Benefits & Methods for Quantifying Operational Risk

Perspectives from Decision Science

Webinar
6 December 2018

Presented to:
The Institute of Operational Risk

Presented by:
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Warwick Blyth
Agenda

• Risk & Opportunity: Opposite Sides of the Coin
• Risk Prioritisation: Overcoming the Pitfalls of Heat Maps
• Characterising and Understanding Risk: Some Tools
• Final Thoughts
What is a risk anyway? When is it an opportunity?

• I am offering a valuable instrument.
  – It is free.
  – Success is contingent on calling the flip of a coin correctly.
  – If the call is correct, the bearer receives $20
  – If the call is incorrect, the instrument becomes worthless.

Win $20 if Call is Correct

• Payment to be made within five minutes of the correct call
• Certificate is worthless if the call is incorrect
• A verified two-sided coin will be used
Consider this ...

- Is the instrument worth something?
- Do you have a risk in accepting the offer?
- Assuming that you have accepted the offer and now you own it, do you have a risk?
- When did the opportunity change into a risk?
The tools for characterizing and quantifying uncertainty are the same whether we are talking about traditional “risks” or opportunities.
The primary goal of the CEO and Board is to shift the uncertainty to the right and reduce it.

- This includes all the upside and the downside opportunities
- Individual risks and opportunities are incremental changes to the whole value distribution
- Uncertainty management requires managers in different functional roles to handle specific strategic and operational risks.
Decision analytic tools and methods can help the Risk Management process at various points.

1. Identification
   What are the risks?

2. Assessment & Selection
   What is the likelihood of the risk occurring?
   How severe will the risk impact be?

3. Mitigation/Decisions
   What can we do to reduce the risk impact or likelihood of occurrence?

4. Monitoring & Control
   Are the risk owners managing the risks?
   Has the situation changed?
   Are there new risks emerging?

- Influence Diagrams
- Opportunity Tornados
- Probabilistic Modelling
- Heat Maps
- Expected Loss
- Assessment Techniques
- Enterprise level understanding of risk
- Risk Registers
- Business Tornadoes

Progressive Screening to Focus Resources on Highest Value Risks

1000s
Top 20
~10 Decision Projects
Continuing management effort
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Enterprise level understanding of risk
Risk Registers
Business Tornadoes

Heat Maps
Expected Loss
Assessment Techniques

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Poll: How do you prioritize risks in your organization?

a) Not at all
b) Adhoc/subjective approach
c) Use a Heat Map/Risk Matrix (Red/Yellow/Green)
d) Quantitative approach e.g. Expected Loss
Heat Maps (or Risk Matrices) are commonly used to assess and prioritize risks and are considered a “best practice” for this purpose.

The risk matrix (heat map) is a strongly applicable tool for risk identification, risk analysis, and risk evaluation.

— ISO (International Organization for Standardization)
But there is relatively little theory behind “Heat Maps” and numerous practical flaws have been identified.

4 examples:

<table>
<thead>
<tr>
<th>Flaw</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Acceptance Inconsistency</td>
<td>Accepting risks that are worse than risks that are rejected</td>
</tr>
<tr>
<td>Range Compression (Lie Factor)</td>
<td>Gross distortions of the likelihood, but especially the consequence scale, which biases decision making</td>
</tr>
<tr>
<td>Centering Bias</td>
<td>The tendency of people to avoid extreme values or statements when presented with a choice.</td>
</tr>
<tr>
<td>Arbitrary Ranking</td>
<td>The risk ranking produced by a heat map is determined by arbitrary decisions regarding its construction, such as the number and size of categories and if one prefers to use large or small numbers to signify greater risks.</td>
</tr>
</tbody>
</table>

**Example: Range Compression inconsistency.**

Outcomes with vastly different consequences and likelihoods are often placed in the same position in the matrix, leading to gross inconsistency in the recommended action.

<table>
<thead>
<tr>
<th>Impact Level</th>
<th>Probability/Frequency</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 10 SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 10 SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - 3 SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **A**: $11 million, EL = $0.66 million, p = 6%
- **B**: $1,000 million, EL = $50 million, p = 5%
- **C**: $11 million, EL = $0.66 million, p = 6%
- **D**: $1,000 million, EL = $240 million, p = 24%
So what should we do?

