ACTUARIAL SOCIETY
OF SOUTH AFRICA
Advancing Actuarial Excellence

Operational Risk Modelling – A Banking Perspective

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Definitions

What is Operational Risk	▪ The **potential for loss** arising from **inadequate or failed internal processes, people, systems, or external events** that disrupt an organisation's ability to conduct its day-to-day business activities. ▪ This includes legal risk but excludes strategic and reputational risk. ▪ Operational risk includes risks associated with **human error**, **system failures**, **process breakdowns**, and **external disruptions** such as natural disasters or regulatory changes.
Its Implications	▪ **It is part of doing business:** Operational risk encompasses both the uncertainties inherent in running a business and the effectiveness of management in implementing, training, and enforcing policies and procedures. It can result in direct financial losses or indirect impacts such as reputational damage, regulatory penalties, or operational inefficiencies. ▪ It is recognised as a **pervasive risk category** that affects all sectors and is managed through robust governance, risk culture, and internal control frameworks.

Causes	People	Processes	Systems	External Events

Operational Risk Value Chain

Risk Identification

- Identify potential sources of loss or disruption within the bank
- Effective identification is foundational to managing and mitigating operational risks proactively.

Risk Monitoring

- Continuous tracking of risk indicators, control effectiveness, and incident data to detect emerging threats and ensure timely response.
- Business Environment and Internal Control Factors (BEICF)
  - ✓ Risk Control & Self-Assessment (RCSA),
  - ✓ Key Risk Indicators (KRI)

Risk Assessment

- Evaluating the likelihood and impact of potential risks arising from operational risk exposures.
- Prioritises risks and guides mitigation strategies aligned with the bank's risk tolerance.
- Tools: Risk and control self-assessments (RCSAs), key risk indicators (KRIs) scenario analysis, and risk matrices

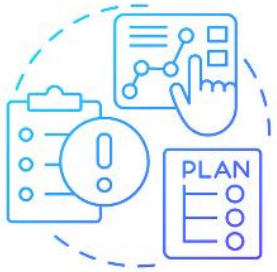
Operational Risk Value Chain

Risk Control & Mitigation

- Implements measures to reduce the likelihood and impact of risk events.
- Includes designing effective internal controls, automating processes, training staff, and using insurance or outsourcing to transfer risk.
- Regular testing and monitoring ensure controls remain effective and aligned with business objectives.

Loss Collection

- Systematic capturing information on internal loss events, including their causes, impacts, and recovery actions.
- Supports risk assessment, trend analysis, and model calibration.
- Includes categorising events, setting thresholds, and ensuring completeness and accuracy to inform risk management and regulatory reporting.



Scenario Analysis

- Forward-looking method that uses expert judgment to identify and assess potential risk events, estimate their frequency and severity, and evaluate their effect on business operations and capital needs.
- This assessment considers extreme but plausible events not captured by historical data that are relevant to the bank operational risk profile.
- Enhances risk awareness, supports strategic planning, and prepares organisations for rare, high-impact disruptions by evaluating potential effects on operations and capital.

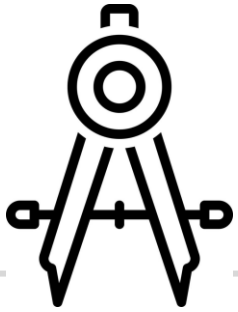
Operational Risk Value Chain

Quantitative Modelling

- Statistical and mathematical techniques to estimate potential losses from operational events.
- Typically incorporates internal loss data, external data, scenario analysis, and control assessments.
- Helps the bank assess capital requirements, prioritise risk mitigation, and support regulatory compliance through data-driven insights.

Risk Aggregation & Reporting

- Involves consolidating risk data across business units to provide a comprehensive view of exposure.
- Supports decision-making by aligning risk insights with the organisation's risk appetite—defined as the level of risk it is willing to accept.
- Effective reporting ensures transparency, accountability, and timely escalation of key risks.



Model Review & Recalibration

- Regularly evaluating the model's accuracy, relevance, and alignment with the bank's risk profile.
- Updating assumptions, data inputs, and parameters based on new loss events, business changes, or regulatory requirements.
- Ensures the model remains robust, credible, and fit for purpose.

