Beating the Unknown

A Simplified Approach for Risk-Based Decision-Making

Businesses continuously face unsteady and challenging waters as the world becomes more complex and change happens every day. Nonetheless, most businesses support their decision-making processes using simple and static net present value or internal rate of return calculations – neglecting to assess the uncertainties present in the underlying assumptions. Drawing from a recent project in the energy & utilities sector, Arthur D. Little presents a pragmatic approach based on the Monte Carlo method, which allows thorough evaluation of the risk in business cases. Using this approach, businesses can reduce their downside potential and maximize the outcomes of their decisions.

The average gambler

Thanks to the turbulent business environment nowadays, making decisions is becoming both quicker and more complex. Therefore, one would assume that business decisions should consider all potential scenarios, and that only then, underlying risks could be evaluated thoroughly.

In reality, most decisions are made based on single numeric metrics (e.g. NPV, IRR). One reason for the widespread use of such metrics is that they offer simple calculations, but more importantly, decision-makers are familiar with them. Hence, they are able to understand the evaluation even with limited knowledge about the underlying assumptions.

The factor of risk is usually included by adding contingencies or by calculating multiple deterministic scenarios using different assumptions (e.g. sensitivity analyses). But even if risk-adjusted metrics are developed, the possibility of neglecting huge upside and downside potential is still there. This possibility might be crucial for the final decision.

In this Viewpoint, Arthur D. Little presents a strong but pragmatic approach to the assessment of the risks associated with business decisions, such as asset evaluations and project engineering. The approach represents an easy-to-implement solution for decisions that are significantly complex. At the same time, it keeps an eye on usability and transparency. The approach is illustrated using a recent project example in which a business case for a power plant was developed.

Knowing the rules

The first challenge is to tackle the selection of assumptions to be considered uncertain. Of the vast number of underlying assumptions, which are the main risks affecting the potential outcome? When it comes to decisions and business case calculations, Arthur D. Little has identified three broad categories of risks:

- **Low-impact uncertainties** are the large number of small, independent risks with relatively low impact (e.g. late deliveries, cost overruns). Experience shows that for these risks, adding a contingency based on project management knowledge or historical data works well.
- **Non-negligible uncertainties** involve manageable amounts of uncertainty with significant impact and a realistic probability of occurrence. Often these uncertainties are correlated additionally. An example would be a political election influencing the boundary conditions (e.g. regulations) of the business case.
- **Black swans/catastrophic events** are surprising, rarely occurring events with a major effect on the outcome of a scenario (e.g. a vapor cloud explosion or a plane crashing into the power plant). Basically, the entire business case boils down to the question of whether you believe these

risks will occur. If they do, the business case is not really needed. Hence, these risks are often managed separately through expected maximum loss calculations and transferred to insurances.

From our experience, there should be clear focus on the assessment of non-negligible uncertainties. The reason is that the combination of these can be crucial to the final outcome. Emphasis on these factors can add certainty to the basis of your decision-making process and enhance the results. An additional measure could be a stress test including "major risks". This test could be used to further enhance the robustness of the business case.

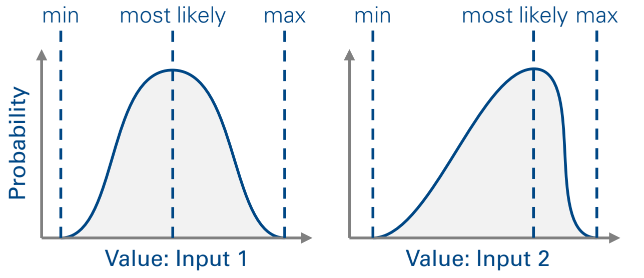
Nevertheless, the final choice of uncertainties to be included in an evaluation strongly depends on the industry, the asset lifecycle phase and the specific business case.

Counting the cards

With the focus of the analysis on the right assumptions, an adequate representation of the corresponding uncertainties is necessary. Here, finding the appropriate balance between the accuracy of the model, easy analysis and clear communicability is key.

Various mathematical models specifically developed to reflect all types of uncertainties (e.g. Gaussian, log-normal and Bernoulli) are available. However, choosing the right one and supplying the required inputs (e.g. expected value and standard deviation) is difficult – especially if data density is low and one has to rely on expert judgment. Therefore, for most business cases, a pragmatic approach is desirable.

