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Operational Risk Modelling

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Principal, Milliman

Agenda

- Introduction
- Assessment Methods
- Delivering Business Value

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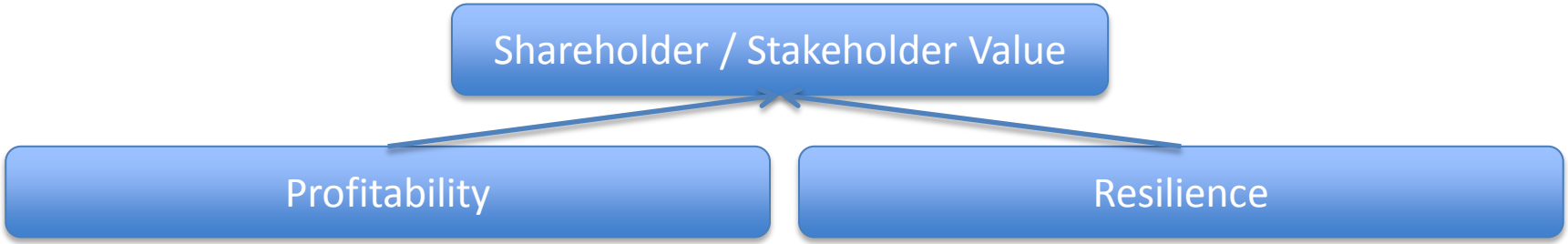
Section 1

INTRODUCTION

Milliman Research Report

- Just published global research report, authored by myself and Paola Luraschi (Milan) with input from global consultants
  - 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

Why Should We Care?

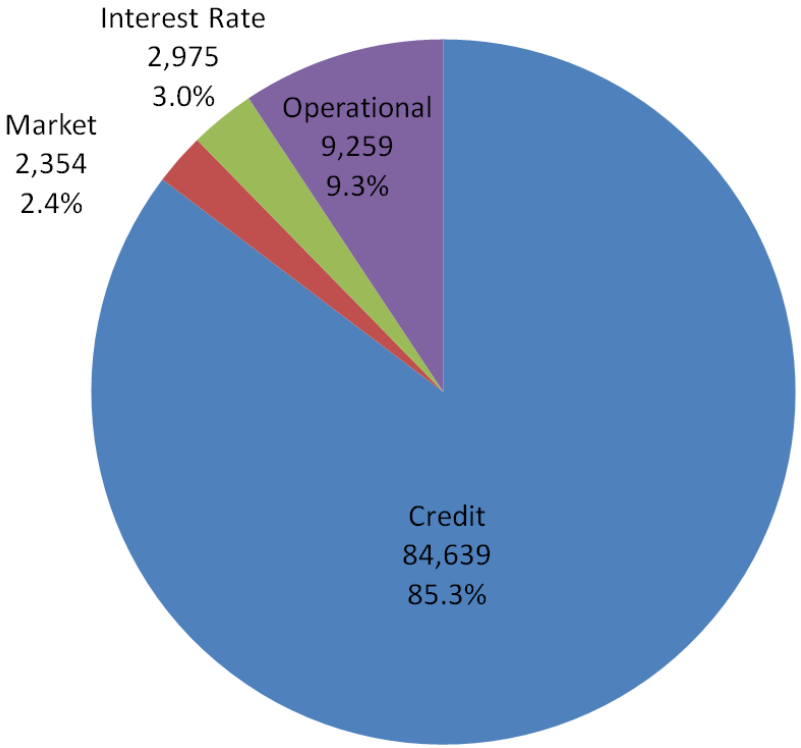


- Generate operational revenue
- Return on capital
- Resource allocation
  - Cost efficiency → margins / ROE
  - Relative decision framework
- Manage operational complexity

- Mitigate impact of op failures
  - Single high severity
  - Multiple complex events of moderate severity
  - Emerging operational risks
- Protect solvency for benefit of stakeholders

Operational Risk Capital

- Graph shows aggregate required risk capital of top 4 Aussie banks as at end-2012 (99.9% VaR in AUD Billions)
- Op risk capital approximately double the aggregate of interest rate and market risk
- Roughly, wealth management accounts for around 10% of this = $0.9 Bn



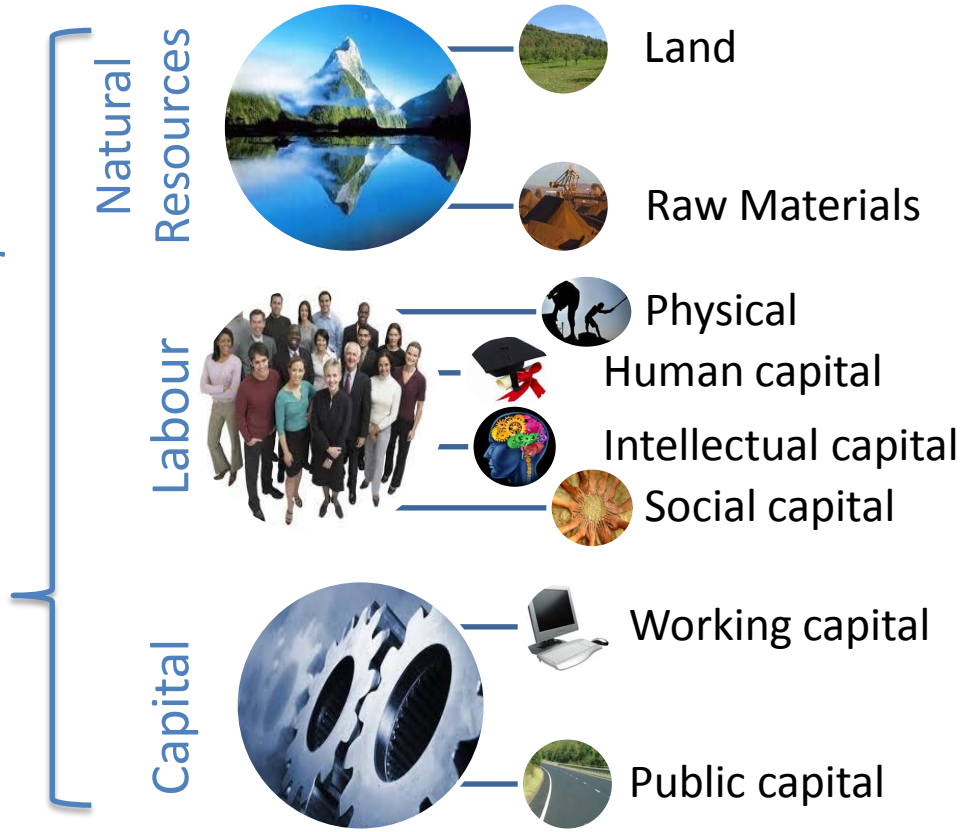
A Definition

Typical

"the risk of loss resulting from inadequate or failed internal processes, people and systems, or from external events"

