Why and how we should quantify risk

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Summary:

We take and manage risk to achieve objectives. In order to do this well we need to think through our risks and how they could impact us. This paper asks: is it worth quantifying risks and creating models to simulate the effects that risks could have on our ability to achieve our objectives? Or is quantifying risk a waste of time, detached from the reality of real life?

In my experience, thinking through and quantifying our risks in an informed way allows us to better understand the uncertainty we face, and helps us make good risk-informed decisions. This paper, which is orientated towards non-financial industries and sectors, discusses various aspects of risk quantification.

There are different ways to quantify risk – this paper touches on a few methods. Regardless of the methods used, the following three elements are, in my experience, important to bear in mind:

1. The value of thinking through ranges of outcomes
   When you are putting together your plans and objectives, and also when you review them on a regular basis, carefully think through, in an unbiased way and ideally in a team environment, the range of outcomes (expressed as values) that cover the possible effects your risks could have on achieving your objectives. Try to understand as best you can what you don't know and what you are not sure about. Seek viewpoints and possibilities about your uncertainties. The more you can do to understand uncertainty, the better your decision-making will be.

2. Build a good model
   Model your risks in an appropriate way, so that when you run the model it provides insights for intelligent decision-making, and to maximise your probability of achieving your objectives.

3. Do something with the results
   Assess the results of your risk quantification work, along with qualitative reviews of your risks, against your appetite for risk. Review scenarios of possible outcomes (including outliers) to understand whether your strategy is sound and resilient to potential changing circumstances, or whether it could be enhanced if changes were made (for example, introducing new controls or changing your objectives).
Why should I bother quantifying risk? Because I’m not sure…

Let’s start with an argument against quantifying risk.

Since we can’t predict the future, why waste time and resources trying to guess what could happen in a theoretical model? Shouldn’t we focus our efforts on understanding our risks qualitatively, and work out actions to take to manage them, rather than creating quantitative models?

Qualitatively understanding and reviewing risks is important. Maybe quantitatively assessing risk can complement a qualitative review. Let’s discuss this with a simple example of betting on a coin flip.

How much money would you be willing to bet on a coin (which you are not allowed to examine beforehand) landing on heads five times in a row? Here are my rules:

<table>
<thead>
<tr>
<th>Amount you bet</th>
<th>If five heads in row, you win</th>
<th>If the fifth flip is tails, you lose</th>
<th>If any of flips 1-4 are tails, you lose</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5</td>
<td>$500</td>
<td>-50</td>
<td>-10</td>
</tr>
<tr>
<td>$10</td>
<td>$1000</td>
<td>-100</td>
<td>-20</td>
</tr>
<tr>
<td>$50</td>
<td>$2500</td>
<td>-500</td>
<td>-50</td>
</tr>
</tbody>
</table>

Doing the maths, you can calculate your odds of winning as $0.5 \times 0.5 \times 0.5 \times 0.5 \times 0.5$, which is 3.125%, or a one in 32 chance. But how do you know that a one in 32 chance is accurate? What assumptions are you making? How much have I told you about the coin? You are probably assuming the coin is “fair”, but what if it is weighted to land on tails, or it is a two-headed “heads” coin so it will always land on heads?

What if you tried a similar coin flip exercise two hours ago and it landed tails four times out of five? You will probably have “recency bias”, and feel negative about your chances. We are all biased in our assessments of any type of situation. My Newsletter from May 2018 includes interviews with experts who discuss ways to de-bias your views and your decision-making.
We all tend to have a tendency to:
- Believe we know more than ‘the facts’ in front of us
- Cling to ‘our anchors’ (for example, our experiences, good and bad)
- Seek confirmation of our beliefs, rather than a rejection of them

To reduce your uncertainty, you could do the following:
1. Ask to hold 50 test coin flips (if it comes up 50 times heads or tails, there’s probably something up with the coin)
2. Calculate a probability analysis to assess outcomes, and see if this helps inform your decision

There are different ways to model these scenarios. When I apply probability theory, I determine that option 3, to bet $50 is the best bet. But would you be comfortable with this bet? Any tail flip in flips one to four would cost you your $50, and a final (fifth) tail flip would cost you $500, whilst flipping five heads in a row would win you $2500.

If you cannot afford to lose $50 – if you do not have the appetite for the downside risk – you won’t want to place this much in a bet.

The best answer to a five-time coin flip bet choice is probably: “I don’t know. I need to review my circumstances.”

