Dynamic Evaluation of Enterprise Risk Management (ERM) at Electrobras Furnas Brazil A Case Study

Dr Jonathan Mun
CEO Real Options Valuation, Inc USA

Dr Nelson Albuquerque
CEO of ROV-Brasil

Dr Zaidi Bin Isa
Chief Risk Officer, Universiti Kebangsaan Malaysia

Overview

- Electrobras Furnas is a regional power utility and a major subsidiary of Eletrobras.

- The company generates or transmits electricity to 51% of households in Brazil and more than 40% of the nation's electricity passes through their grid.

- The company has a generating capacity of 10,050 MW which corresponds to 10% of Brazil's electrical production.

Objectives

- This paper is intended to describe the methodology applied in automating ERM for Electrobras Furnas i.e dynamic evaluation,

- To propose a better methods to measure risk as compared to qualitative methods.

Why do we need Risk Management?

The only alternative to risk management is crisis management --- and crisis management is much more expensive, time consuming and embarrassing.

JAMES LAM, Enterprise Risk Management, Wiley Finance © 2003

Without good risk management practices, government cannot manage its resources effectively. Risk management means more than preparing for the worst; it also means taking advantage of opportunities to improve services or lower costs.

Sheila Fraser, Auditor General of Canada

Why bother with RM?

- Allows intelligent "informed" risk-taking.
- Focuses efforts –helps prioritize. Top 10 list. Or top 3. Or…
- Is proactive…. not reactive – Prepare for risks before they happen. Identify risks and develop appropriate risk mitigating strategies.
- Improve outcomes – achievement of objectives (corporate, clinical, etc)
- Really comes to down to simple good management
- Enables accountability, transparency and responsibility
- And maybe even mean survival

Basic principles, concepts, definitions

A risk is **ANYTHING** that may affect the achievement of an organization's objectives.

It is the **UNCERTAINTY** that surrounds future events and outcomes.

It is the expression of the **likelihood** and **impact** of an event with the potential to influence the achievement of an organization's objectives.

Risk Vs Uncertainty

- Risk in connected to two parameters

  - Impact caused by uncertain event
  - Likelihood or probability of an event happening in future

- Uncertainty is a measure of likelihood when there is no observable impact.

Example

- Risk of Car Accident

  Likelihood : Low

  Impact: Medium

  Total Risk : Moderate

- Uncertainty of Car Accident

  Likelihood: Low

  Impact : 0

  Why Impact = 0 (Reason: you don't drive to work)

Definition of ERM

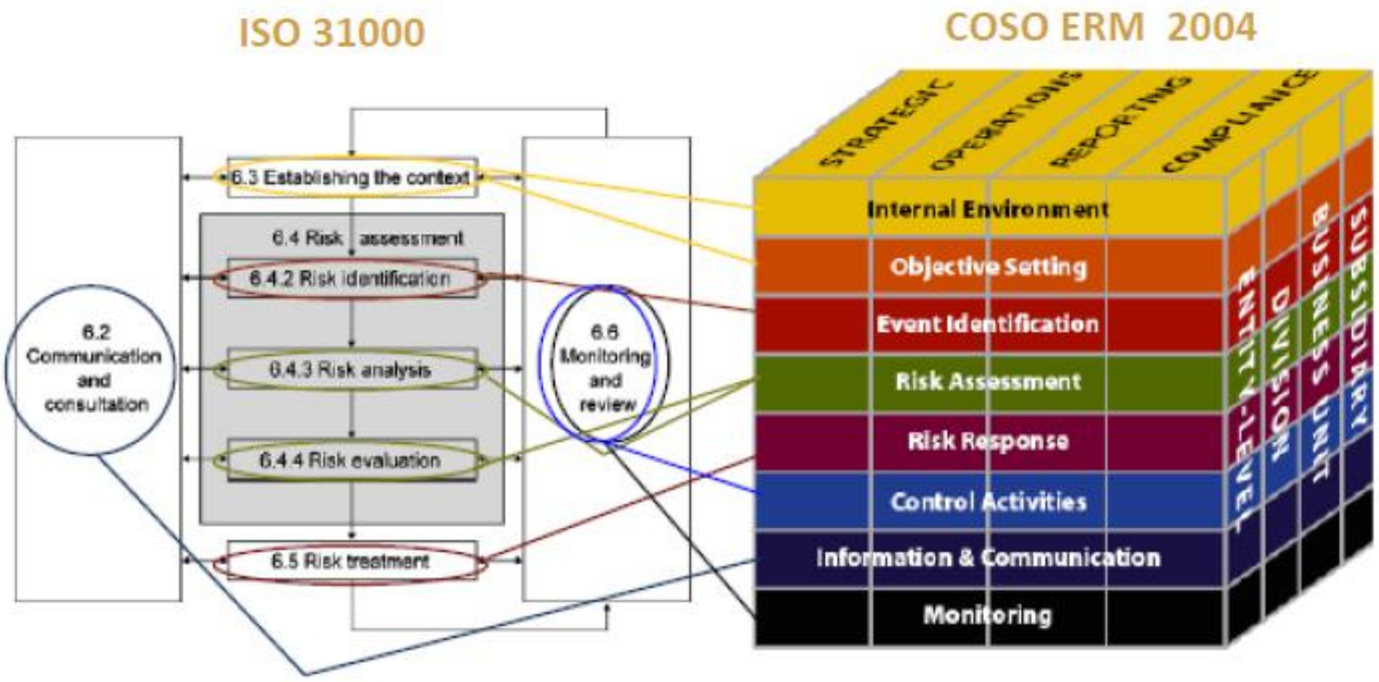
*"… a **process**, effected by an entity's board of directors, management and other personnel, applied in strategy setting and **across the enterprise**, designed to identify potential events that may affect the entity, and manage risks to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives."*

Source: COSO Enterprise Risk Management – Integrated Framework. 2004.

