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Risk Management
Today

Assessing the profit and loss balance in capital projects by risk analysis

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Key points

- Major resource project performance in Australia continues to be poor.
- Improved risk analysis before projects are committed, to expose the full range of risks due to operational and business risks as well as project risks, is clearly needed.
- A quantitative risk analysis methodology integrating project development and delivery with operations and revenue streams has been developed that provides a comprehensive understanding of the balance between profit and loss when all sources of uncertainty and risk are incorporated.

Introduction

Increased uncertainty and risk to Australian resource projects

Recent experience of substantial uncertainty in global commodity markets has shown the need for improving the ability of project owners to assess pricing cycle volatility as part of their business risk assessment of projects, particularly in Australia. Likewise, when assessing the viability of resource projects, exchange rate risk has become a major business and project risk:

- A project risk due to the increase in the cost of Australian content from the substantial structural appreciation of the Australian dollar.
- A business risk due to the effective reduction of AUD product revenue, as a result of its appreciation against the USD and other global trading currencies.

Continuing poor performance of major capital projects in Australia

Since my previous article in *Risk Management Today* in April 2011, the performance of large scale resource projects has continued to fall short of owner and market expectations:

- Every LNG Project completed, or in execution phase, since the Darwin LNG plant, is late and over budget. Woodside's Pluto project finished about 12 months late and was more than 30% over budget. Chevron's Gorgon project is believed to be at least one year late and more than 40% over budget. All three Coal Seam Gas LNG projects in Queensland appear to be over budget and are probably late.
- Iron ore and coal projects are either late, over budget or have been restructured or cancelled due to falling product prices.
- Fortescue Metals Group (FMG) had to defer its Solomon project and retrench a number of staff to save costs when the price of iron ore dropped below FMG's production costs. Although the price has since recovered significantly to enable FMG to regain viability, the strategy of funding its expansion substantially from its own production revenue suffered a severe setback and asset sales continue to reduce debt.

Apart from exchange rate appreciation, significant causes of price rises include increasing construction labour costs and project cost price index increases at rates substantially higher than the general consumer price index.

These circumstances demonstrate the need for improved ability to evaluate business, operational and project risk together so that the combined effects on a project and its deliverables can be modelled and assessed together.

Benefits of integrating cost and schedule risk analysis for realistic assessment of projects

In my previous article, I explained how performing Monte Carlo simulation on a realistic schedule model of a project loaded with the project estimate and with cost and schedule impact risk events from the project risk register enables the simultaneous analysis of schedule and cost uncertainty, the evaluation of appropriate levels of time and cost contingency and the identification of schedule and cost drivers most responsible for driving out the schedule and driving up the cost. We describe this approach as our integrated cost and schedule risk analysis (IRA) methodology.

The benefits of this IRA approach include the following:

- Analyses of time and cost uncertainty are simultaneous and interdependent, reflecting the old saying that "time is money". This removes the problem of how to apply the output of a schedule risk analysis (SRA) to a separate cost risk analysis (CRA).
- The method permits the identification and ranking in descending order of the riskiest activities and costs, including identifying the main causes of the cost impact of delay uncertainty and risk (which separate schedule risk analyses and cost risk analyses cannot do). This provides the project team with direct guidance on how best to focus scarce resources to optimise the time and cost risk profiles of the project for the most favourable outcomes.
- The method enables the quantification and separation of project time and cost contingency to be held by the project team/project manager for use during normal project execution, from unallocated contingency (UC) for time and cost, to be held by the project owner and released to the project team when risk events occur or substantial slippage to the schedule and/or control budget occur. This keeps these important project documents from losing credibility while ensuring that they also act as incentives to the team to continue to strive for the best outcome.
- The IRA methodology also integrates qualitative risk analysis with quantitative risk analysis and provides a means of determining the most cost-effective combination of risk treatments for a given risk event, if the risk has multiple treatments or mitigations proposed, by use of Monte Carlo method analysis with and without each treatment in turn. This is justifiable where the risk event is a high ranking contributor to project time and/or cost uncertainty.