Figure 1: PERT distribution functions provide an adequate uncertainty model set up from three input variables



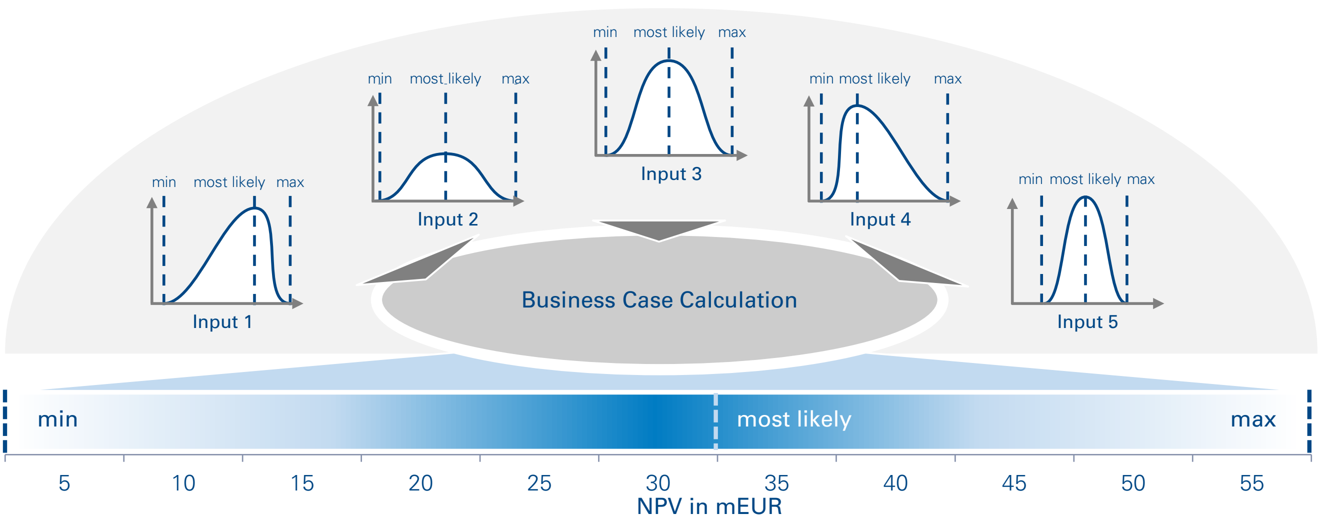
The PERT distribution is a robust and easy-to-use solution to pragmatically model uncertainty. It is a continuous, bell-curved distribution function constructed from the following three input variables:

- **Most likely value** to occur
- **Minimum value** potentially occurring
- **Maximum value** potentially occurring

The PERT's maximum is in the most likely value, and it can be skewed in either direction (see Figure 1).

Going back to our project experience, one of the most uncertain factors in the power plant business is the market price for electrical power. The price strongly affects the business cases at power plant levels and fits into the definition of a non-negligible uncertainty. Of course, very sophisticated and complicated price prediction models can be developed. But if a business is aiming for reduced complexity, the application of a PERT distribution results in a reasonable approximation. The minimum and maximum price over the last 25 years can be used as boundary

Figure 2: The Monte Carlo approach results in a range of outcomes using repeated calculations with varying input samples



inputs. In the business case calculation, the fixed value of power price is then replaced by the created price distribution variable.

An additional example of non-negligible uncertainties can be permitting time, which can have a huge effect on the development and turnaround time of projects and plants.

Playing your hand

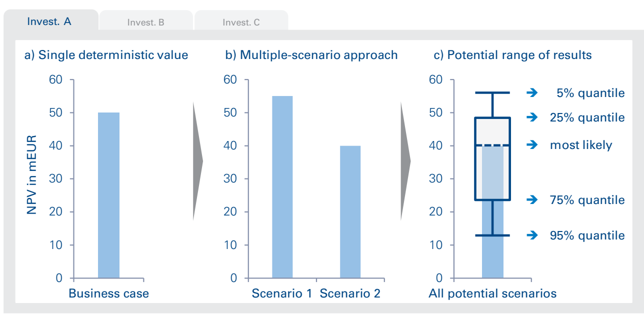
Most of today's business cases are based on a large and often unmanageable number of assumptions. Therefore, integrating potential uncertainties into each of the assumptions – not to mention combining all factors into a final result that is easy to understand – seems difficult.

The main problem is that analytical approaches are basically impossible. Also, for complicated systems, exact solutions using computational methods are only obtainable through an unfeasible amount of effort. Therefore, a widely used approach is to resort to statistical models such as the Monte Carlo method.

The main principle is that the specified business case is computed a large number of times (e.g. 10,000). Each time, different inputs from the underlying, uncertain assumptions are used (so-called samples, Figure 2). At the end, the combination of each calculation results in a range of outcomes. From this range, one can then calculate the expected value and variance associated with the outcome, which is illustrated by the preferred metric (e.g. NPV, IRR). The result is not exact, but it is precise enough.