The Committee of Sponsoring Organizations of the Treadway Commission (COSO)

A Simple Framework

Comparison ISO 31000 and COSO ERM



Source: Aon Risk Solutions, White Paper on Risk Management Committee, 2011

Risk Management Basics

- Risk (uncertainty) may affect the achievement of objectives.
- Effective mitigation strategies/controls can reduce negative risks or increase opportunities.
- Residual risk is the level of risk after evaluating the effectiveness of controls.
- Acceptance and action should be based on residual risk levels.

Approach to Assessing Risk

Advantages/Disadvantages of either approach:

	Quantitative	Qualitative
Benefits	• Risks are prioritized by financial impact; assets are prioritized by financial values. • Results facilitate management of risk by return on security investment. • Results can be expressed in management-specific terminology (for example, monetary values and probability expressed as a specific percentage). • Accuracy tends to increase over time as the organization builds historic record of data while gaining experience.	• Enables visibility and understanding of risk ranking. • Easier to reach consensus. • Not necessary to quantify threat frequency. • Not necessary to determine financial values of assets. • Easier to involve people who are not experts on security or computers.
Drawbacks	• Impact values assigned to risks are based on subjective opinions of participants. • Process to reach credible results and consensus is very time consuming. • Calculations can be complex and time consuming. • Results are presented in monetary terms only, and they may be difficult for non-technical people to interpret. • Process requires expertise, so participants cannot be easily coached through it.	• Insufficient differentiation between important risks. • Difficult to justify investing in control implementation because there is no basis for a cost-benefit analysis. • Results are dependent upon the quality of the risk management team that is created.

Risk Prioritization – likelihood and impact
Qualitative approach

Likelihood of a risk event occurring

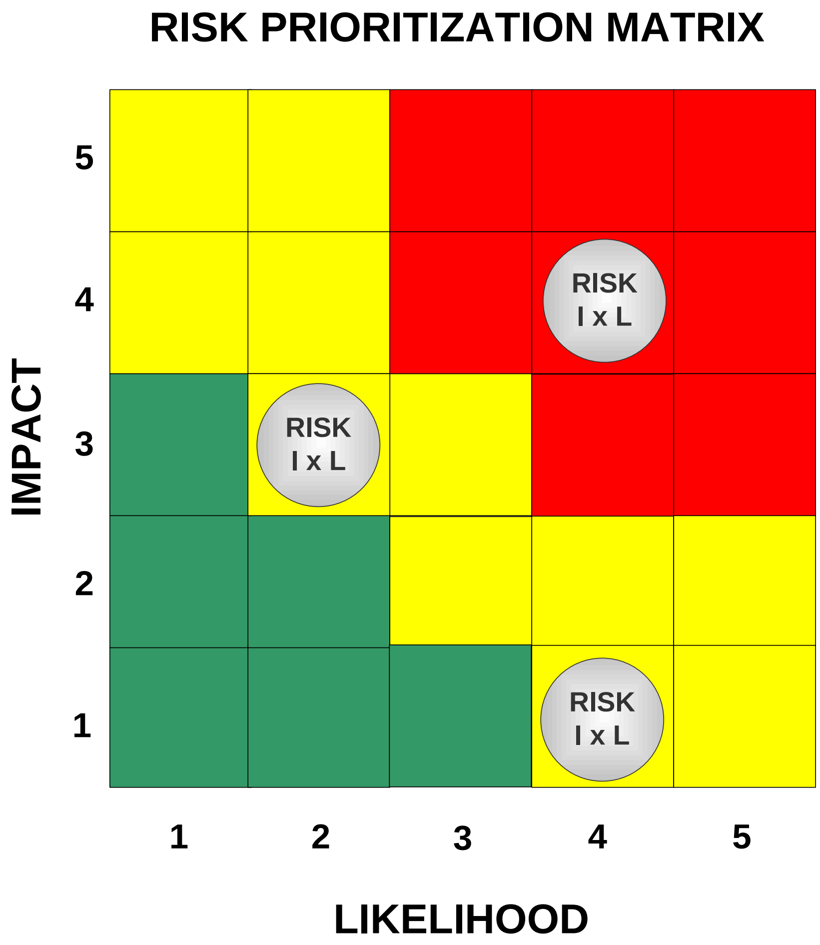
1. **Very Low:** Unlikely to occur
2. **Low:** May occur occasionally
3. **Medium:** Is as likely as not to occur
4. **High**: Is likely to occur
5. **Very High**: Is almost certain to occur