Limitations of above approach

Although the IRA methodology has a number of substantial benefits described above, it has the potential to provide even more benefits during the stages preceding financial investment decision (FID). This is because the traditional approach to assessing project viability is to stop such risk analyses at project startup and restrict them to assessing levels of time and cost contingency and to incorporate only project risk events.

Analysis of the economic viability of the project is either performed using CRA or is done with a combination of CRA and spreadsheet modelling to evaluate the sensitivity of the project cost model to fluctuations in business conditions, exchange rate variation, escalation and the cost of borrowed funds.

However, such an approach is unable to integrate the combined effects of:

- time uncertainty in developing the project to FID;
- proceeding through project execution to first product through project and weather uncertainties and risks; and
- operating the project to produce its deliverables over time through business cycles and operational uncertainties and risks, including risk of regulatory changes.

Further benefits of IRA methodology in assessing project financial viability

Extension of IRA methodology to include operation to fulfil project benefits

We have extended the modelling capability of the IRA methodology to include the operational phase of a project for as long a period as the economic life of the project requires. We have examined the modelling characteristics required to enable this to be effective. Functionality required includes the following:

- fluctuating market price conditions over time;
- fluctuating production costs due to changes in feed conditions such as mineral grades;
- changing operational efficiencies and costs;
- allowance for maintenance shutdowns; and
- the effects of changes in the regulatory environment and the costs of compliance.

Operational risk events that may have a major effect on the viability of the project could include the following:

- risk of major change in product pricing (beyond normal cyclical change) due to change in global demand;
- opportunity to sell product cargoes on spot market at a premium to long term contract pricing;
- threat of protracted industrial dispute by operational workforce;
- threat of change to government charges and subsidies such as royalties, tax rates, fuel rebates and depreciation rates; and
- threat of substantially more expensive requirements for decommissioning and rehabilitation of the project site.

Operational risk factors to be modelled may include the following:

- operating costs (labour, fuel, power and water); and
- market conditions for shipping costs.

All of the above add to the project risks, range of uncertainties and risk factors to be included in the overall model of the project that may span from initial concept, through design, construction and operation, to decommissioning of the project assets and rehabilitation of the site.

Demonstration IRA model

To verify the viability of this method, we took a demonstration mining project schedule already used for IRA modelling and added 10 year operations to it, using Oracle Primavera Risk Analysis (OPRA) and our own suite of software around OPRA.

We took the regular combination of project uncertainty and risks:

- time and cost uncertainty ranging on activity durations and project costs (with appropriate fixed and variable cost splits);
- weather uncertainty during construction (modelling a combination of wind and rain throughout each year with seasonal cyclonic events);
- cost and time impact risk factors affecting the project (applied to various groups of activities); and
- cost and time impact risk events affecting the project up to first product.