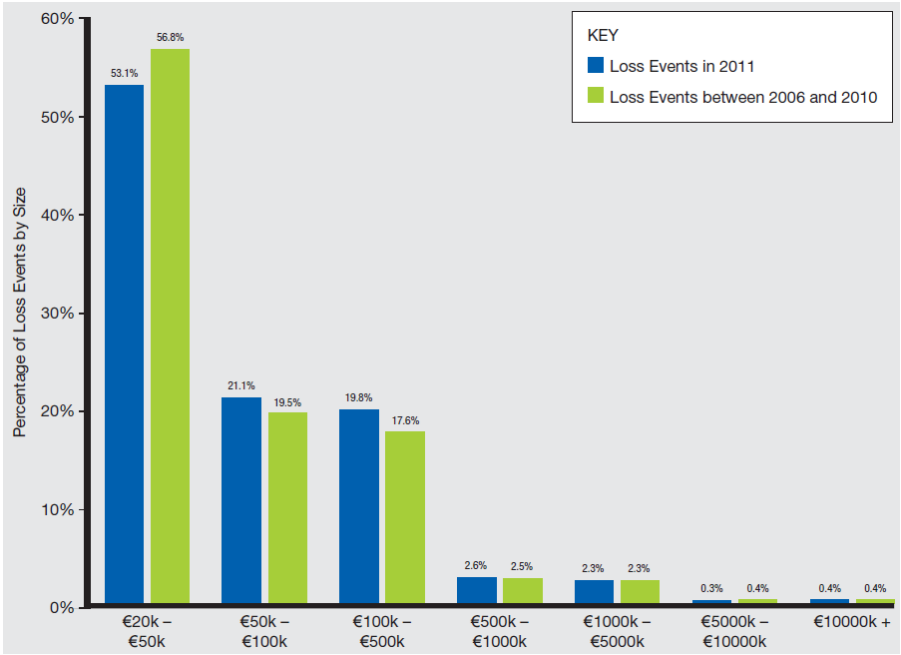
Fundamental

"the risk of loss resulting from inadequate or failed productive inputs used in an operational activity"

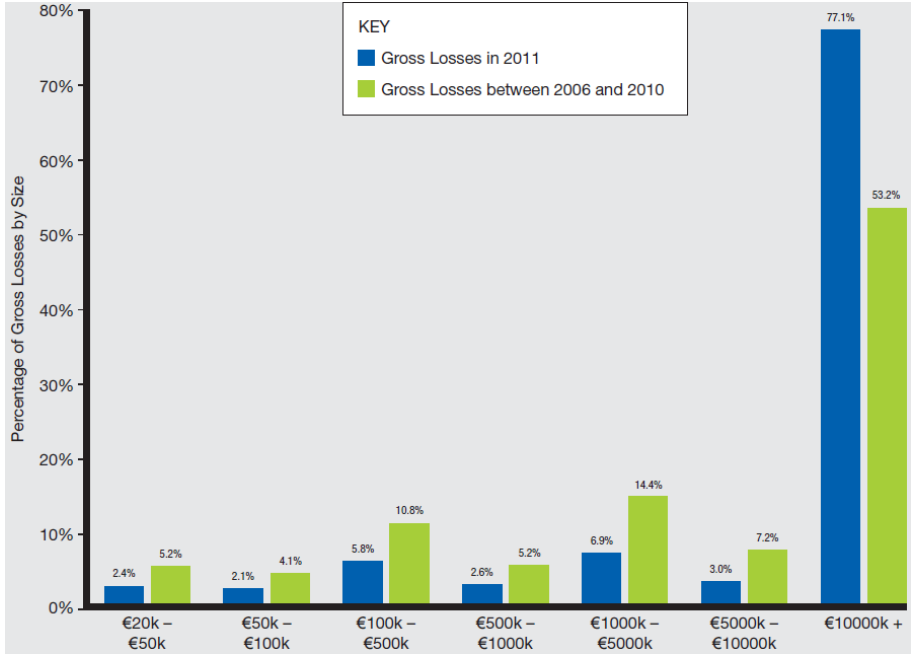


Nature of Operational Risk Events

Distribution of Number of Events by Size (ORX)



Distribution of Total Gross Loss by Size (ORX)



It’s not all financial though…

Industry	Low Severity High Likelihood	Medium Severity Medium Likelihood	High Severity Low Likelihood
Banking	ATM failures	Online security breach	Rogue trader
Insurance	Claims processing	Regulatory compliance failure	Mis-selling Mis-pricing
Mining	Transport service interruption	Environmental contamination	Mine collapse
Energy	Meter reading errors	Environmental contamination	Oil spill Gas plant fire

It’s all about the loss generation mechanisms, which are highly heterogeneous.

Is the system generating the LGM stable or dynamic?

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Section 2

ASSESSMENT METHODS

An Anthropological Study of Op Risk

1. Modeler meets “The Business”

2. “The Business” imparts wisdom

3. “The Business” is shown the model

4. “The Business” gets on with life

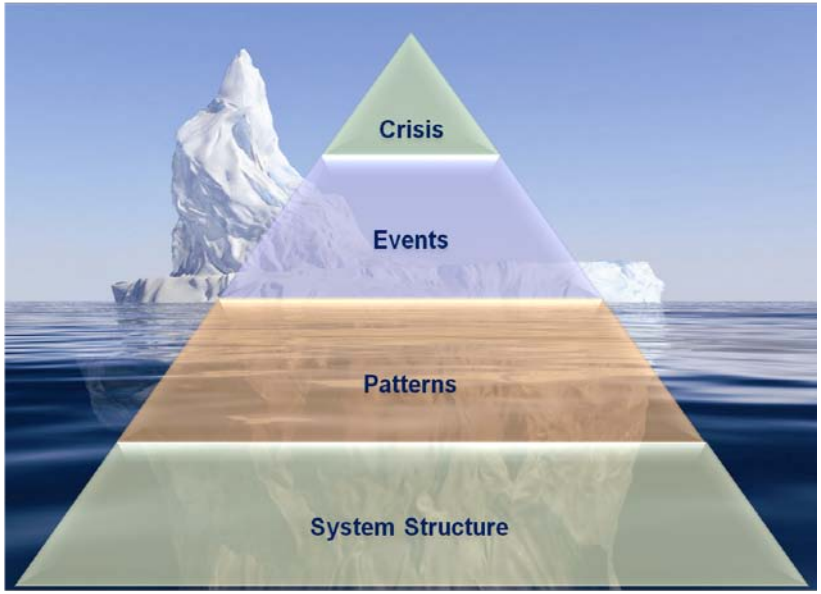
Model Framework Choices

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 systems, below the line items, embracing:

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



Basic Indicators

Standard Formulas

Scenario Analysis

Loss Distribution Approach

Causal Models

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	Floored at 30% of BSCR + 25% UL expenses
Australia, LAGIC	Premium, liabilities, claims	Varies for Life vs General
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!	

Quant Risk Assessment or Scenario Analysis

Common method currently used

Typical method used for Australian Superannuation entities (SPS 114)

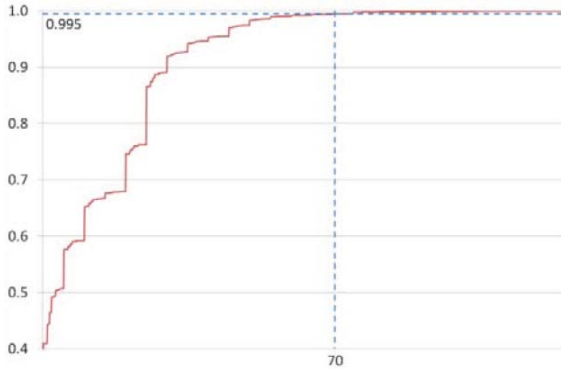
- ORFR must reflect the size, business mix and complexity of the entity's business operations

Forward looking and transparent, but suffer from:

- selection bias
- the when to stop problem
- human bias (e.g. 1 in 1000 event?)
- rubbery inter-relationship assumps
- lack of uncertainty
- allowance for complexity
- no ability to use inference

