

# MATHEMATICAL QUANTIFICATION OF OPERATIONAL & STRATEGIC RISKS

Overcome cognitive biases to quantitatively model enterprise risks

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Gathering information on qualitative risks    Aggregating qualitative risks with math    Presenting the result with actionable insights

## AGENDA

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### ABOUT THE SPEAKER - CAROL

- 15 years in the insurance industry, as regulator and industry insider
- Masters of Science in Risk Management/Insurance from Florida State University
- Designed, implemented, managed, then directed the ERM program for large property insurance carrier
- Help dozens of organizations use ERM to support decision-making

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ABOUT THE SPEAKER - UJAE

- 10+ years in actuarial/quantitative modeling for insurance companies
- Master of Financial Mathematics from University of Minnesota
- Designed quantitative ERM models & reports to meet ORSA and major rating agency requirements

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Strategic and Operational Risk  
Versus  
Underwriting and Investment Risk

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COMMON CHALLENGES WITH QUALITATIVE RISK ASSESSMENTS

- "Squishy" results
- Gut instinct, not metrics
- Answers are all over the board
- Difficult to aggregate
- Translating to action is cumbersome

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**QUANTIFYING QUALITATIVE RISKS: COMMON CHALLENGES**

- Risk managers uncomfortable with process
- Executives hesitate to give hard numbers to softer risks
- Impact \* Likelihood calculation
- Executives override assessment results

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**OVERCOMING CHALLENGES**



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**GATHERING INFORMATION FOR QUALITATIVE RISKS**

- Custom designed for the company
- Recommend between 8 and 20 risks. Never more than 20!
- Focus the interview questions based on the audience.
- Use technology when possible and reasonable.
- Ask questions with the end in mind.
- Avoid asking frequency/likelihood.

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**HELPING PEOPLE DISCOVER IMPROVED PROBABILITY ASSESSMENTS**

What typically happens...

- \* Ask: What is the probability of a flat tire happening over the next week or the next year?
- \* Interviewee: WILL struggle in his/her mind. Then...

A better way...

- \* Ask:
  - \* How many flat or deflating tires have you had in your lifetime? [3 times]
  - \* How many years have you been driving your car? [20 years]
- \* Then you calculate probability:
  - \*  $\frac{3}{20} \approx 15\%$  in any given year  $\rightarrow \frac{15\%}{304} \approx 0.05\%$  in any given day.

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**FOCUS ON THE GOAL: NUMBERS!**

**Quantifying Qualitative Risks**

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11

**WHO PARTICIPATES IN INTERVIEW?**

Operating companies (not holding company) unless centralized functions

3 to 4 layers below executives

Typically 60 to 250 interviews/surveys should be conducted.

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12

USING TECHNOLOGY



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13

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AN ALTERNATIVE TO FACE TO FACE INTERVIEWS

Strategic Risk: Competitor  
 Definition: Unexpected change in competitive landscape, such as new entrants, aggressive competitor actions against the company, price wars, and so forth.\*

Interview Questions?

Regarding this risk, what was the worst annual loss amount within the last 4 (and 10) years in today's scale and scope?

Within the next 1 year, what do you expect loss amount [acceptable risk that you are willing to take, unacceptable risk, only in theory and unrealistic] would be?

\* Sim Segal's Corporate Value of Enterprise Risk Management (2011)

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14

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MATHEMATICAL AGGREGATION OF INTERVIEW RESULTS

- \* Make some simplifying assumptions for the greater good.
- \* Aggregation must use two dimensions
  - \* Product / Subsidiary
  - \* Function