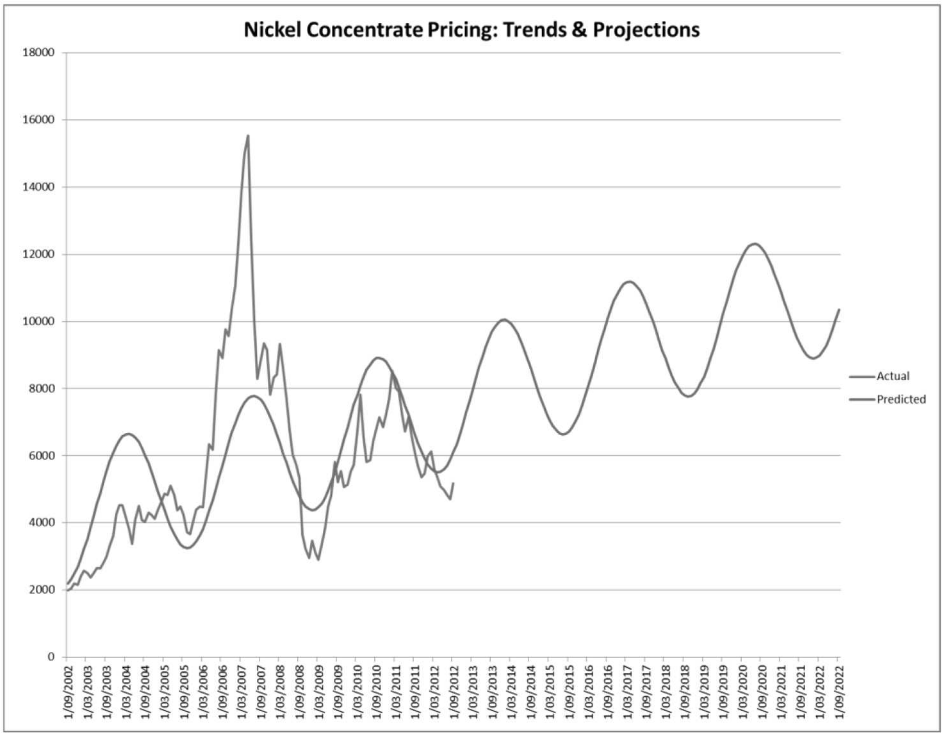
To these we added operational and business risks and uncertainties:

- fluctuating product price forecasting based on 10 years of data for the particular product (nickel concentrate) and projecting into future years;
- uncertainty in major cost inputs (operational labour and fuel); and
- operational and business risk factors (mining grades, costs of conformance with environmental regulations and changes to mining royalties and taxes).

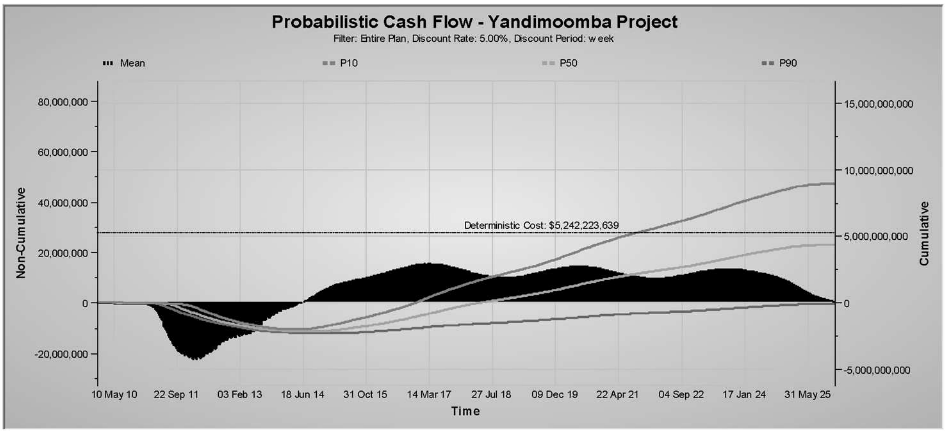
We then ran the combined IRA model through Monte Carlo simulation to obtain overall analysis of the attractiveness of investment, measured by Probabilistic IRR and NPV and derived from probabilistic cashflows, encompassing the initial negative costs of developing the project proposal, design and construction, then the positive costs of production and sales of product.