Scenario-Based Operational Risk Quantification

Purpose and Philosophy	▪ **Leverages expert judgment** to estimate operational risk profiles, especially for events not clearly reflected in historical data. ▪ Operates on the **principle that high-severity events tend to occur infrequently** (thinned Poisson), aligning with the notion that frequent large losses would compromise business sustainability. ▪ Objective is to derive realistic and plausible estimates for rare but impactful operational risk events.
Methodology	▪ Experts are asked **intuitive questions** such as: ○ *"A loss of amount x or higher occurs once every d years"* ○ *"How many years would we wait to observe a loss of x or more?"* ▪ These responses are **converted into severity-duration pairs**, which are then used to fit a parametric distribution. ▪ A **minimum of three such data points** is recommended to ensure robust capital estimation. ▪ *(e.g., Frachot paper)*
Side Note	▪ **Bayesian analyses methods** have been used to build operational risk scenarios (**Exposure Based Models**)

Scenario-Based Operational Risk Quantification

Mathematical Foundation

- The approach is based on Poisson processes and exponential distributions to model the time between loss events.
- The average duration ***d*** between losses exceeding a threshold ***x*** is calculated as:

$$d = \frac{1}{\lambda\left(1 - F(x, \theta)\right)}$$

where:

- λ is the average annual frequency of events,
- $F(x)$ is the cumulative distribution function (CDF) of loss severity – with parameters θ.

(e.g., Frachot paper)

Implementation Considerations

- **Frequency is standardised** to one event per year / quarter / etc. to simplify elicitation and reduce bias.
- Severity estimates are used to **optimise for the parameters**, θ, of the selected distribution using **weighted least squares**, with weights inversely related to the variance of the duration estimates.
- *(Frachot paper – above equation)*

The Quantification Process

Benefits	▪ **Promotes ownership** of risk estimates by business units. ▪ **Facilitates identification** of control weaknesses and supports risk-informed decision-making. ▪ Provides a **statistically sound and business-relevant framework** for estimating capital requirements for operational risk.
Integration with Modelling	▪ Scenario data is **transformed into a loss distribution** that can be used in capital estimation. ▪ The methodology ensures that **expert input is mathematically sound and statistically valid**. ▪ The approach supports both **regulatory and internal capital modelling**.
Methods for Calculating OpRisk Capital	▪ Panjer's Recursive Algorithm ▪ Fast Fourier Transform (FFT) ▪ Closed-Form Approximation – Single Loss Approximation (SLA) ▪ Bayesian networks (Exposure Based Model such as XOI)
Monte Carlo Simulation	▪ Simulates **a large number of possible loss scenarios** by randomly generating both the frequency and severity of losses. ▪ **Strengths:** 1) Highly flexible and intuitive. 2)Can incorporate complex business logic (e.g. insurance, thresholds). ▪ **Use Case:** Preferred when analytical **solutions are infeasible** or when **modelling complex dependencies**.

The Quantification Process

The Loss Distribution Approach

Objective

To estimate the distribution of aggregate losses over a given time horizon (typically one year) and determine a high quantile (e.g., 99.9%) as the capital requirement.

Process Overview

Let:

- $N = number\ of\ loss\ events\ in\ a\ year\ (random\ variable)$
- $X_i =\ severity\ of\ the\ i^{th}\ loss\ event\ in\ that\ year$
- $L = \sum_{i=1}^{N} X_i$

The simulation process involves:

1) **Simulating the frequency**
   Draw N from the frequency distribution (e.g. Poisson with parameter λ)

2) **Simulating severities**
   For each N simulated, draw $X_1, X_2, \ldots, X_N$, from a severity distribution (e.g. Lognormal with parameters $\theta = \mu, \sigma$)

The Quantification Process

The Loss Distribution Approach

3) Aggregating the Losses

Compute total loss for each iteration:

$$L = \sum_{i=1}^{N} X_i$$

4) Repeating

Repeat steps 1–3 for a large number of iterations (e.g., 1,000,000) to build an empirical distribution of L

5) Estimating capital

Determine the Value-at-Risk (VaR) at the desired confidence level α

$$VaR_\alpha = inf\{l \in \mathbb{R} : P(L > l) \leq 1 - \alpha\}$$

Advantages	Practical Considerations
▪ Handles complex and non-linear risk profiles. ▪ Easily incorporates insurance, thresholds, and dependencies. ▪ Suitable for combining multiple risk types or business units.	▪ Requires robust parameter estimation for frequency and severity. ▪ Computationally intensive but scalable with modern computing. ▪ Often used with copulas to model dependencies between risk cells.

Economic Capital (ECap)

Economic Capital	
	▪ Economic Capital (ECap) is the **internal estimate of capital needed to absorb unexpected losses** from operational risk. ▪ It **differs** from **Regulatory Capital**, which is a **minimum requirement set by supervisors**. ▪ **ECap** reflects the **bank's specific** risk profile and is calculated at **higher confidence levels** (e.g., 99.93%). ▪ Calculation **also** involves probabilistic models such as Value-at-Risk (VaR). ▪ Enables **realistic solvency assessment** and **risk-sensitive product pricing**. ▪ **Supports internal decision-making** beyond **regulatory compliance**.