Risk Impact: Level of damage that can occur when a risk event occurs

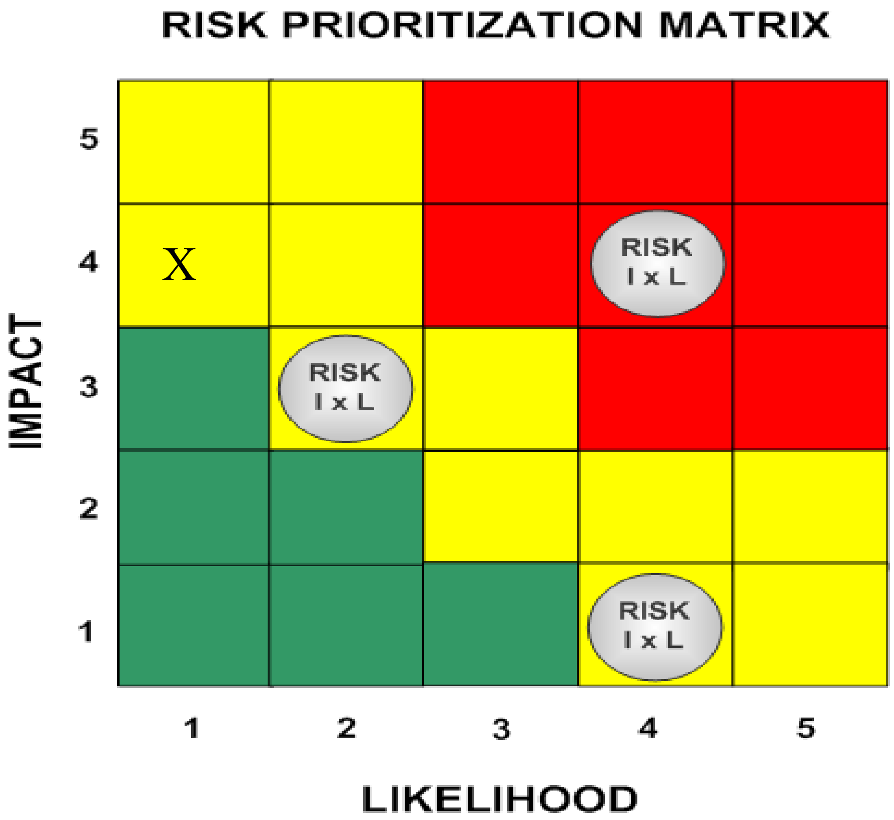
1. **Very Low**: Negligible impact
2. **Low:** Minor impact on time, cost or quality
3. **Medium:** Notable impact on time, cost or quality
4. **High:** Substantial impact on time, cost or quality
5. **Very High**: Threatens the success of the project

Risk rating

…*Combining impact and likelihood*



Qualitative Risk Analysis



Used of words to describe the likelihood and the impact.

Judgmental approach

Based on Risk Matrix or Heat Map to categorized risk

Example : Likelihood : Low
Impact : High
Total Risk : Medium

Example of Qualitative Risk Register

Owner	Risk Description	Risk Category	No	Consequence	Likelihood	Risk Rating

Quantitative Risk Analysis

- Use of numerical values to describe likelihood and impact
- Involve mathematical modelling, monte carlo simulation, sensitivity analysis and fuzzy logic etc.
- Accuracy of the risk analysis depends largely on the historical data and assumptions
- Example : Likelihood 5%, Impact : RM 12000
- Overall Risk exposure : 0.05*12000= RM600

Problem

- If the information given is qualitative, can we convert it to quantitative?
- If the value given is vague, how should we judge?

Mitigation of Risk Consequences

- Objective is to reduce the risk level

  - Reduce Impact (taking preventive measures)
  - Reduce Likelihood (Improve process to reduce mistakes)

- Mitigation measures can only reduce risk. Not to eliminate risk. Residual risk still exist.

- (Inherent Risk-Mitigation Measures=Residual risk)

Static vs Dynamic Evaluation

- In traditional qualitative analysis, the measure of riskiness of a company is a snapshot at a point in time. Mitigation measures are evaluated later often after auditors verify the degree of compliance on previous snapshots.

- Dynamic evaluation allows the assessment and measure the degree of vulnerability over time using % Mitigation completed.

- Vulnerability is a measure to indicate the % of incomplete reduction of risk mitigation.

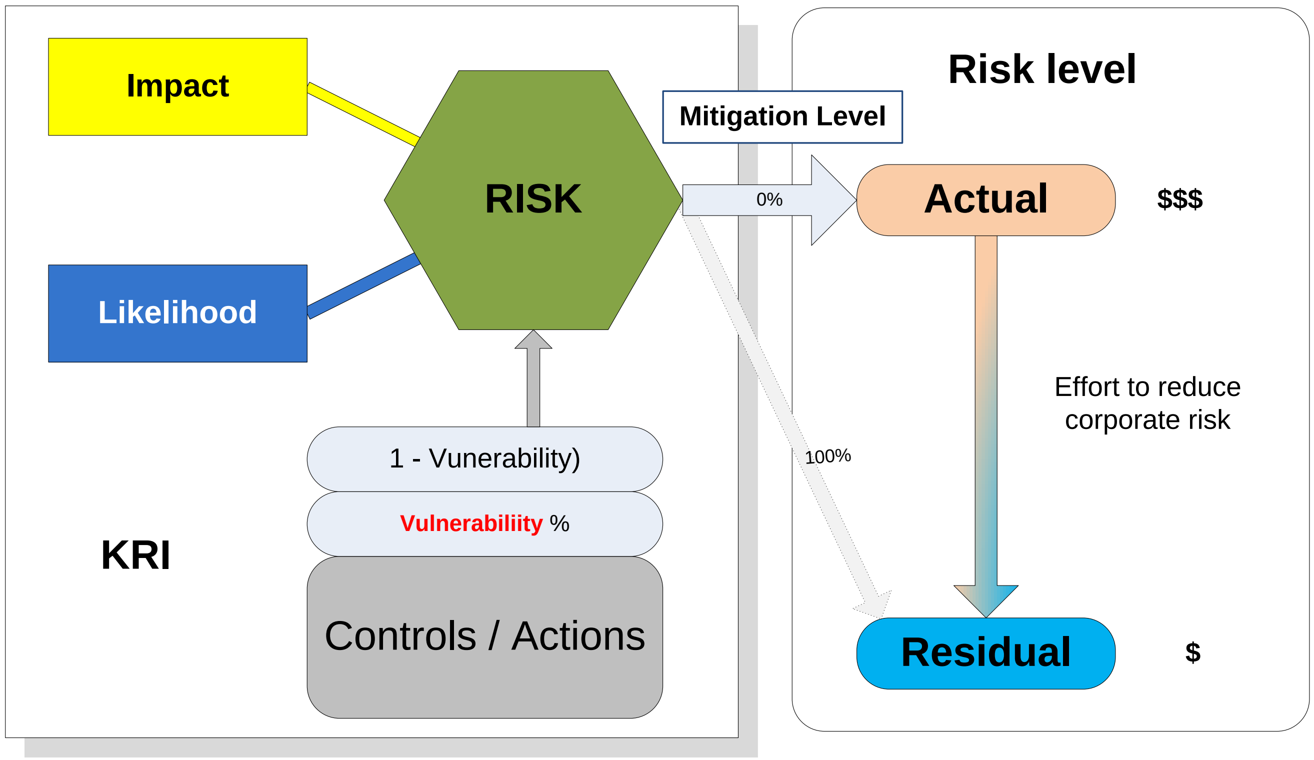
- %Mitigation completed = 1 - % Vulnerability