Sample inputs and outputs from the analysis

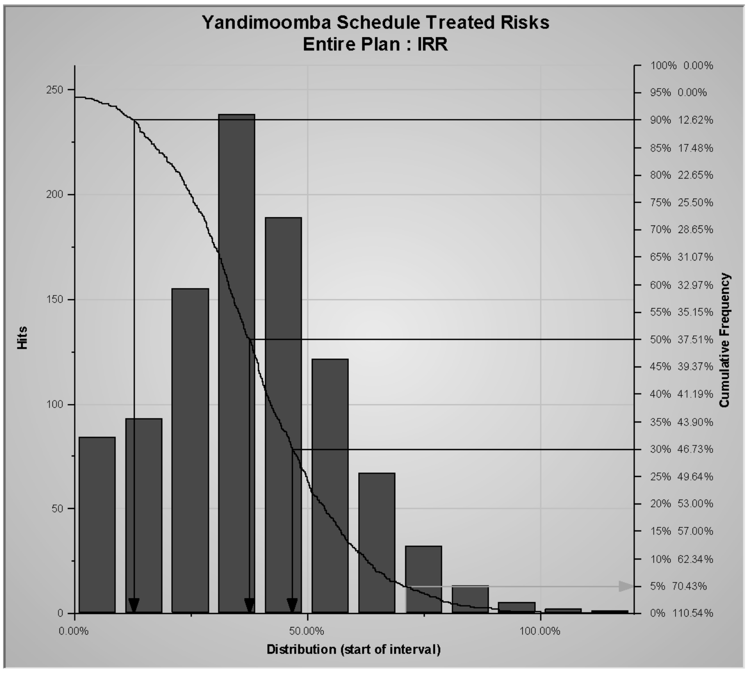
1. Nickel concentrate pricing fluctuation forecasting
   Shown below is our analysis of 10 years of nickel pricing, ratioed to express as nickel concentrate pricing, with the cyclical pricing converted to a function used for forecasting pricing in the future (recognising that this would certainly need modification for structural changes in the nickel market). The forecast curve was used as the basis for forecasting future product sales revenue. Any forecasting of product pricing can be incorporated in the modelling.



2. Probabilistic cash flow from analysis
   The following probabilistic cash flow based on a discounted cash flow (DCF) of 5% shows that the P10 projections are very profitable, the P50 is healthily profitable and the P90 does not break even after 10 years of production. The cash flow is sensitive to the DCF. If the DCF is set to zero, the P90 breaks even after about 6.5 years.
   Note the fluctuating revenue due to the cyclical pricing function. The revenue peaks also decline gradually with time due to the DCF.



3. Probabilistic IRR
   The following IRR is for a DCF of 0%. Under those conditions, the break-even IRR is at P95.



Further comments

The complete probabilistic analysis of the completion of the plant and the key intermediate milestones are also available from the same analysis, together with drivers to show what drives the project completion for startup and the project cost. These drivers can focus solely on project uncertainty, risk factors and risks or business and operational risk and uncertainty, either separately or together. This can provide project owners with a full range of selectable scope to focus on understanding the full range of cost and time influences on the project.

We have also developed the modelling ability to compute the cost of borrowed funds during project construction, with the borrowing interest rate independent from the DCF rate. This has the effect of reducing project profitability and lengthening payback time.

This enables project owners to conduct a comprehensive range of scenario sensitivity analyses with a fully integrated time and cost model of the project. As a final contribution to developing reliable ranking of drivers of project duration, cost and project profitability, a useful tool has been developed. This tool is used for systematic exclusion of identified high ranked time and cost uncertainty contributors to the model and is then used to re-run complete Monte Carlo simulations. This reports the contribution that each contributor makes to time and cost uncertainty in the model by the difference at selected P-levels. This can include individual tasks, risks, costs or groups or complete classes of uncertainty (for example, all risks, all weather uncertainty, all duration uncertainty, all or some risk factors and so on).

Such integrated time and cost analysis is simply not possible using conventional spreadsheet modelling. Further, the ability to obtain reliable ranked risk driver information makes this approach very attractive for gaining the widest possible understanding of the riskiness of the profitability of a proposed project.

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Colin Cropley is a chemical engineer with a career in project management, project controls and, for the last seven years, has been leading the development of risk management and quantitative risk analysis software and methodology. He is the Managing Director of Risk Integration Management Pty Ltd, providers of risk management and project controls consulting services.