In Excel, add-ins such as @Risk from Palisade and Crystal Ball from Oracle provide reliable and manageable solutions to the implementation of Monte Carlo assessments in business applications. Using these add-ins, risk assessments can be integrated into existing Excel models. This is achieved by changing the form of the input parameters from single numbers to distributed variables. However, the challenge remains to systematically structure the risk analysis around the requirements of the existing business case.

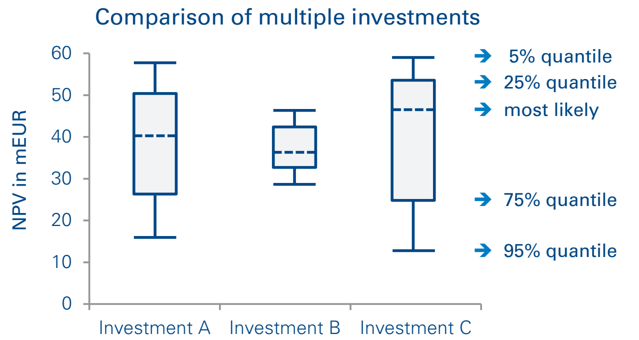
Figure 3: Only an adequate simulation can consider all potential outcomes of the business case



The visual result of such a calculation is a so-called "boxplot". In comparison to a single numerical metric, or even a multiple-scenario assessment, the box plot provides a clear view of all potential outcomes and corresponding probabilities (Figure 3). In addition to the most likely value, four probability segments (called "quantiles") are presented. A quantile represents a minimum value that is reached with a certain probability. For example, the 75% quantile in Figure 3 indicates that there is a 75% chance of the business case resulting in an NPV of at least 25 million euros.

Looking at this visual representation of the potential outcomes, one can get a very good feeling of the risk level associated with the investment. Additionally, one can clearly see how the result is influenced by the assumptions without having to trace complicated calculations. Furthermore, a better comparison of alternative investments is possible, as shown in Figure 4.

Figure 4: Investments with the highest-expected NPV may also provide the highest downside potential.



As seen in Figure 4, our experience from the asset evaluation (power plant) provides a clear example of the advantage of risk assessments. Before our analysis, "Investment C" was considered the best investment opportunity. But taking the associated risks into account, a huge downside potential was also revealed. In this example, "Investment B" presented the most reasonable choice, having a moderate expected return but a very low spread of potential outcomes.

Conclusion

Today's decision-making processes need to adapt to the trends of the volatile and fast-moving business environment. Decision-making has to become quicker and take uncertainties on a large base of assumptions into account. Using traditional approaches, this challenge may be unmanageable for decision-makers, who are then compelled to rely on simplified metrics with an unknown input quality.

However, by leveraging the right tools, a suitably qualified and experienced person can rapidly perform a pragmatic risk assessment. The assessment can then clarify the entire range of potential for investments and business cases – even in environments with limited data densities.

The PERT distribution offers an easy-to-handle model to evaluate risks based on historical data and/or expert opinion. A Monte Carlo simulation delivers a good approximation of the uncertainty using the preferred decision metric. And by taking advantage of Excel add-ins, the simulation runs at the click of a button.

Using such methodologies, possible outcomes of an investment and the resulting impact on a business will be assessed much more realistically than it is possible with simple static models. Executive decision-makers will then have a broader understanding of the numbers presented and a deeper understanding of the consequences of their decisions. Hence, valuable time can be used for actual decision-making instead of the alignment and communication of oversimplified assumptions.

Wrong business decisions can be avoided for the benefit of the company and all people involved in the decision-making process.

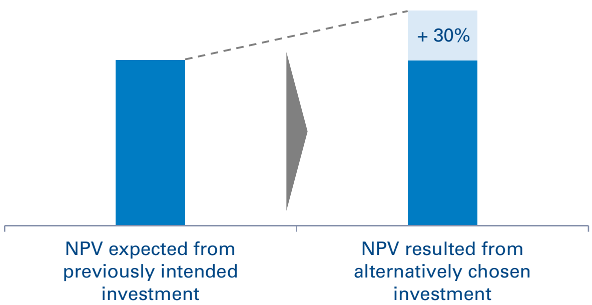
In our asset evaluation example from the energy & utilities industry, the use of the method discussed led to the following two outcomes:

- A drastic reduction in the effort of alignment between supervisory and executive board due to a common understanding of the business case
- A switch from the originally planned investment decision to a more lucrative option

The revision ultimately resulted in an increased benefit of approximately 30% of the previously expected NPV (Figure 5).

Figure 5: Using the presented approach, an additional 30% in NPV could be achieved compared to the previously planned investment.

Result of revision due to Monte Carlo assessment



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Arthur D. Little

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