Example: Static Evaluation

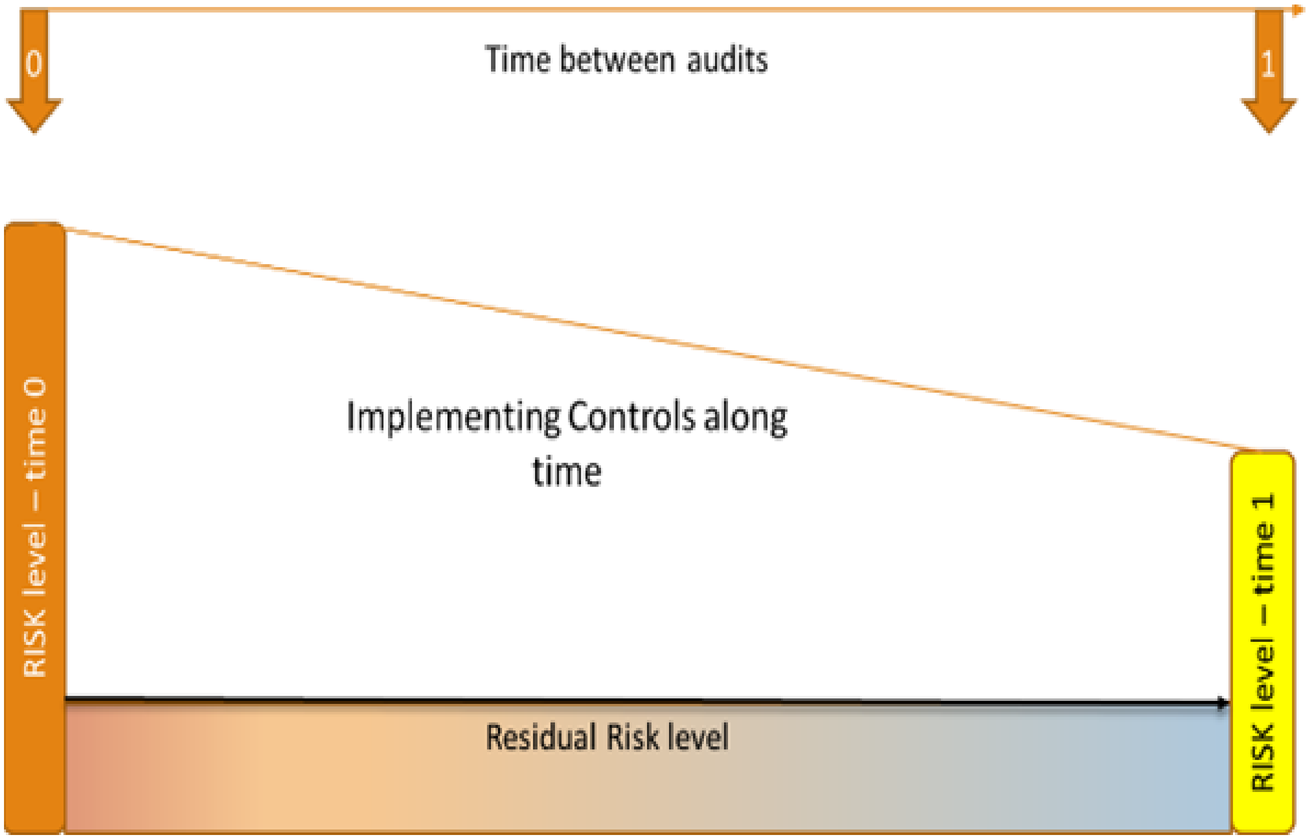
Identify Risks		Analyse Risks				Evaluate Action
Risk – Description / Impact	**Cause**	**Existing Controls**	**Control Assessment**	**Risk Assessment**		**Treat Risk?**
				Consequence Likelihood Risk Rating		☐Avoid Risk. ☐ Accept Risk. ☐ Reduce Risk. ☐ Transfer Risk. ☐ Increase Risk

Treat Risks				Monitor & Review	Insurance	KRI KCI
Risk Treatment / Action Plan	**Accountabilities**	**Timelines**	**Risk Rating**	**Review / Monitor**	**Insurance Status**	**Measurement and monitoring**
					☐Insurable? ☐ Insured?	