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%



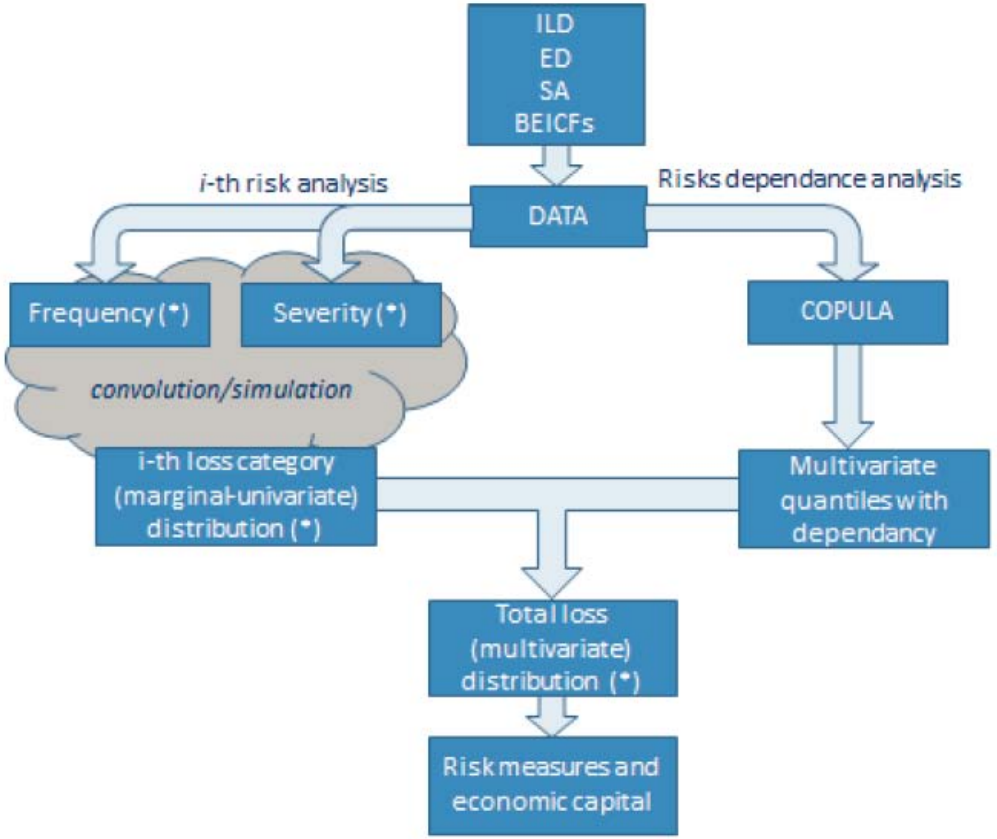
Loss Distribution Approach (LDA)

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

Current common practice in leading banks (including the big 4 in Aus).

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)



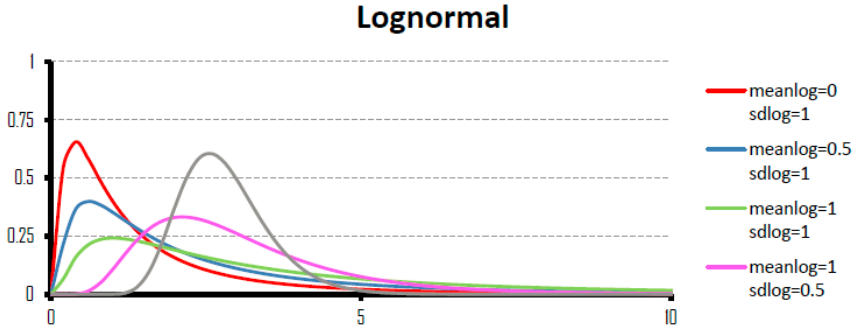
LDA Distribution Choices

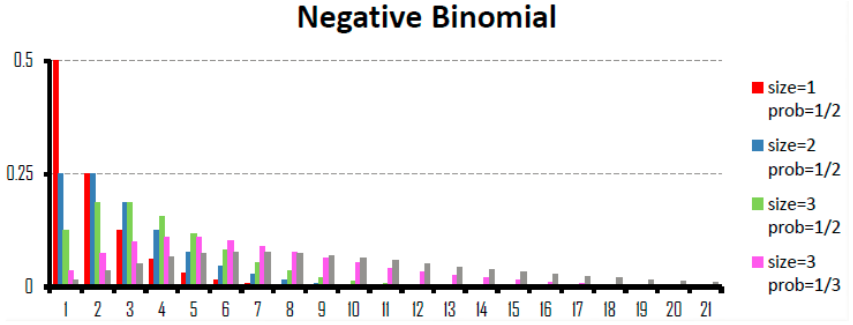
Severity Distributions

- Continuous: Lognormal, Pareto, Gamma, Weibull

Frequency Distributions

- Discrete: Poisson, Negative Binomial



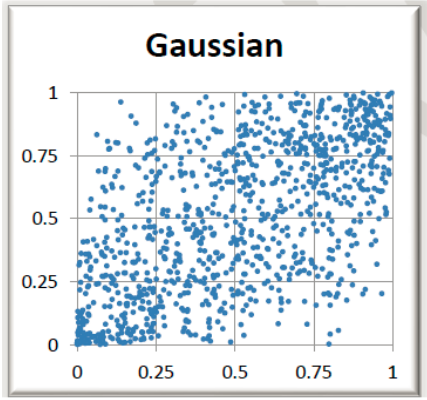


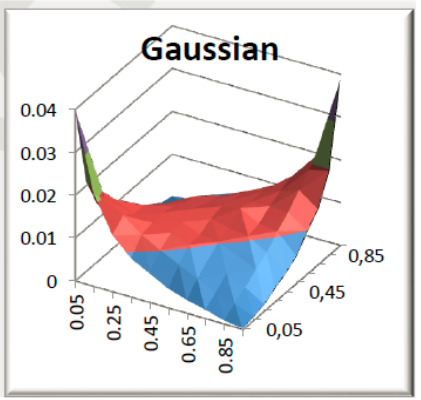
- Choice of prior distribution critical for low frequency events

Loss Inter-relationships

- Choice of segmentation drives inter-relationships
- Common to assume independence between severity and frequency at the segment level
- Aggregation across segments uses correlations or copulas
- Assumes stable LGM

- Correlations – linear
- Copulas – tail dependence
  - Gaussian
  - Student's t
  - Archimedean





Pros and Cons

Pros

- Linked to LGM
- Incorporates multiple types of information
- Allows for uncertainty
- Greater perceived accuracy
- Reasonably flexible and adaptable

Cons

- Assumes stable LGM and inter-relationships
- Requires credible data (particularly copulas)
- Difficult to relate / explain results in terms of business drivers
- Results can be sensitive to many subjective choices
- Possible lack of coherency
- Doesn’t allow inference
- Op risk insensitive during GFC