The coin flip example is just a simple one. Business and organisational decision-making involves many variables, which can be challenging to assess. Life is full of uncertainty, randomness and chance. To help us navigate this uncertainty, thinking through a problem and, when appropriate, using the right kind of data, can help us to understand and quantify our risk in order to see insights – but not certainty – into possible future outcomes.

You are what you measure

You need to have an objective for quantifying your risk. Make “the need to see insights” a measurement / metric. Risk quantification has to help you to optimise your decision-making to be worth conducting.

Understand what data you need to quantify your risk

A good starting position for quantifying risk is, in an unbiased way, to collect and record appropriate data, which we can use to make assumptions in order to reduce the uncertainty we face to achieving our objectives. Sometimes you only need a surprisingly small data set. It depends on the situation. What is key is that you have good data, which must relate to your objectives. Don’t collect data if you can only relate it to risks and you can’t tie it to objectives.
What can you apply risk quantification to?

Applications of quantifying risk range from assessing business plans, to modelling litigation outcomes with decision trees, quantifying the sustainability of a supply chain and the impact of supply chain breakdowns, making product development decisions, modelling safety risk, and managing project cost contingency and escalation risk.

Organisations in some industries have been using risk quantification to decide how to achieve their objectives for years. The insurance industry is an example. When you buy insurance, you are paying for a probabilistically-determined (i.e. measurable and quantified) risk outcome which takes many variables into account.

For examples on a global scale, insurance companies are quantifying risk to decide how to deal with the effects of climate change and natural disasters.

What do I need to consider when quantifying my risks?

You can’t predict the future… but you can anticipate and adapt with smart observations

An important part of quantifying risk is to admit that you are not sure how events may turn out. You can’t be.

Despite this if you were able to simulate how your risks could play out 10,000 times in a well-thought-through model, could that help you to make an informed decision on how to proceed, whilst always remembering that the outcome might unfurl differently?

Here are some points which may be useful to bear in mind:

1. Our world is complex – maybe modelling it can help us to understand it

In our interconnected and increasingly digitised world, many risks and uncertainties that we contend with cannot be evaluated and managed in isolation. Quantifying our risks and, if appropriate, correlating their impact on each other may help us to understand how scenarios could unfold. By doing this, we may spot insights that we might otherwise miss if we looked at risks in isolation or in just a few basic scenarios.

2. Use System 2 (deep thought) to think through your risks:

To quantify risk well, you have to think carefully about possible outcomes and scenarios – expressed as a range of outcomes – rather than focus on black and white “point estimates”. Thinking about possible outcomes, and describing assumptions we have made to justify them, is good risk management. Having specific targets to reach is fine, but risk is about uncertainty and we can’t be sure of achieving a specific target.
To think carefully about possible outcomes that may affect whether we achieve our objectives, we need to use our “System 2” thinking, which has been brought to popular attention by Daniel Kahneman in his book, Thinking Fast and Slow. As Kahneman says in his book, we need to pay attention and focus properly when using our System 2, otherwise we will not do it well. Engaging in deep thought is a good habit to develop (or redevelop), whether you are quantifying risks or doing something else that requires concentration.

3. What’s your risk appetite and tolerance (do you know?)

We should know what our appetite and tolerance for risk is in order to know whether a risk matters or not (risk management is all about focusing on the uncertainty that matters). Have you articulated your appetite and tolerance for risk? Quantifying your risks can help you to understand the probability of outcomes falling within or exceeding your risk appetite and maybe your tolerance too.

If there is a high probability that you could exceed your appetite and tolerance for risk, you may still choose to continue on your current path to achieving your objectives, but perhaps you will put in place more actions, such as bolstering the controls you need to manage your risks.

4. Are you being too negative with your decision-making?

Many of us tend to overplay the effects of possible risks. That’s not to say that we should go out and “bet the house” on things, but it’s worth bearing this in mind when you put together a model to quantify risk.

So how can we quantify risk well?

Different methods exist. Here are some elements to help ensure it adds value:

1. Quantifying risk should be stitched into your business activities, and done as you set your goals, strategies and plans. It should be clear to people how risk quantification helps them achieve objectives. If you do not have proper buy-in, you may be wasting your time, or only having a marginal impact.

2. Quantify risk collectively as a team, not just one person’s view of the world. Use good cognitive management techniques to de-bias views and decisions and uncover “unknown knowns” (sometimes called “elephants in the room”).