Model of Dynamic Measurement and Evaluation



Dynamic Mitigation of Risk Factors



Dynamic Assessment of Vulnerability: An Ilustration

$$VF_j = \frac{\sum_{i=1}^{n} Cr_{i,j} * w_{i,j} * GC_{i,j}}{\sum w_j}$$

- Vulnerability Factor (VF)
- A set of controls ($Cr_{i,j}$),
- A weight ($w_{i,j}$) equal to one, two, or four, depending on the degree of importance attached to it.
- The use of weights allows us to distinguish between controls that are more difficult to be implemented or which would have a much greater impact on risk mitigation.
- Degrees of conformity ($GC_{i,j}$), implemented (0%), partially implemented (50%), and nondeployed (100%)

Case Illustration

Risk Element 1 (Catastrophic Fire)	Control 1	Control 2	Control 3	Vulnerability Factor (%VF)	Degree of Mitigation (%DM)
Weight/Importance	6	3	1	40%	60%
Degree of Conformity %	0%	100%	100%		

Let’s further assume a simple scenario involving Risk Element 1 where the estimated total and complete catastrophic fire event will mean a loss of

1. $6M in Assets, 2. $3M in Production, 3. $1M in Productivity.

Total loses = $10M

Example Control : Catastrophic Fire

Control 1 : Mitigates losses in Assets by purchasing fire insurance
Control 2 : Mitigates losses in Production by installing capacitors and storage areas in a different off-site location
Control 3 : Mitigates Productivity losses by initiating a joint venture with a partner company

Illustration continue:

- **Risk Element 1: Catastrophic Fire.**
  - $\%VF = (6 \times 0\% + 3 \times 100\% + 1 \times 100\%) \div (6 + 3 + 1) = 40\%$
  - $\%DM = 1 - \%VF = 100\% - 40\% = 60\%$, or, similarly, we have:
  - $\%DM = 1 - (6 \times 0\% + 3 \times 100\% + 1 \times 100\%) \div (6 + 3 + 1) = 60\%$

Control 1 (fire insurance) is very simple to execute and coverage was already purchased for the full amount of the Assets, which means that the % Mitigation Completed (%M) is 100% or, alternatively, % Vulnerability (%V) is 0%.

Controls 2 and 3 are more difficult to complete and take time and money, and, as of right now, they are 0% completed (0% mitigated or 100% vulnerable if a fire occurs).

Calculation of Residual Risk

- $Residual\ Risk = Gross\ Risk \times \%\ Vulnerability\ Factor$.
- $Residual\ Risk = Gross\ Risk \times (1 - \%\ Degree\ of\ Mitigation)$.
- That is, we can compute $Residual\ Risk =$

$$\$10\text{M} \times 40\% = \$10\text{M} \times (1 - 60\%) = \$4\text{M}.$$

Probability Assessment (Fuzzy Logic Approach)

- The probability of an event is a measure associated with the likelihood of an event occurring

- It can be obtained from a statistical analysis based on Monte Carlo simulation (e.g., for measuring the associated Value at Risk factor or extreme worst case scenario percentiles) or from a **subjective evaluation** of those responsible for its management.

Qualitative Representation of Probability

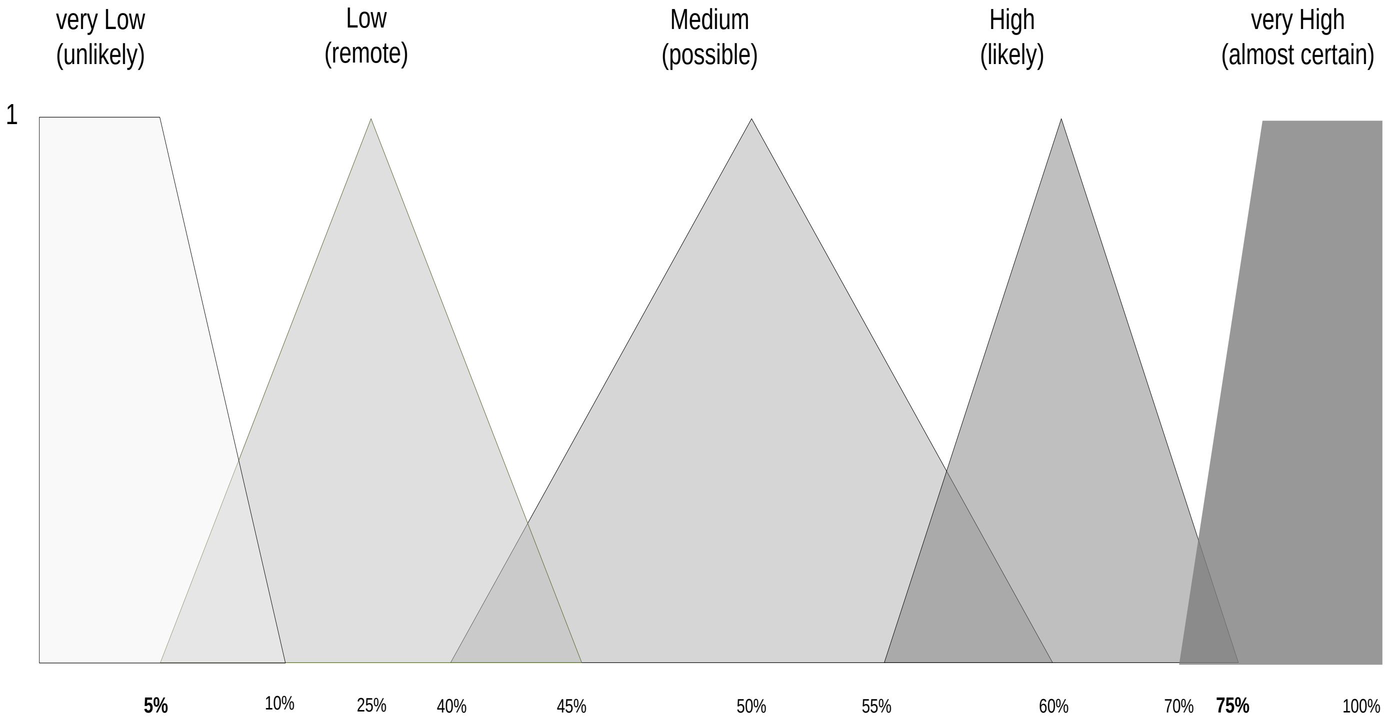
Probability range		Qualitative classification		Equivalent scale (grid 1-5 or 1-10)
> 75%	→	Very High/ almost certain	↔	**5** or **10**
55% - 75%	→	High / likely	↔	**4** or **7**
40% - 60%	→	Medium / possible	↔	**3** or **5**
5% - 45%	→	Low / remote	↔	**2** or **3**
< 5%	→	Very Low/ unlikely	↔	1