“it seems clear to us that RM{s} should not be used for decisions of any consequence…… Our best chance for providing high-quality risk-management decisions is to apply the well-developed and consistent set of processes and tools embodied in decision science

- Thomas et al in “The Risk of Using Risk Matrices”

Risk registers can easily be modified so that instead of using ordinal scales like 1-5, experts learn how to subjectively assess quantities behind them.

<table>
<thead>
<tr>
<th>Replace</th>
<th>With</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likelihood ratings on scales of 1 to 5 or “Low”, “Medium”, “High”</td>
<td>Estimated probability (0%-100%) the risk event will occur in a given period of time.</td>
</tr>
</tbody>
</table>
| Impact ratings on scales of 1 to 5 of “Low”, “Medium”, “High” | An estimate of the average monetized loss resulting from the event **OR**
A range estimate of the monetized loss e.g. 80% confidence interval of the monetized loss, or P10-P50-P90 assessment of the loss.
Subjective assessment of probabilities and monetized outcomes allows prioritization of risks by their “expected” or probability-weighted loss.

<table>
<thead>
<tr>
<th>Event Name</th>
<th>Probability Event Occurs (Annual)</th>
<th>Event Occurrence ($millions)</th>
<th>Expected Loss ($millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Losses</td>
<td>40%</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td>Well Control</td>
<td>10%</td>
<td>25</td>
<td>2.5</td>
</tr>
<tr>
<td>Blowout</td>
<td>5%</td>
<td>250</td>
<td>12.5</td>
</tr>
<tr>
<td>Small Blowout</td>
<td>15%</td>
<td>25</td>
<td>3.8</td>
</tr>
<tr>
<td>Leak</td>
<td>20%</td>
<td>19</td>
<td>3.8</td>
</tr>
<tr>
<td>Rig Failure</td>
<td>30%</td>
<td>40</td>
<td>12.1</td>
</tr>
<tr>
<td>Overburden Penetration</td>
<td>8%</td>
<td>53</td>
<td>4.3</td>
</tr>
<tr>
<td>Jammed Casing</td>
<td>60%</td>
<td>9</td>
<td>5.4</td>
</tr>
<tr>
<td>Stuck Tool</td>
<td>40%</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td>Poor Cement</td>
<td>2%</td>
<td>110</td>
<td>2.2</td>
</tr>
</tbody>
</table>

"Expected loss" can be adjusted for risk appetite to provide an upper bound on how much you’d be prepared to invest to mitigate or fully offset the risk.

![Diagram showing sorted expected loss values]
Assessing & Prioritising Risk

Assessing risks with actual assessments enables other tools that create useful visualisations of total portfolio risk.

<table>
<thead>
<tr>
<th>Event Name</th>
<th>Probability Event Occurs (Annual)</th>
<th>Event Outcome ($millions)</th>
<th>Expected Loss ($millions)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
<td>1.3</td>
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<td>10%</td>
<td>20</td>
<td>2.5</td>
</tr>
<tr>
<td>Blowout</td>
<td>5%</td>
<td>205</td>
<td>12.5</td>
</tr>
<tr>
<td>Small Blowout</td>
<td>15%</td>
<td>10</td>
<td>3.8</td>
</tr>
<tr>
<td>Leak</td>
<td>20%</td>
<td>4</td>
<td>3.8</td>
</tr>
<tr>
<td>Rig Failure</td>
<td>30%</td>
<td>18</td>
<td>12.1</td>
</tr>
<tr>
<td>Overburden Penetration</td>
<td>8%</td>
<td>52</td>
<td>4.3</td>
</tr>
<tr>
<td>Jammed Casing</td>
<td>60%</td>
<td>8</td>
<td>5.4</td>
</tr>
<tr>
<td>Stuck Tool</td>
<td>40%</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>Poor Cement</td>
<td>2%</td>
<td>100</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Monte Carlo Analysis

39% chance that total loss (on all events) will exceed $40 million

Distribution of Potential Loss Outcomes

This can be particularly useful if, for example, you wanted to understand total exposure to a category of risk e.g. cyber risk events.
Some practical considerations:

• In the case of very large risk registers it may not be essential to undertake the overhead of quantifying all the risks – a screening system to triage risk can be helpful.
  – This is necessarily subjective and really focuses on identifying lower priority risks

• Quantification is inherently subjective as are the common ordinal scale ratings.
  – What we are trying to do is capture a mental model in a consistent framework that supports clear and high quality decision making.