3. Break down risks into components that can be quantified. You may have to ask people “why?” and “how much?” a few times to break risks down into components. This can be a valuable exercise, as it can lead the risk owner and other team members to see new insights into their own assessment of their risks, and what they mean to their objectives.
4. Learn how to build simulation models correctly and use good tools for it. This will require a little time to master, and it is very important. You may integrate quantitative analysis into an existing document / analysis that a team is already using (which is a good approach), or you may build a quantitative model from scratch. Either way, do it well, get it peer-reviewed, test it and make sure it stands up to scrutiny. See this reference paper by David Vose, and this information from Palisade as example information sources.

5. Ask “So what?” after you run an analysis. Perform risk quantification as an iterative process. Don’t run an analysis, write a report and leave it at that. Use the outputs to ask: “what does this mean for our objectives?” Look at different scenarios, look at sensitivities and seek insights into how you could improve your probability of success by making good risk-informed decisions.

Do you need to be a statistician to quantify risk?

You do not need to be a statistician to quantify risk, however, you need to make the time to have a good grasp of basic statistics, in order to build a good model. This is important, to ensure you can apply probability distributions to reflect the risks that people face, to understand whether and how to correlate risks with one another, and how to use probability theory.

You need to be good at interpreting what people say in a workshop or interview, by turning their assumptions and feedback about the risks they face into good quantifiable values. This requires using logic to break problems and challenges into manageable chunks, and to understand how to construct models to accurately represent risk.

What are some pitfalls to avoid?

Some things to avoid when quantifying risk include:

1. If you are quantifying risk to ‘tick a box’ rather than gain real value out of the process, don’t bother doing it.

2. If you are quantifying risks but you cannot clearly link the outputs to business objectives, you are limiting the value you provide.

3. If it is done without the right people being involved, the value will be limited.

4. If you don’t know how to create a good quantification model using the right rules, you won’t generate a good outcome (indeed, an incorrect model will mislead decision-makers).

5. If you use a tool that isn’t appropriate to quantitatively analyse your risk, you won’t generate the best outcome.
6. Don’t confuse good probabilistic decision-making with decision outcomes. For example, if you calculate a 90% probabilistic chance of success by taking one path and 10% in another, always remember that the 10% possibility could still occur, through bad luck or a combination of events that go against you. It’s just less likely. You might still go for it if your risk-reward gauge judges it worthwhile. Focus on the quality of decision-making and avoid falling into the hindsight bias trap that can cloud your judgement in future (poker players are good at avoiding this – they have to be given the quantity of hands they play).

What kinds of tools and techniques help us to quantify risk?

Here are four ways in which you can quantify risk, which work independently and with each other. Other methods exist; these are ones that I often find useful.

1. **Embedding risk optimisation within existing work activities**

When you build risk quantification into work that is already being conducted by a team, you are integrating it into work people are already doing. For example, you can review the probability of achieving operational targets in an existing production schedule, or a business plan, or a supply chain analysis.

It requires effort to stitch quantitative risk into existing tools and documents that people use, but it’s worth it. Done well, it can provide insights to help people determine how they can best achieve their objectives.

You could use a blend of tools and techniques to do this – for example, statistical calculations to quantify how to mitigate the effect of supply chain disruption, or how to best anticipate changes in demand for different products.

Some key things that you need to bear in mind are:

1. Are people focusing on the best way to measure results? If not, help them to do so.
2. Are people assessing probabilities of situations occurring? If not, help them to do so.
3. Are people really focusing on what matters most, or are they lost in details? Help them to focus on what really matters.
2. Monte Carlo analysis

When many people hear the words “risk quantification” or quantitative risk analysis (QRA) they think of Monte Carlo analysis – the method that produces a probability distribution curve like this:

Monte Carlo analysis has been around for some time (at least since the 1930’s) and its use for quantifying risk is widespread. Monte Carlo uses computational algorithms to conduct repeated random sampling in a model to obtain numerical results.

You may apply this tool to existing work activities that people undertake, or you may build a Monte Carlo model from scratch.

One way to apply Monte Carlo is as follows (taking into account our key points listed above, on how to quantify risk well):

1. Ensure you have a group of people who can contribute diverse views and facts
2. Ensure your objectives to what you are doing are clear
3. Agree how you are going to build a model (either in an existing analysis document, or create from scratch)
4. If you have single point assumptions, replace them with ranges of outcomes (in statistical terms, these are your distributions)
5. Articulate all assumptions and management inputs
6. If appropriate, apply a percentage probability of occurrence (in statistical terms this is called a binomial factor), if it makes sense to do so (which depends on your data and your model)
7. If appropriate, identify and create correlations between risks, if it is feasible to do so (it is relevant some situations, not in others)
8. Create a simulation model using good statistical methods that fit your data and what you are trying to achieve, perhaps comparing different distribution types to review results
9. Run a simulation and check it makes sense
10. Discuss the results as a team and look at different scenarios
11. Review the impact of changing variables and run the model again
12. Decide what risk-based decisions you can make to put you in the best position to achieve your objectives, whilst considering your appetite and tolerance for risk
Different technology tools exist to run Monte Carlo analysis, including the Palisade @RISK solution and the Decision Tools Suite which integrates into Microsoft Excel, and Vose Model Risk. You can integrate Monte Carlo analysis into a variety of other tools and decision-making techniques, such as Decision Trees.