Issue: There is an intersection between categories

Qualitative Representation of Probability

Risk Probability / Likelihood of Occurrence				
Typ e	#	Rating	Description	Keys
Threats	5	very High	Likelihood of this risk factor occurs in the year is greater than 75%	High potential for occurrence. This risk factor occurred twice or more within 3 years.
	4	**High** (likely)	Probability of one or more events in the year is 55% to 80%.	It was observed that the risk factor run several times over the period of 10 years, or at least three times in five years, or it has recently occurred.
	3	**Medium** (possible)	The risk factor likely to occur in a time period of 5 years and it is estimated that the probability varies between 45% and 55%.	Could occur once or at most twice within the 5-year time period.
	2	**Low** (remote)	Unlikely to occur this year. Lower probability than 50%.	There was no occurrence of history in the last five years, but there is external history, in other companies, up to two occurrences in this period.
	1	**very Low** (unlikely)	It is not likely to occur in a period of 10 years or less than 5% chance of occurrence.	There was no case record in the last ten years. There is no external historical occurrence.

Fuzzy Representation of Variable Probability i.e The Membership Function



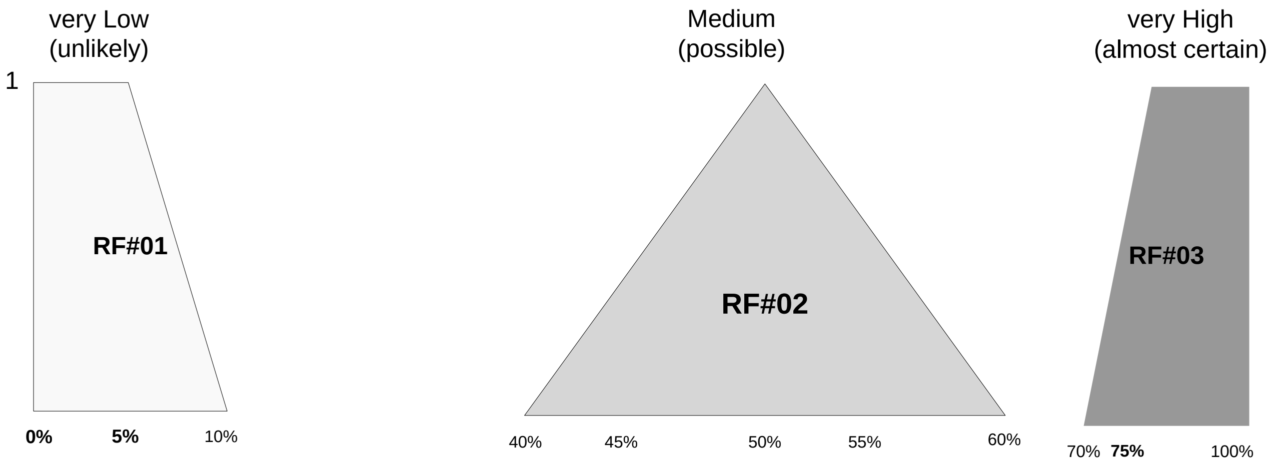
- The intersection between the categories is deliberate because there is no clear boundary between one category and another.
- We need to use fuzzy arithmetic numbers to obtain an average value which becomes the expected value of the probability of the risk event.

How do we obtain the average probability value?

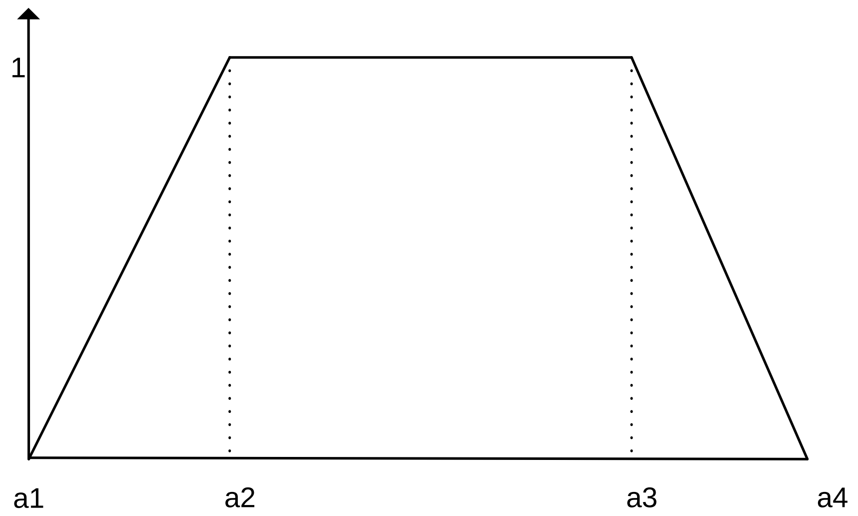
- Each risk event can be explained by one or more causes, and each cause can occur with different probabilities
- It is necessary to obtain a mean value of the probability of occurrence.
- This calculation, initially based as qualitative values (Unlikely, Medium, or Very High), cannot be carried out with traditional arithmetic.