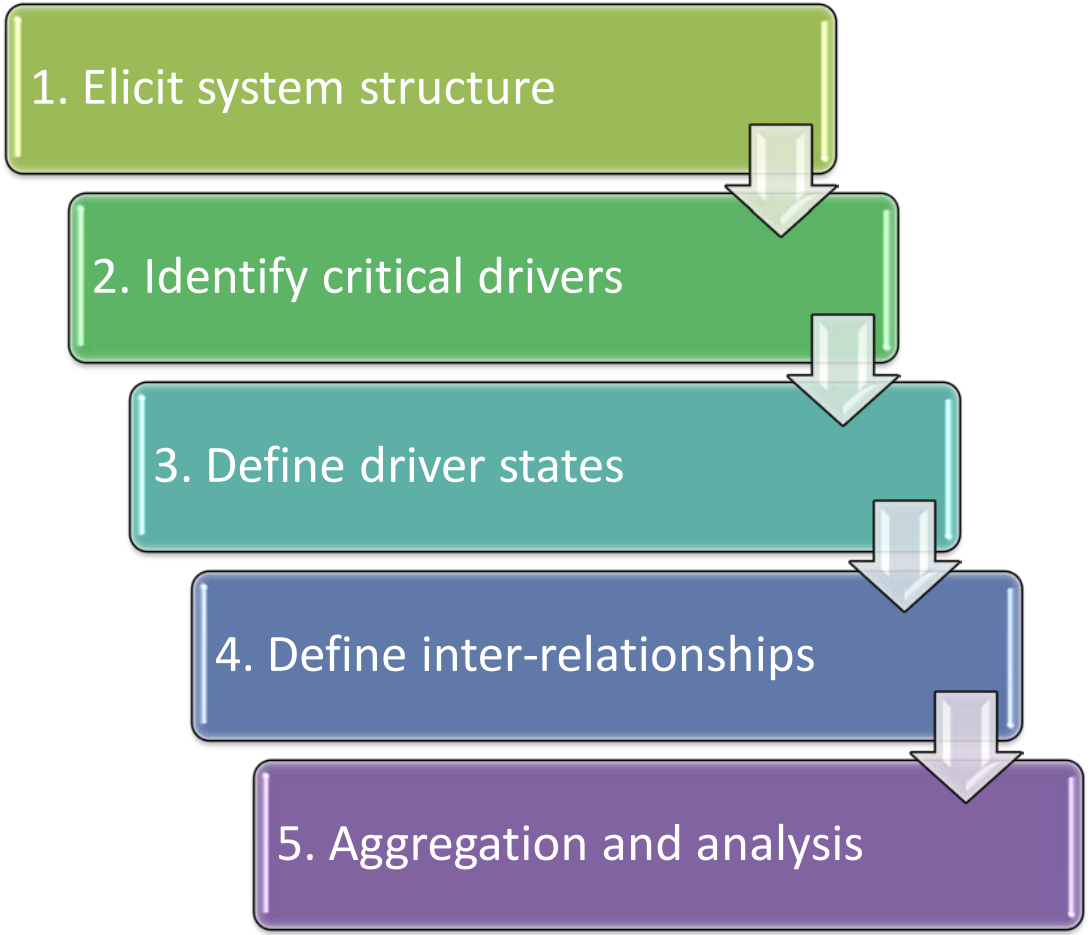
Structural / Causal Models

Loss outcomes are conditioned upon the underlying states of the drivers / risks constituting the LGM system

"System" in the context of a complex adaptive system

Designed to capture the important dynamics actually driving operational risk

Incorporates and leverages the beneficial features of SA and LDA



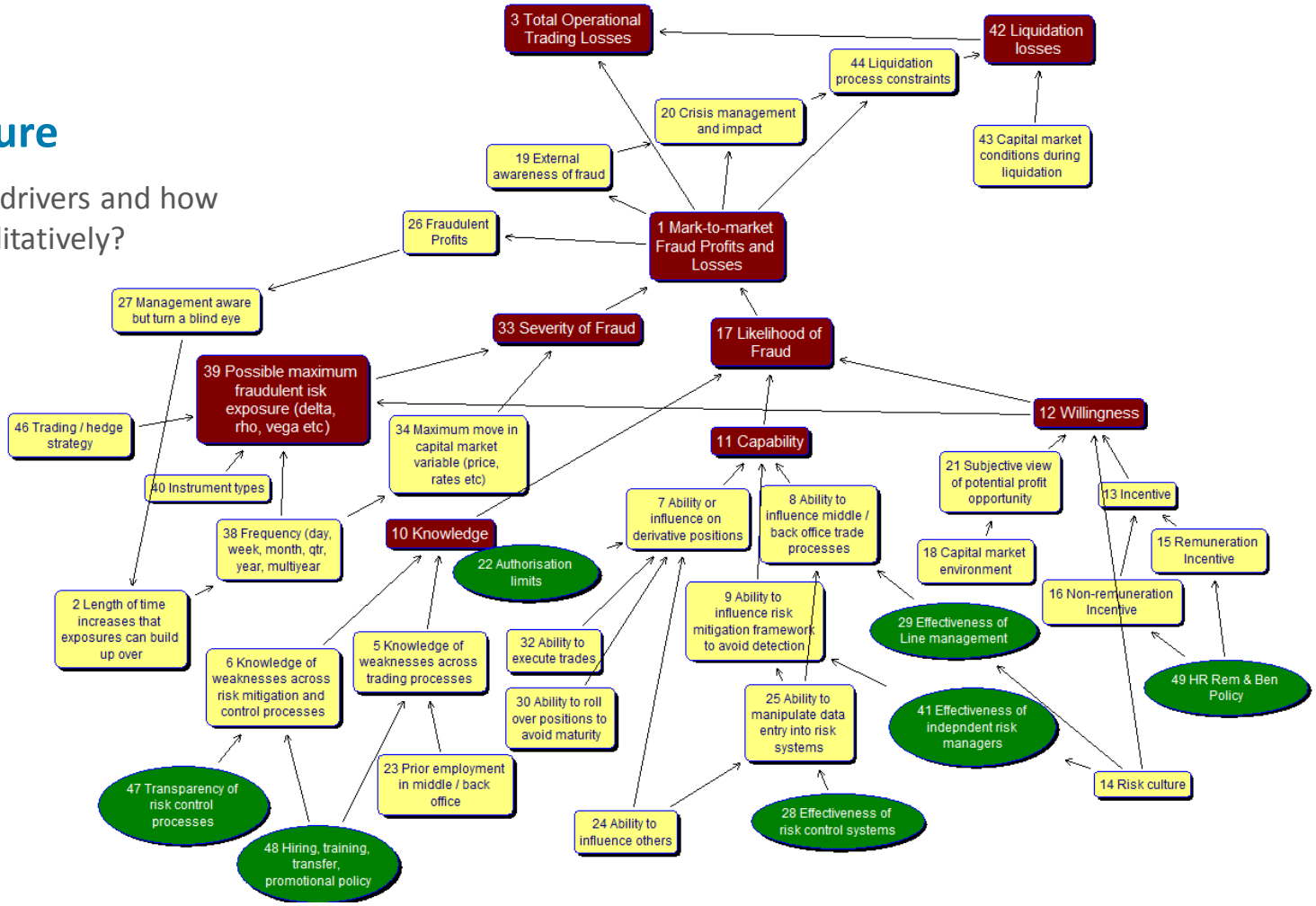
System Structure

What are the causal drivers and how do they interact qualitatively?

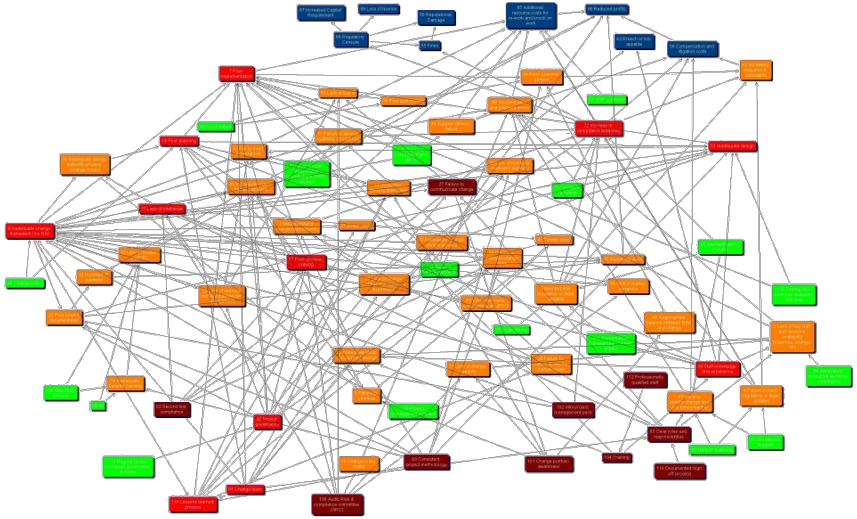
A few alternative ways to structure these:

- By LGM
- By scenario
- By operational process

Example shows a cognitive map of the LGM operational drivers of rogue trading



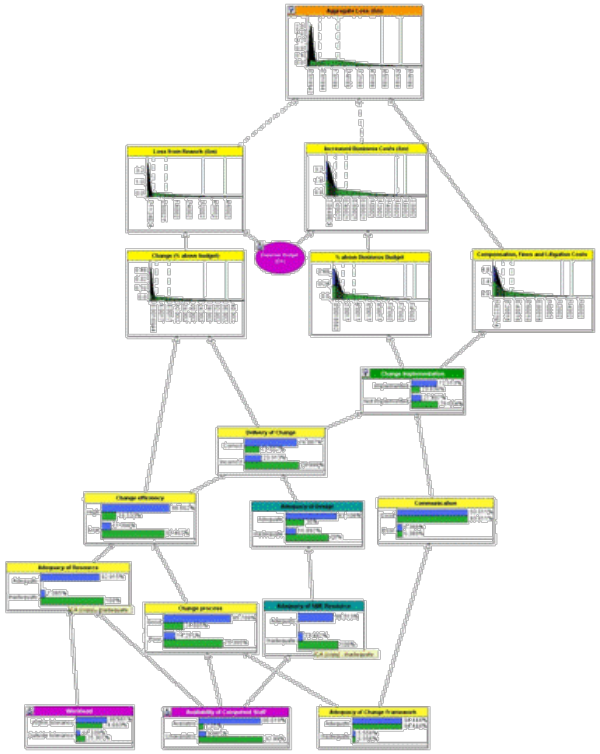
Identifying important drivers and dynamics



Example system structure by scenario

Graph & network theory

Complex systems science



Bayes Probability

Bayesian Networks

Statement of conditional probability.

P(A/B) = P(A) . P(B/A)/P(B)

P(A/B): Posterior probability

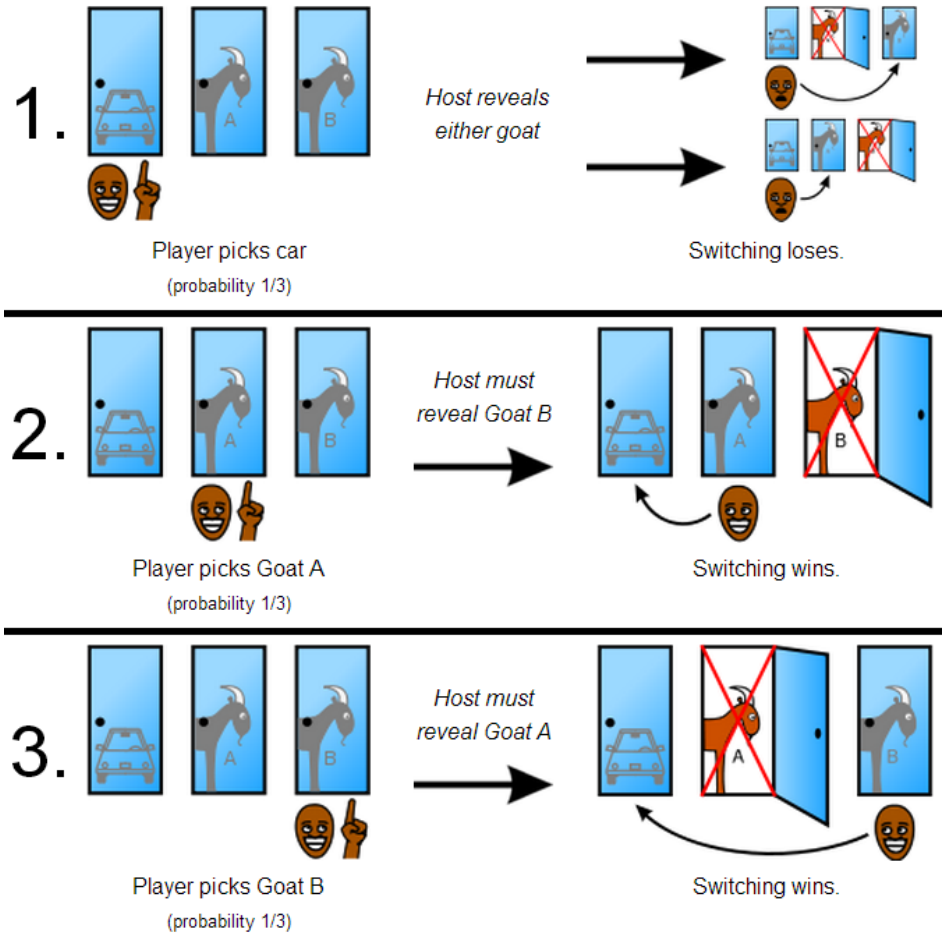
P(A): Prior probability

P(A/B)/P(B): Evidence

BN applies this to probability distribution functions and their complex dependencies within a causal network.

Bayesian inference provides a principled way of combining new evidence with prior beliefs

Monte Hall Example



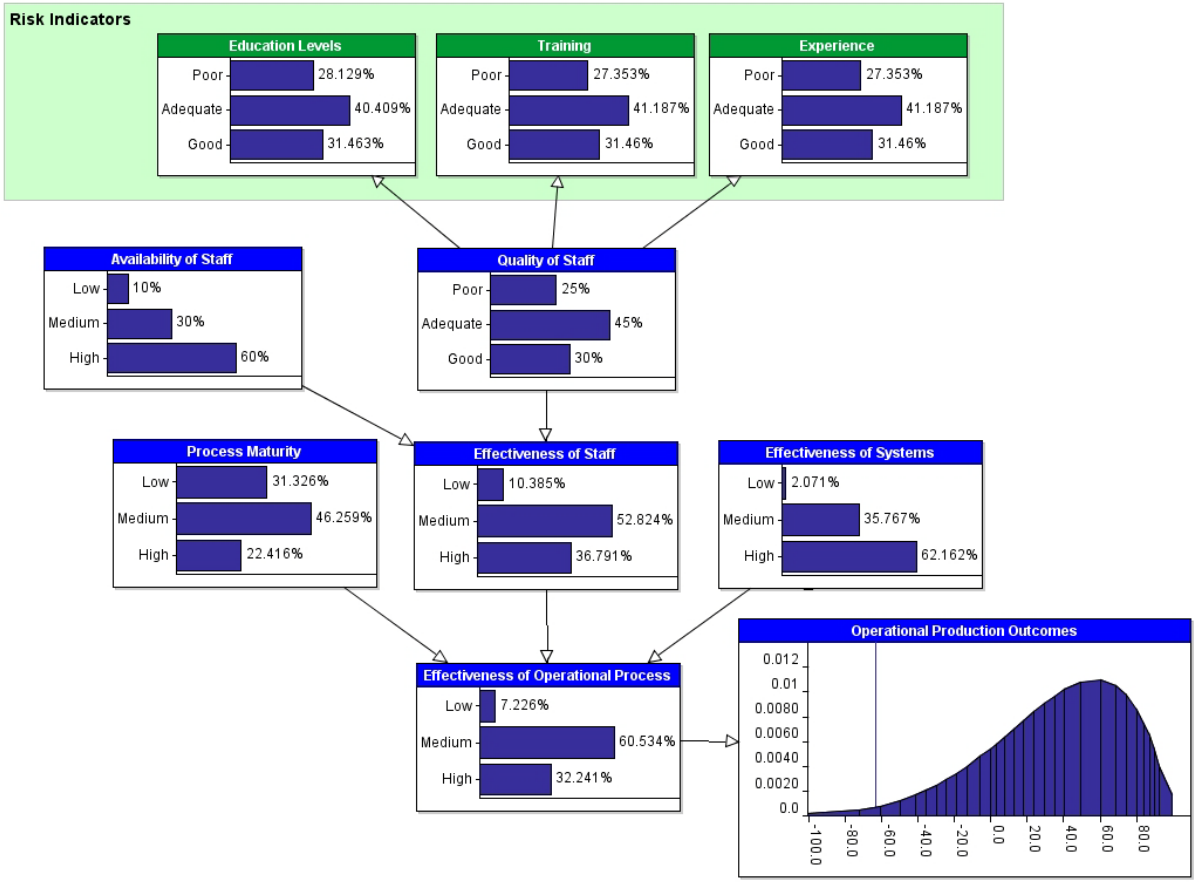
Defining Driver States

Driver states reflect:

- Current operational dynamics
- How operational people think, manage and communicate
- Points at which behavioural impacts change and/or become non-linear (tipping points)

Calibration of prior distribution reflects:

- Theory, data, expert views on each driver
- The natural degree of uncertainty associated with the information



Inter-Relationships

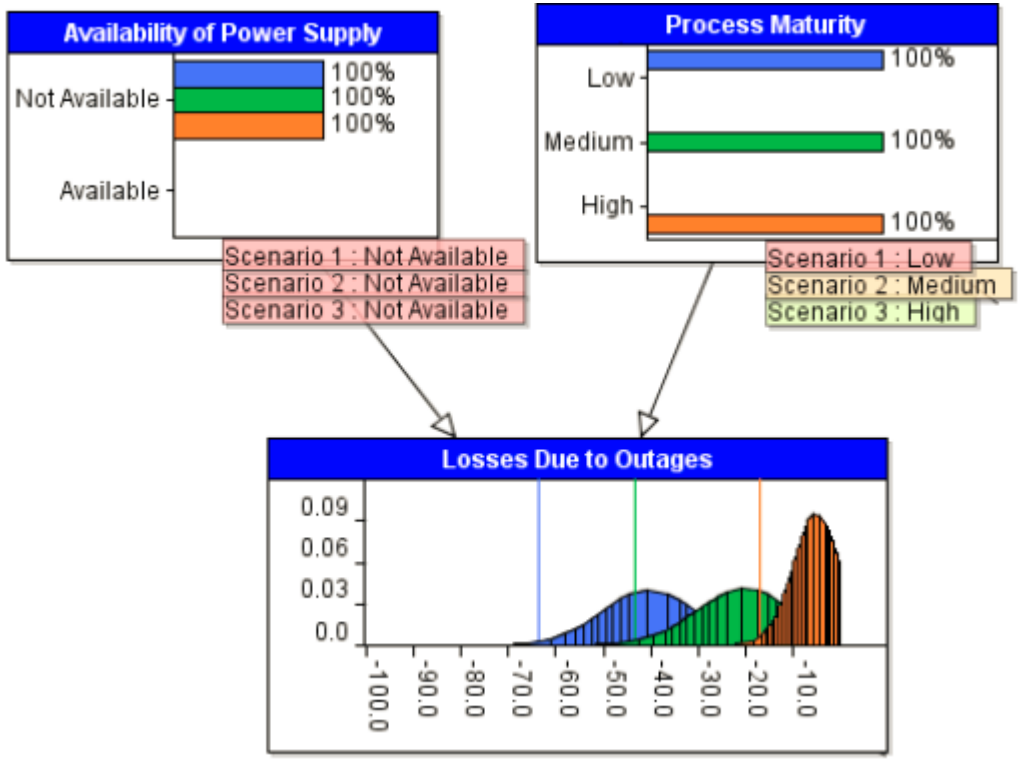
The core IP of op risk: how does the operational or LGM process work?

Non-linear and complex relationships

Informed by:

- data on BEICFs
- business expert opinion
- uncertainty
- quantifying intuition

Risk management is all about understanding and constantly (re)assessing these dynamics



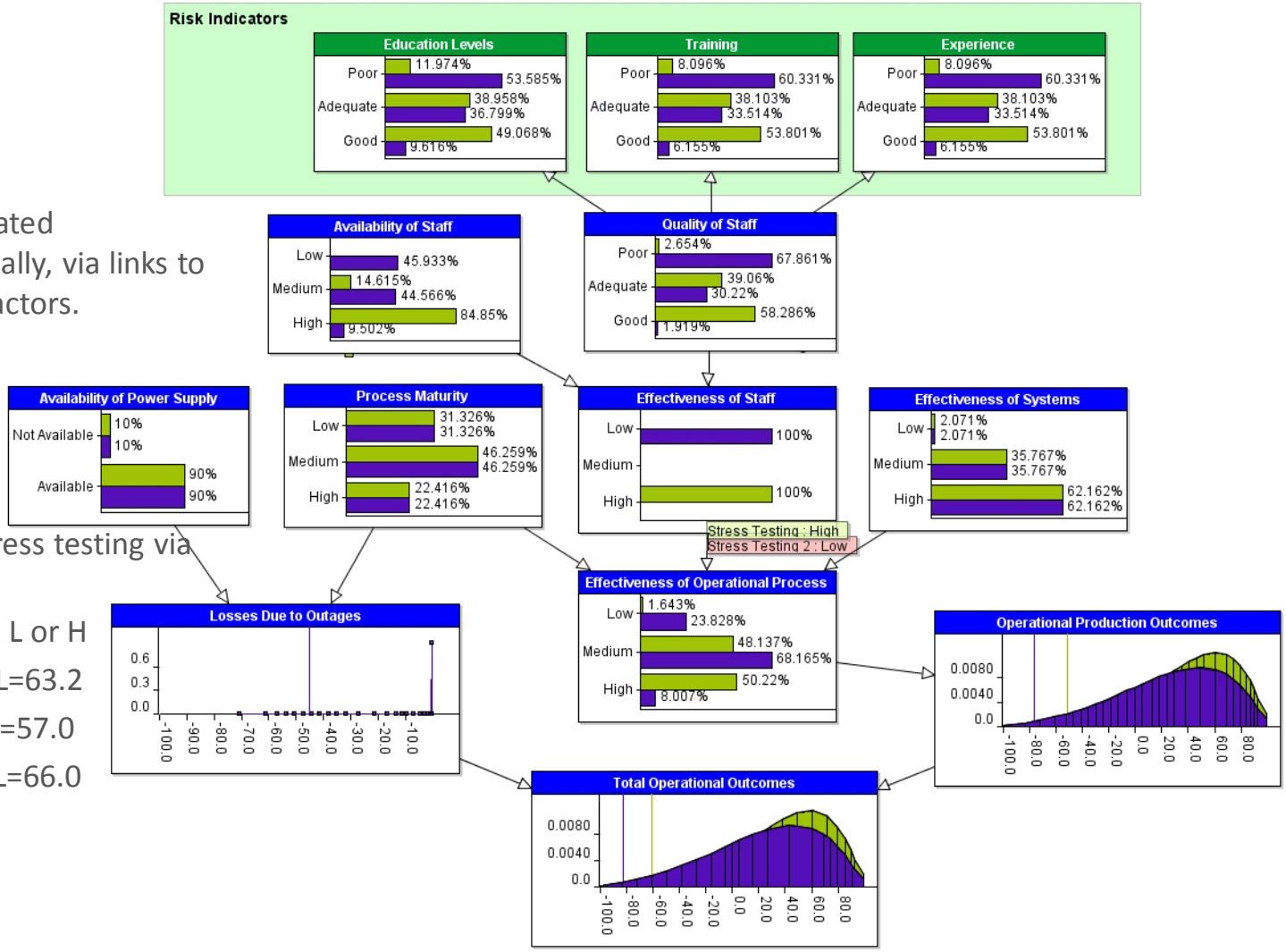
Aggregation and Analysis

Loss sources are aggregated structurally, not statistically, via links to common drivers / risk factors.

Aggregate capital (VaR) determined directly.

Can use structure for stress testing via Bayesian inference: e.g.