The Standardised Measurement Approach (SMA)

Standardised Measurement Approach

Summary: Standardised Measurement Approach (SMA) for Operational Risk Capital
The Basel III reforms introduced the **Standardised Measurement Approach (SMA)** to simplify and standardise the calculation of operational risk capital for banks. It replaces previous complex models like the Advanced Measurement Approach (AMA), aiming for greater **comparability, stability, and risk sensitivity**.

Key Components of SMA:

1.Business Indicator (BI): A proxy for operational risk exposure, based on gross income. It comprises:

1. **ILDC (Interest, Leasing, Dividend Component):** Reflects traditional lending risks.
2. **SC (Services Component):** Captures risks from fee-based services.
3. **FC (Financial Component):** Represents risks from trading and investment activities.

2.Business Indicator Component (BIC): Derived from BI and scaled using regulatory coefficients.

3.Internal Loss Multiplier (ILM): Adjusts capital based on a bank's 10-year operational loss history. A higher loss history increases capital requirements, incentivising strong risk management.

The Standardised Measurement Approach (SMA)

Standardised Measurement Approach

Strategic Implications:

- **Business Mix Drives Capital:** A bank's focus (e.g., lending vs. trading) shapes its BI and capital needs.
- **Profitability's Dual Role:** While not directly reducing capital, sustained profitability can lower ILM through better controls and fewer losses.
- **Loss History Matters:** A clean loss record reduces ILM and capital; major losses have long-term capital impacts.
- **Transparency & Comparability:** SMA enhances cross-bank comparisons and aligns capital with actual risk exposure.

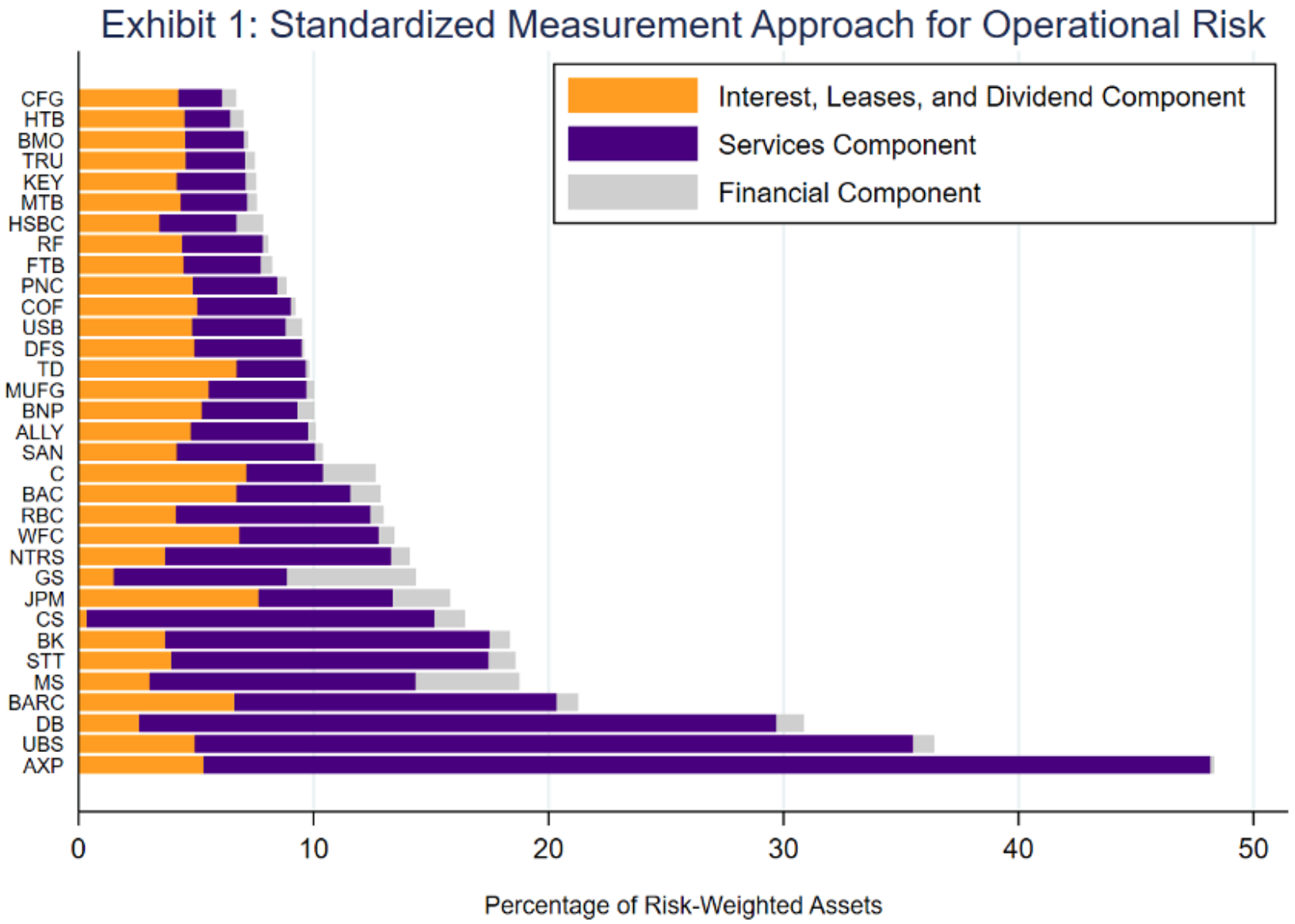
Conclusion:

The SMA embeds operational risk capital within a bank's strategic footprint—linking capital to **what the bank does**, **how big it is**, and **how well it manages risk**. (Size and Complexity) It promotes a more resilient financial system by encouraging investment in risk mitigation and aligning regulatory and economic capital frameworks.

SMA – Some Implications

Component	High Activities	Low Activities	Nature of Dominant Losses
SC (Services)	Payment processing, Asset/Wealth Management, Investment Banking Advisory, Custody & Fund Administration, Retail Brokerage, Credit Card Issuing	Plain vanilla retail lending, Simple deposit-taking, Treasury operations (non-trading)	Process Failure, Client Misconduct, Cyber / Data, Execution / Delivery
FC (Financial)	Proprietary Trading, Market-Making, Complex Derivatives Structuring/Sales, Securitisation Trading, Principal Investing	Retail/Commercial Lending, Basic Treasury Management, Simple Payment Services	Trading Misconduct (Rogue Trading), Model Risk, Settlement Risk, Legal Risk
ILDC (Interest/Div)	Mortgage Lending, Corporate Lending, Consumer Finance, Leasing, Investment Portfolio	Pure Fee-Based Advisory, Custody, Execution-Only Brokerage	Credit Admin, Mis-Selling, Fraud, Physical, Employment Practices

Some ("Known") International Examples



Description

The RWA for operational risk relative to total RWA as currently defined. The bar chart uses data on bank income statements between 2018 and 2020, since the BI is calculated using an average of financial data over a three-year period

Reference:
A Modification to the Basel Committee's Standardised Approach to Operational Risk - Bank Policy Institute (2022)

Thank you

Appendix

The Scenario Analysis Process

Its Importance	▪ **Scenario analysis** is a critical component in the estimation of operational risk capital ▪ **Scenario analysis** strengthens the credibility and completeness of operational risk capital models by ensuring they are not solely reliant on historical data, but also incorporate expert judgment and forward-looking perspectives.
Governance and Ownership	▪ **Clear accountability**: Assign roles for scenario development, validation, and approval. ▪ **Cross-functional involvement**: Include risk, business, compliance, and audit teams to ensure diverse perspectives. ▪ **Executive sponsorship**: Senior management should support and use scenario outputs in decision-making.
Scenario Development Framework	▪ **Structured methodology**: Use consistent templates and criteria for scenario creation. ▪ **Risk taxonomy alignment**: Scenarios should map to the organisation's operational risk categories. ▪ **Plausibility and relevance**: Scenarios must be realistic, based on internal/external loss data, and tailored to the institution's risk profile.
Data and Evidence Integration	▪ **Use of internal loss data**: Ground scenarios in actual historical events. ▪ **External benchmarks**: Incorporate industry events and peer data for broader context. ▪ **Expert judgment**: Engage SMEs to validate assumptions and fill data gaps.

The Scenario Analysis Process

Quantification and Impact Assessment	▪ **Severity and frequency estimation**: Use techniques like Monte Carlo simulation to model potential losses ▪ **Control effectiveness**: Assess how existing controls mitigate scenario impacts. ▪ **Capital impact analysis**: Link scenarios to capital adequacy and stress testing frameworks.
Documentation and Traceability	• **Scenario narratives**: Clearly describe the event, triggers, progression, and outcomes. • **Assumption logs**: Record all assumptions and sources used in scenario construction. • **Version control**: Maintain a history of scenario changes and updates.
Review and Challenge Process	▪ **Independent validation**: Risk oversight functions should review scenario logic and assumptions. ▪ **Challenge sessions**: Conduct workshops to test scenario robustness and refine inputs. ▪ **Audit trail**: Ensure all steps are documented for internal and external review.
Integration with Risk Management	▪ **Link to RCSA and KRIs**: Align scenarios with control assessments and key risk indicators ▪ **Use in decision-making**: Inform strategic planning, capital allocation, and risk appetite setting. ▪ **Continuous improvement**: Update scenarios regularly based on new data, events, or business changes.