Example : How to obtain average from 3 risk factors

Suppose a Risk Critical event is explained by three Risk Factors, RF#01, RF#02, and RF#03, with the following probabilities: "**unlikely,**" "**possible,**" and "**almost certain.**"



Calculating average



Geometric shape of a trapezoid

Figure above is the membership function of probability output.

Geometric figures of trapezoids and triangles, with the points of the set base as a_1 (minimum), a_2 and a_3 (greater membership), and a_4 (max),

Determining the values of the points in the trapezoids

- The result of the evaluation of *n* risk factors in an average of the following Category:
  - $\bar{a}_1 = (a_{11} + a_{21} + \ldots + a_{n1})/n;$
  - $\bar{a}_2 = (a_{12} + a_{22} + \ldots + a_{n2})/n;$
  - $\bar{a}_3 = (a_{13} + a_{23} + \ldots + a_{n3})/n;$
  - $\bar{a}_4 = (a_{14} + a_{24} + \ldots + a_{n4})/n;$

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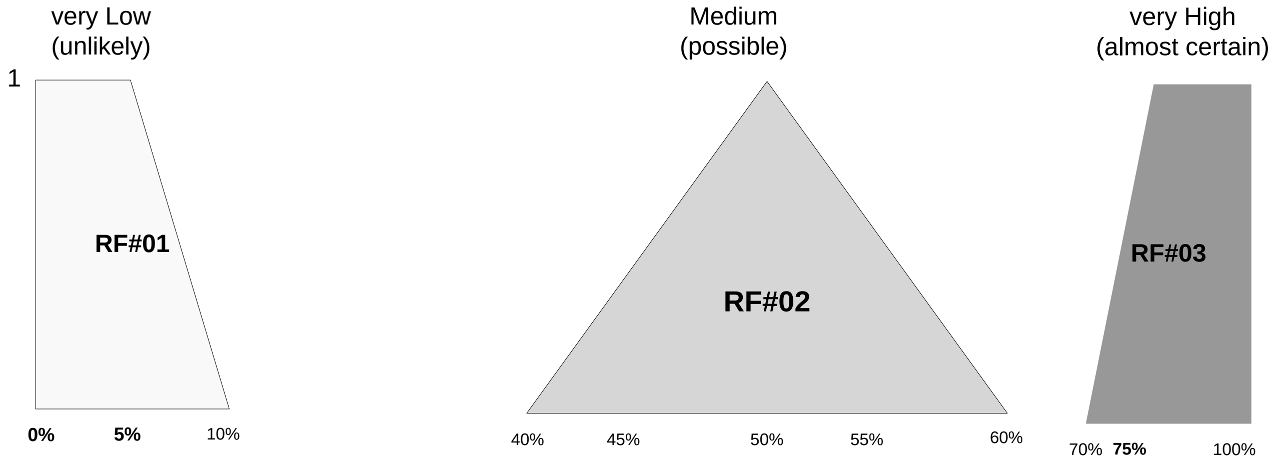


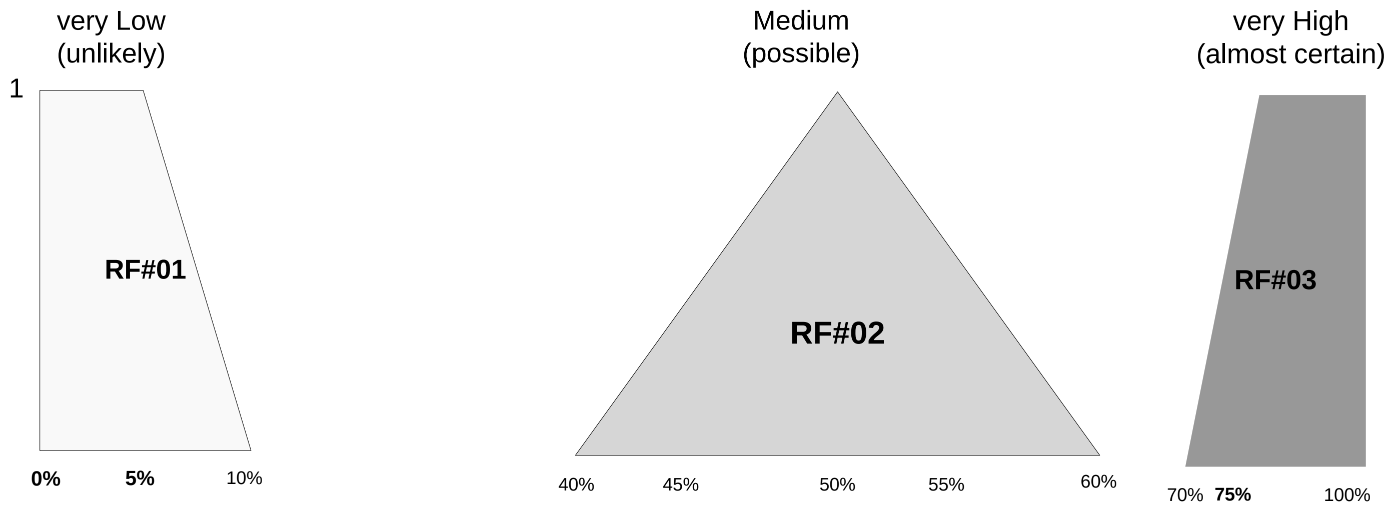
Example: Reputational Risk

Examples of reputational risk components are:

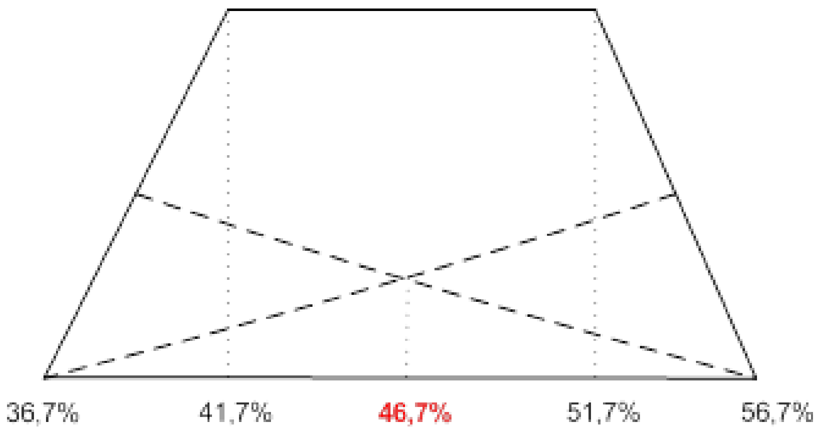
- Financial risk: integrity of donations and fundraising activities.
- Research risk: integrity of research, its methods and its dissemination.
- Admissions risk: adverse perception on student (PG and UG) admissions.
- Academic staff: staff must be of high academic quality.
- Regulatory risk: failure to satisfy stakeholder requirements (e.g. data quality).
- Governance risk: the University must be seen to be well managed strategically and operationally

- The average probability is obtained from the arithmetic average of each point: example for 3 risk factors under Reputational risk

$$\bar{a}_1 = (0\% + 40\% + 70\%) \div 3 = 36.7\%$$
$$\bar{a}_2 = (0\% + 50\% + 75\%) \div 3 = 41.7\%$$
$$\bar{a}_3 = (5\% + 50\% + 100\%) \div 3 = 51.7\%$$
$$\bar{a}_4 = (10\% + 60\% + 100\%) \div 3 = 56.7\%$$



Calculating average probability across risk factors



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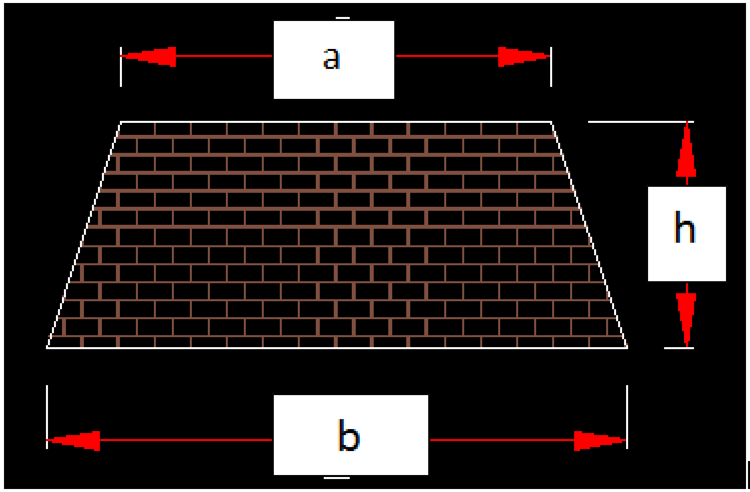
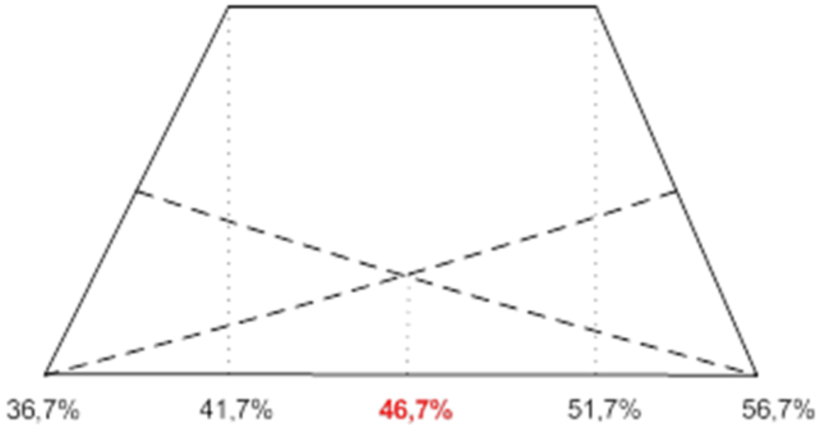
CENTROID OF TRAPEZIUM FORMULA





$$x = \frac{b + 2a}{3\,(a + b)}h$$

a=10 (46.7%-36.7%), b=20 (56.7-36.7) H= 100

Average(x) = 44.44%

Probability value based on qualitative information is 0.44

Conclusion

- Dynamic evaluation of risk assessment will lead to a better risk calculated decision.
- Fuzzy logic approach is one of the alternative that can be employed to convert judgmental information to quantitative values.
- There is a big opportunity for people with good quantitative to explore and contribute to the area of Risk Management.