- Staff effectiveness = L or H
- Base: Cap=73.6, P&L=63.2
- Low: Cap=82.6, P&L=57.0
- High: Cap=61.4, P&L=66.0



Operational Risk Appetite and Risk Limits

RAS operational outcomes:

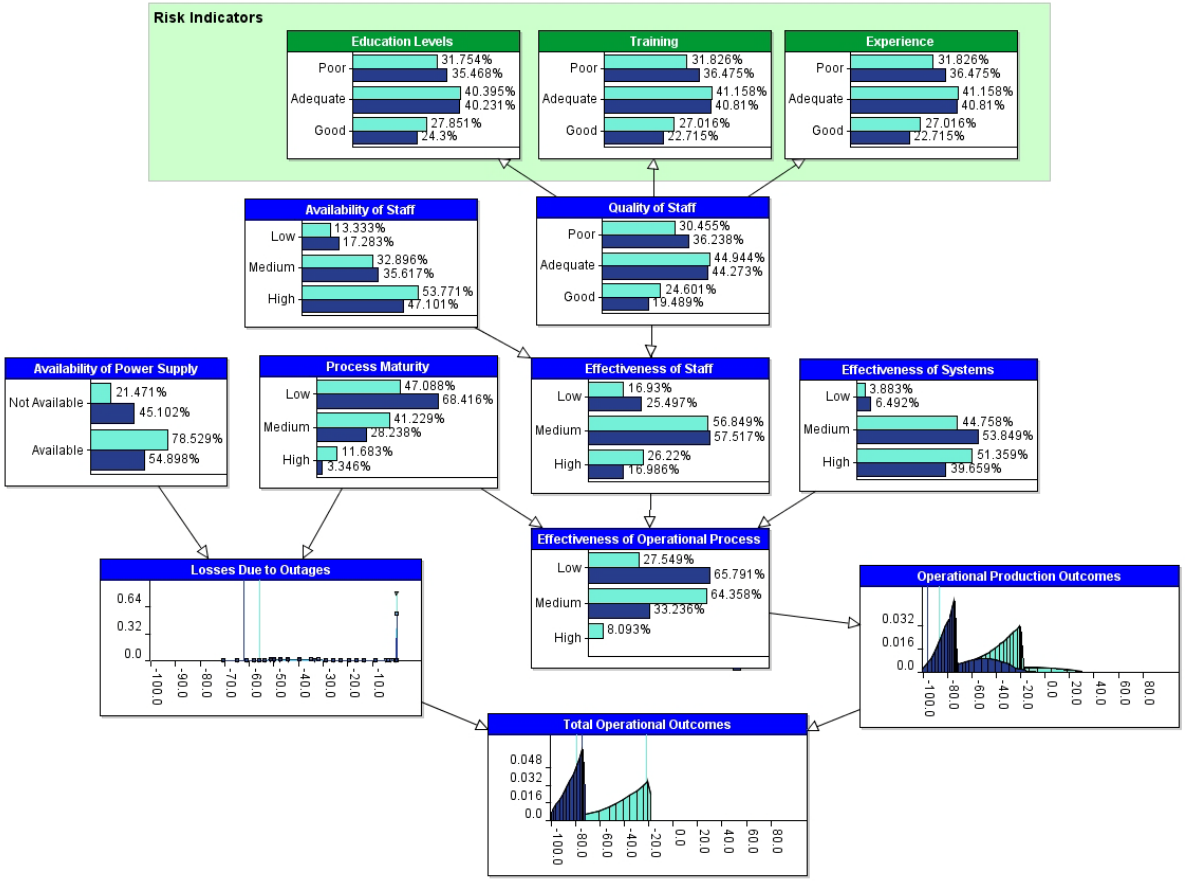
- Risk capacity = bottom 1%
- Risk appetite = bottom 10%

What are the driver risk limits that are consistent with these statements?

Use Bayesian inference via the BN to determine the self-consistent state spaces (i.e. risk limits).

Resolve multi-dimensionality via application of further constraints

- Dynamic op risk management



Derivative Op Risk Loss Events

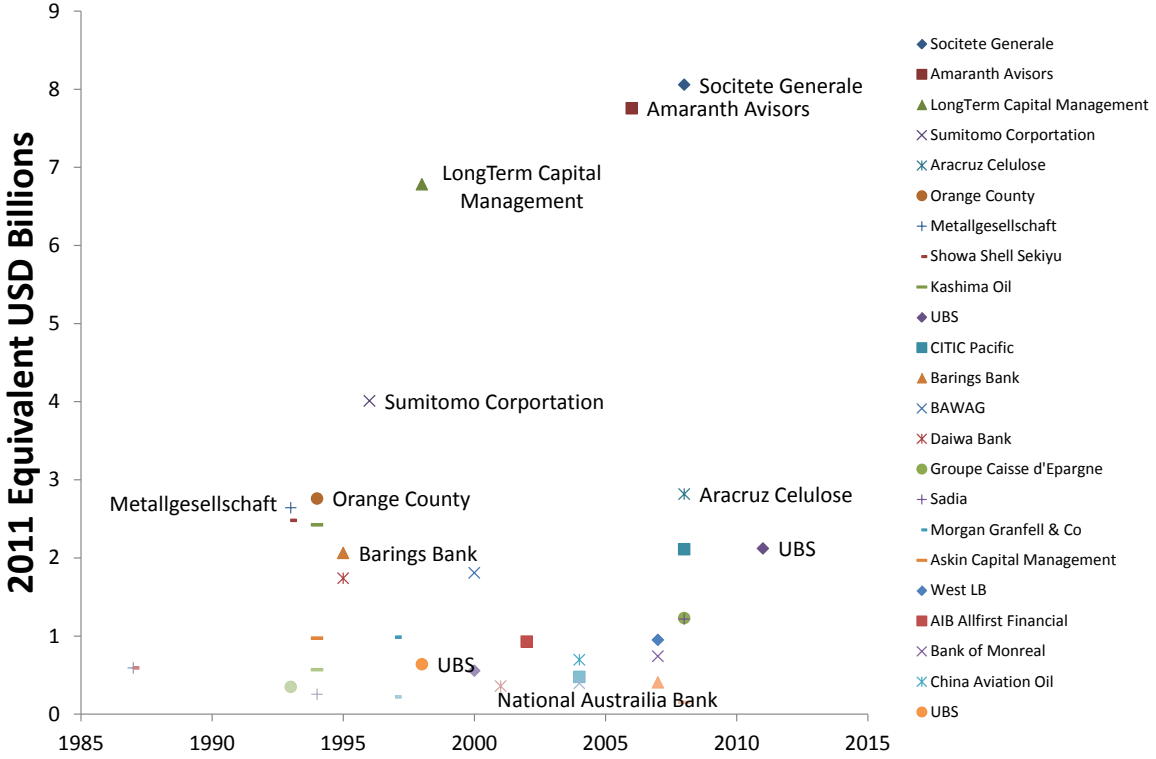
Emerging Operational Risk

How can we understand the next emerging operational risk event?

