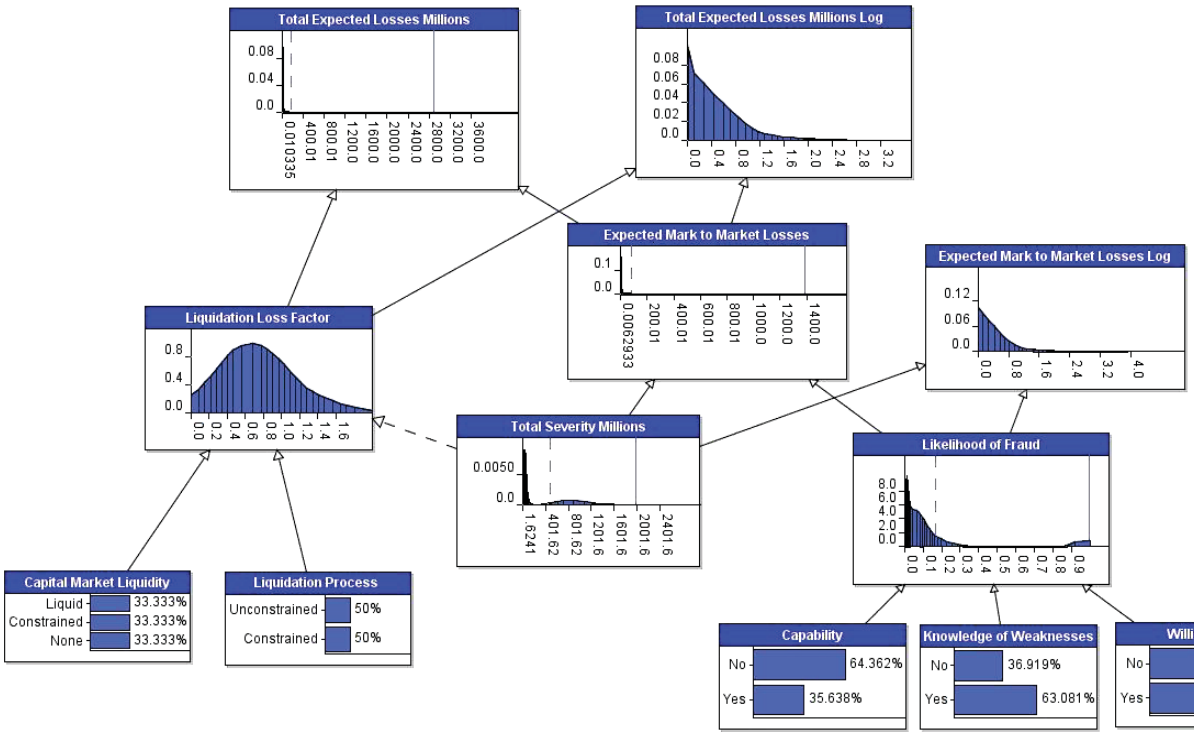
Willingness to Commit Fraud



- Capture uncertainty in states of each driver
- Capture non-linearities
- Significant increase in the *willingness to commit fraud* driven by:
  - Increase in the *view of potential profits* from committing fraud;
  - Decrease in *risk aversion*; and
  - Decrease in *risk alignment of HR remuneration and benefits policy*

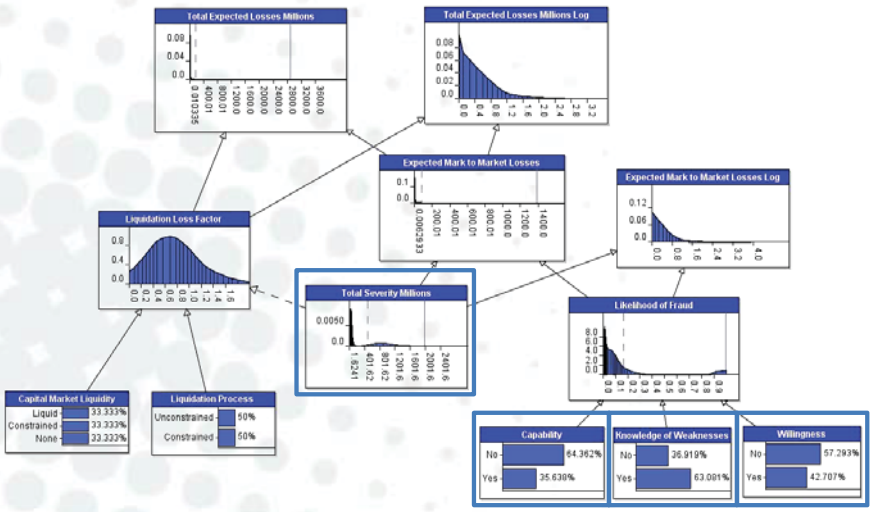
BN: Rogue Trader Loss Severity

Linking Discrete Business Drivers to Highly Discretized “Continuous” Loss Distributions

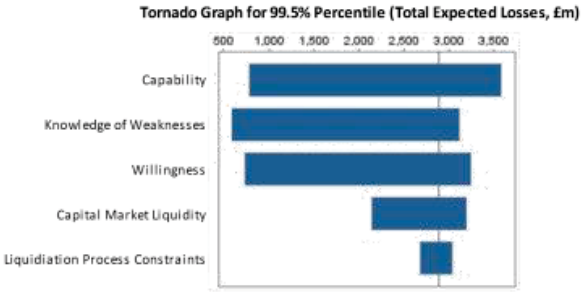


BN: Rogue Trader Scenario

Modelling the Expected Loss



- Model capture core drivers of exposure:
  - *Likelihood of fraud*
    - *Knowledge of Weaknesses*
    - *Willingness*
    - *Capability*
  - *Severity of fraud*
- Total Expected Loss:
  - *Mean*: ~ 0.2 billion
  - *99.5%:* ~ 2.9 billion
- Sensitivity Analysis:



Summary and Questions

- Cognitive mapping provides a mechanism for capturing business intuition in how causal risk drivers influence the uncertainty in business outcomes
- Bayesian networks can integrate risk indicators, causal drivers to tangible business outcomes in a quantitative framework, directly accounting for the uncertainty involved. It can capture the complex range of interactions that drive modal and tail outcomes. Calibration can leverage the combination of the best of expert judgment and data analytics wherever appropriate.
- Both these approaches facilitate reverse stress testing which can answer important management questions in a way that makes sense to the business.