• Subjective assessments are subject to cognitive biases; calibration training can significant improve expert performance in these assessments.
  – Assessments can also be assisted with data and/or analytical models which can be developed selectively to inform the process.
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In complex situations, decision makers rely on analysts to use reasoning to deliver insights around different alternatives.

- **Do Nothing**
- **Mitigation Strategy A**
- **Mitigation Strategy B**
Influence diagrams help us to structure an analysis and decompose the problem to a level where sound input assessments can be made.

Example based on example in Hubbard & Seierson (2016), "How to Measure anything in Cybersecurity Risk."
To illustrate the modelling process we are going to use a simple property investment example.
Inputs to decision models are uncertain and experts are asked to specify P10-P50-P90 ranges on their assessments.

<table>
<thead>
<tr>
<th>Uncertainties</th>
<th>Description</th>
<th>Low P10</th>
<th>Base P50</th>
<th>High P90</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Vacancy Rate</td>
<td>0%</td>
<td>5%</td>
<td>30%</td>
</tr>
<tr>
<td>27</td>
<td>Real Rent Escalation</td>
<td>−3%</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>28</td>
<td>Operating Expenses ($000)</td>
<td>1,300</td>
<td>1,450</td>
<td>1,650</td>
</tr>
<tr>
<td>29</td>
<td>Points to Refinance</td>
<td>1.0%</td>
<td>2.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>30</td>
<td>Discount Rate</td>
<td>5.0%</td>
<td>8.5%</td>
<td>6.5%</td>
</tr>
<tr>
<td>31</td>
<td>Inflation</td>
<td>2.0%</td>
<td>3.5%</td>
<td>11.0%</td>
</tr>
<tr>
<td>32</td>
<td>Capitalization Rate</td>
<td>7.5%</td>
<td>8.0%</td>
<td>12.0%</td>
</tr>
<tr>
<td>33</td>
<td>Interest Rate at Refinance</td>
<td>8.5%</td>
<td>10.0%</td>
<td></td>
</tr>
</tbody>
</table>

We typically build decision models with spreadsheets; in the Risk Management world there is a lot of potential to build libraries of models to analyse specific types of recurrent risks.
A “tornado diagram” graphically depicts the variables’ contributions to uncertainty in overall value/loss.

- Each variable is changed from low to high inputs, with all other variables at their base-case values.

**Variable**

- **Real Rent Escalation (%)**
  - Low: -3
  - High: 3
  - Base Case: 0
  - Cumulative NPV Variance: 47%

- **Vacancy Rate (%)**
  - Low: 30
  - High: 0
  - Base Case: 5
  - Cumulative NPV Variance: 79%

- **Inflation Rate (%)**
  - Low: 2
  - High: 6.5
  - Base Case: 3.5
  - Cumulative NPV Variance: 95%

- **Capitalization Rate (%)**
  - Low: 11
  - High: 7.5
  - Base Case: 8
  - Cumulative NPV Variance: 97%

- **Refinance Rate (%)**
  - Low: 12
  - High: 8.5
  - Base Case: 10
  - Cumulative NPV Variance: 99%

- **Operating Expenses**
  - Low: 1,650
  - High: 1,300
  - Base Case: 1,450
  - Cumulative NPV Variance: 100%

- **Refinance Points (%)**
  - Low: 3
  - High: 1
  - Base Case: 2
  - Cumulative NPV Variance: 100%

**Net Present Value ($ thousands)**

- Base Value: 203

These are the critical uncertainties that we should try and control or mitigate.

*Contributions to uncertainty in NPV.*
Understanding the Tornado for the business as a whole can help teams identify value and risk mitigation opportunities.

In this example business value was doubled in 12 months by redirecting teams from a cost to a yield and export focus.
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Some additional resources:

- **Decision Quality** book by Carl Spetzler et al.
- **Handbook of Decision Analysis** by Greg Parnell, Steve Tani et al
- **How to Measure Anything** by Doug Hubbard.

- SDG Website: https://sdg.com/thought-leadership/resources-hub/
- Decision professional associations
  - SDP https://www.decisionprofessionals.com/
  - EDPN (Europe) www.edpn.org/
- SDG leaders teach strategic decision making in courses with The University of Texas at Austin.
SDG is committed to helping our clients improve the quality of their decisions and their decision processes around Risk Management.

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