3. Decision Trees

A Decision Tree is a good tool to assess options and decide the best route to take, including assessing options should circumstances change “during the course of events”. A Decision Tree can be produced on paper, or with software tools. Producing it on paper is recommended even if you are going to use a tool to create it. The linkage with quantitative risk is that when you have appropriate data about your options, a Decision Tree can be built with probability assessments incorporated into it (and you can run a Monte Carlo analysis if appropriate as well).

A basic Decision Tree diagram (the square = a decision point; the circle = a chance of an outcome occurring):

Here’s one way of building a Decision Tree:
1. It’s important to visualise what your Decision Tree could look like. Whilst you could build it from scratch in software, it’s a good idea to draw it on paper. You can change it as you go – it doesn’t need to be fixed in stone.
2. If you are building it as a team, try using some large sheets of paper on a wall, and create “nodes” using Post-it notes (with lines drawn in between them).
3. Start with a box on the left-hand side of a piece of paper and write down the decision you need to make.
4. From here, do you need to make a decision straight away, or do you have a fact to state as a “next step”?
5. If you need a decision, draw lines outwards for each possible solution, and write that solution along the line. Keep the lines as far apart as possible so that you can expand your thoughts on these “decision branches”.
6. At the end of each line, if the result of taking this decision is uncertain, draw a small circle, which is a “chance” shape in a Decision Tree. If the result is another decision that you need to make, draw a square. If it is simply a “next step”, draw a line to the next step. Write the decision or factor above the square or circle. If you have the solution at the end of the line, leave it empty.
7. Build your Decision Tree in a flexible way, assessing options and – if you have it – adding data for numbers (costs, values) and/or probabilities of outcomes.
8. Review your Decision Tree as a group – does it make sense?
9. If you have data and you are using an IT tool to build it, calculate your options (you may want to set up a table of “variables” for it to change and assess impacts):
   a. You can do this in Excel for a simple Decision Tree
   b. For a complex Decision Tree, or indeed a simple one, software is advisable (such as Palisade’s Precision Tree which is a plug-in to Excel)
10. Run through different scenarios, change variables and see what the impacts are on the options available.
11. At the end of a Decision Tree review, confirm the preferred decision, perhaps using a simple “voting tool”.

4. Quantitative analysis of time risk on programmes & schedules

Quantitative schedule risk analysis (QSRA) is a technique that a team can use to understand time risk in a programme / schedule for a project or piece of work that is being undertaken. By understanding time risk with the help of QSRA, a team can decide what risks are tolerable and what risks needs to be managed with appropriate controls in place.

Using the QSRA approach, a mathematical model is applied to a schedule through an appropriate IT tool, which simulates how the project schedule could play out. The outputs of this risk analysis are a probabilistic risk-quantified schedule with calculated confidence factors to achieving activities, groups of activities and the schedule as a whole by their target dates.

By reviewing this analysis, the project team can decide whether it should change parts of the schedule to lower or increase its risk level to an acceptable level of confidence in order to achieve the project delivery timelines.

For more details about quantitative schedule risk analysis (QSRA), refer to my paper on my website.

What’s a good way to get started with quantifying risk?

If you haven’t used techniques to quantify risk before, seek out and speak to someone who practices it and get some tips and advice from them, and learn from their experience.

Seek to gain a good understanding of statistics and statistical models and test your skills with risks that you and teams that you are working with are facing right now with different tools and techniques.
Conclusion

At the start of this paper we made it clear that we take and manage risk to achieve objectives. We need to understand risk and be comfortable making decisions in uncertainty in order to make good decisions to achieve these objectives. When it is done well, quantifying risk can help you make good quality decisions. It requires diligent thought, a sound understanding of probability and a curious mind that can create models of how risks could impact objectives.

As with all tools and techniques we use to take and manage risk, quantifying risk isn't the answer to everything. It can give you a view into how outcomes could materialise, which could lead to insights into the best actions to take to achieve your objectives.

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For more information about quantitative risk techniques and how to gain maximum value from them, including examples and models to work through, please contact Gareth to ask for further information.