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### MATHEMATICAL AGGREGATION FOR PRODUCTS: ADD VERSUS AVERAGE

When to Add Results: **between** subsidiaries/product lines

When to Average Results: **within** subsidiaries/product lines

$(\text{Piggy Bank} + \text{Piggy Bank}) / 2$

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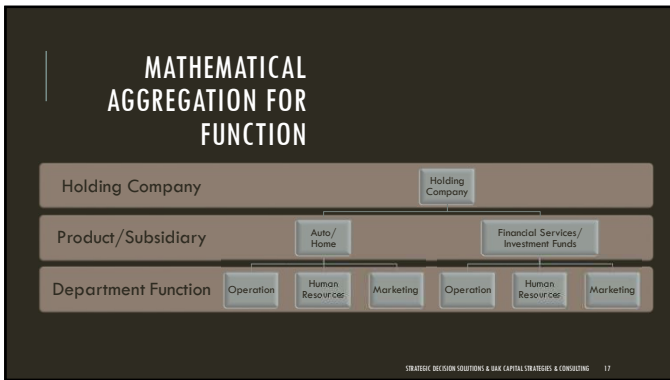
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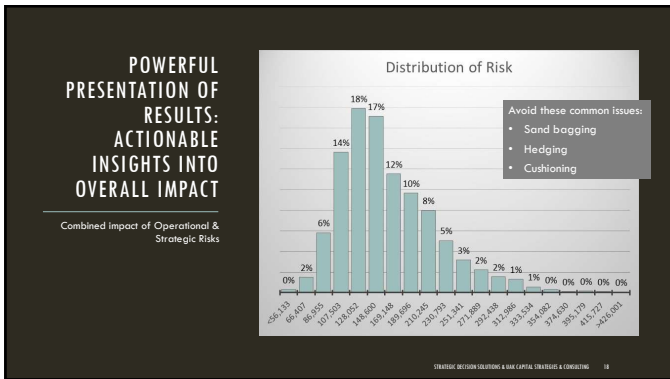
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### POWERFUL PRESENTATION OF RESULTS: PRIORITY AREAS TO FOCUS

Percent	Label	Value	Unit	Target	Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance	Weighted Variance
2%	Label	1,487	1,382	105	800	1,487	987	1,054	1,111	718	1,284	1,487	1,487	1,487	1,487	1,487	1,487	1,487	1,487
10%	Label	1,999	1,592	407	1,000	1,999	1,000	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999
15%	Label	2,440	1,880	560	1,200	2,440	1,200	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440
8%	Label	1,688	1,111	577	800	1,688	800	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688
8%	Label	1,688	1,111	577	800	1,688	800	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688
10%	Label	1,999	1,592	407	1,000	1,999	1,000	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999
10%	Label	1,999	1,592	407	1,000	1,999	1,000	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999
10%	Label	1,999	1,592	407	1,000	1,999	1,000	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999	1,999

Group Of Sub: (All)  
Product: Annuity

Labels	Value Avg	Value Sum
Litigation	2,148	12,520%
Competitor	1,882	10.95%
Credit	1,717	9.98%
Compliance	1,329	7.80%
Execution	1,057	6.15%
Processes	1,007	5.80%

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19

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### POWERFUL PRESENTATION OF RESULTS: SOURCES OF UNCERTAINTY

Overall uncertainty source by the product, subsidiary level.

Percentile	Annuity	Disability	International Annuity	International Life	Investment Products	Life	Long Term Care	Sum
1%	819	1,813	908	1,127	98,289	4,412	3,500	101,212
5%	8,419	8,532	2,364	2,959	28,254	23,399	9,819	117,768
25%	12,707	12,698	3,261	3,898	38,657	34,076	13,199	145,277
50%	18,718	17,568	6,746	8,417	83,624	50,872	17,058	185,069
75%	23,106	20,600	7,889	8,282	113,707	85,207	26,778	236,396
90%	27,045	24,344	12,432	11,344	170,492	119,819	42,351	315,917
95%	30,106	26,900	15,811	14,611	213,707	145,207	53,119	393,351
99%	37,106	33,344	19,811	18,611	263,707	185,207	66,119	480,351
Average	15,510	14,844	3,987	4,521	60,904	42,115	15,100	156,971

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20

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### POWERFUL PRESENTATION OF RESULTS: INVESTMENT OPPORTUNITIES

Concerned about missing earnings per share (EPS) target?