Emerging risk events are simply new combinations of known risk characteristics

We can analyse which risk characteristics exhibit evolutionary change and hence are more likely to evolve into new emerging risk events

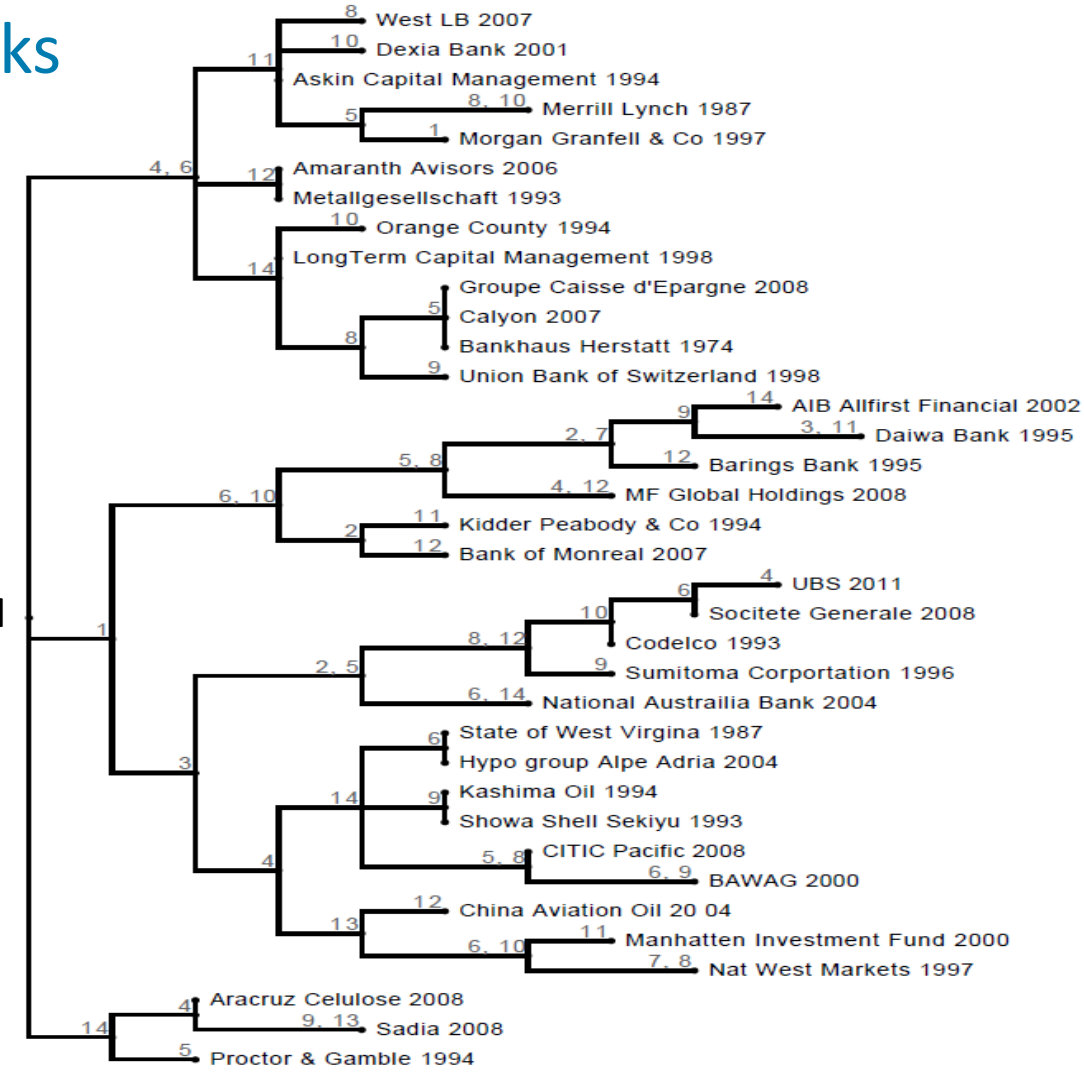
Cladistics is the study of evolutionary relationships



Cladogram of Drivers / Risks

Normal trading activity gone wrong &
primary activity financial / investing

1	Involving Fraud
2	Involving Fraudulent Trading
3	To Cover Up a problem
4	Normal trading activity gone wrong
5	Trading in Excess of limits
6	Primary Activity Financial or Investing
7	Failure to Segregate Functions
8	Lax Mgmt/control Problem
9	Long-term accumulated losses >3 years
10	Single Person
11	Physicals
12	Futures
13	Options
14	Derivatives



Fraud clade

Derivatives clade

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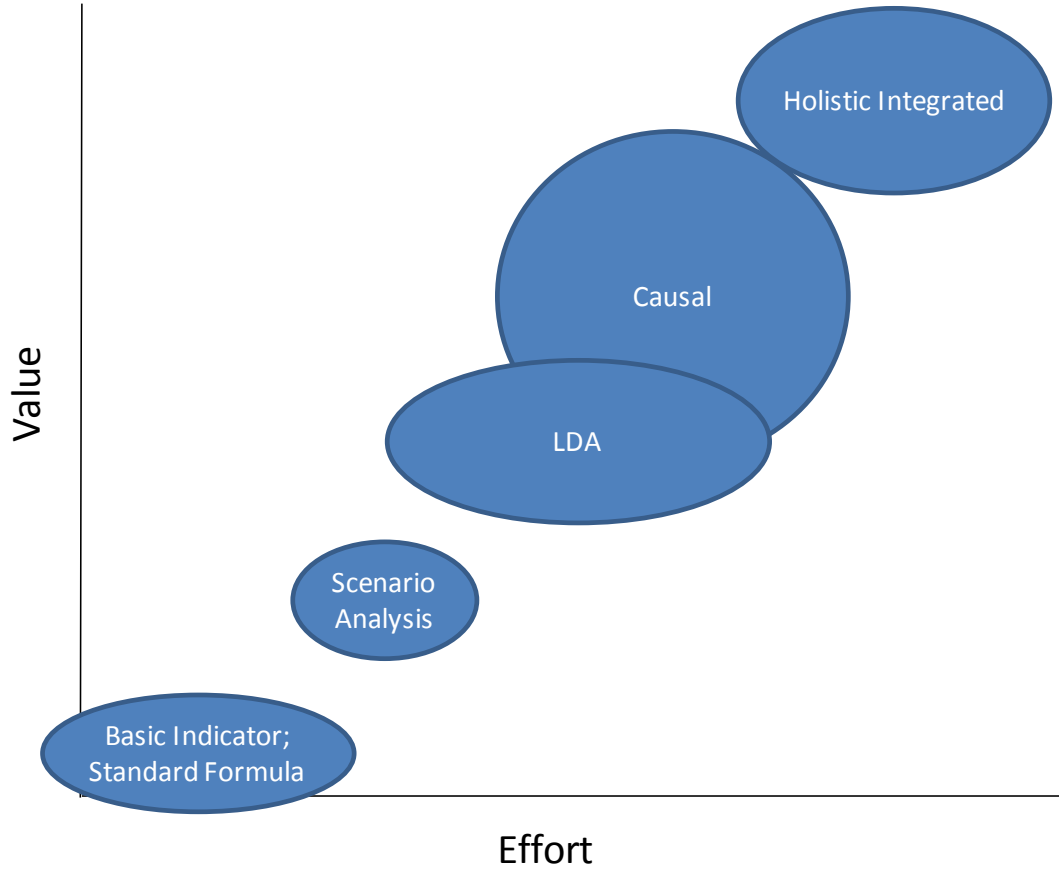
Section 4

DELIVERING BUSINESS VALUE

Choice of Model

Depends:

- Use case objectives
  - Capital assessment
  - Operational risk management
  - Operational business decisions
- Possible loss materiality
  - BI / SA / LDA for low severity
  - Causal for high severity
- Effort (people, $, time)
  - Development
  - Implementation / integration
  - BAU
- Operational complexity
  - Stable vs dynamic operations
  - Assuming complexity away where it exists destroys value



Loss Data Collection

ORX is the established global database collector and provider for operational risk for the banking community

Nothing exists for insurance or wealth management, outside of those entities that are divisions of banks.

ORX is designed to meet the needs of banks first.

Potential opportunity for the Institute to create a LDC service for the Australian wealth management industry serving the operational risk needs of:

- Life insurers
- General insurers
- Superannuation funds
- Wealth managers

Call to Action

1. Actuaries to get involved in operational risk

2. Focus on how operational risk frameworks can add value to management decisions focused on:
    1. Profitability
    2. Capital
    3. Business resilience
    4. Optimal trade-offs between these

3. Push the boundaries for the use of new techniques where appropriate, rather than replicate simple techniques that are lacking

4. The potential of the Institute to facilitate the introduction of an industry wide operational risk LDC process for the insurance, superannuation and wealth management sectors