- ◆ Pinpoint low investment opportunities
- ◆ Reduce the most unexpected volatility around EPS.

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21

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### IT CYBER SECURITY CASE STUDY

Revenue	92,000,000,000
FTE	63,900
Total IT Cyber Budget	N/A
# of Customers/Members	40,000,000
# of enterprise seats or nodes	N/A
Total Individual Data	90,000,000
Center 1	9,000,000
Center 2	18,000,000
Center 3	27,000,000
Center 4	36,000,000
Center 5	0
Insurance Policy	
Aggregate Limit	250,000,000
Deductible	10,000,000
1st Party	N
3rd Party	Y
Attack Frequency	1

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22

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### IT CYBER SECURITY CASE STUDY

The amount of time, effort and other organizational resources spent, but not as a direct cash outlay.

Opportunity Cost

the direct expense outlay to accomplish a given activity.

Output

IT Cyber Security Budget Spent Approximation		140,580,000		~	368,000,000
Percentile	Description of likelihood	Total Cost Indirect	Total Cost direct	Total Cost (Ceded)	Unceded Total Cost
1%	Extreme Remote Favorable	0	0	0	0
10%	Passible very Favorable	0	0	0	0
25%	Favorable within Normal	0	0	0	0
75%	Adverse within Normal	644,337	226,234	870,571	870,571
90%	Passible very Adverse	8,443,825	2,964,721	11,408,546	11,408,546
99%	Extreme Remote Adverse	539,607,323	189,462,127	729,069,450	178,497,812
Average		28,321,578	9,958,100	38,279,678	3,854,684
Median		1,227	431	1,658	0

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### CYBER SECURITY: WORDS OF WISDOM

Abundant data sources, making actuarial modeling possible and feasible.

Cyber security risks fat-tailed and skewed nature make them difficult for human judgement

Avoid the contentious discussion on budget/investment in Cyber Security by using objective actuarial modeling reports to bring consensus.

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### PERCEPTION VERSUS REALITY

The likelihood an organization will have another data breach

**Figure 16: Expert Judgement VS Reality**

Data Breach Count	Survey Result (%)	Actual Data (%)
10,000	14%	13%
20,000	10%	9%
30,000	8%	7%
40,000	7%	6%
50,000	5%	5%
60,000	3%	4%
70,000	2%	3%
80,000	1%	2%
90,000	1%	1%
100,000	1%	1%

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### OTHER CONSIDERATIONS: CORRELATIONS

- Most Operational & Strategic Risks are independent.
- However, high positive correlation needs to be treated.   
 Market, Economics, Credit, and Liquidity risks
- Independent vs Monte Carlo Simulation (Partial of Stochastic Approach)

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26

### OTHER CONSIDERATIONS: RATING AGENCIES AND REGULATORS

CURRENTLY DON'T EXACTLY KNOW WHAT TO ASK FOR

GIVE THEM CONFIDENCE AND SENSE OF TRANSPARENCY BY PROACTIVELY SHOWING THEM YOUR PROCESS

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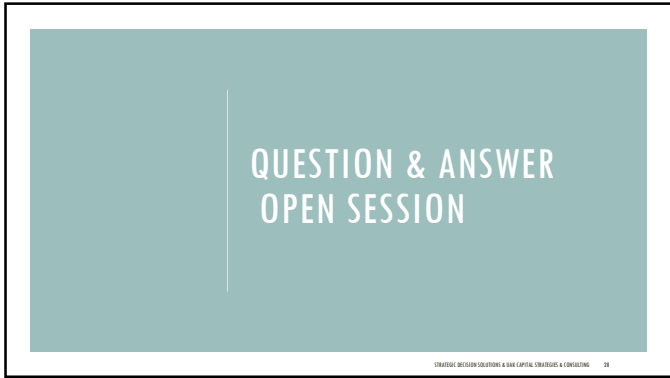
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