Re-engineering Project Budgeting and Management of Risk

Session 9: Risk Management

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Re-Engineering Total Cost Management

Outline of the presentation

- Poor major project outcomes are not inevitable
- Common contributors to project failures
- Integrated Cost & Schedule Risk Analysis (IRA) to forecast project outcomes and optimise risk
- Compare with serial Schedule to Cost Risk Analysis (S2CRA)
- Dealing with scepticism for Quantitative Risk Analysis (QRA)
- Extend IRA to full Project and Asset Lifecycle using Integrated Costs, Schedule & Revenue Risk Analysis (IRRA) – illustrated with a Floating LNG Project
- Conclusions

Project Failures: frequent contributors

Poor Major Project outcomes not inevitable; need to understand causes

- Mega and complex projects frequently fail to meet their time, cost and asset profitability targets
- Failure is not inevitable and rarely the result of conspiracy
- To improve success rate requires we understand causes of failure to prevent or manage them
- We will examine causes related to time, cost & profitability
- During the process we will identify ways to deal with them

Cause 1: Time & Cost without enough Scope

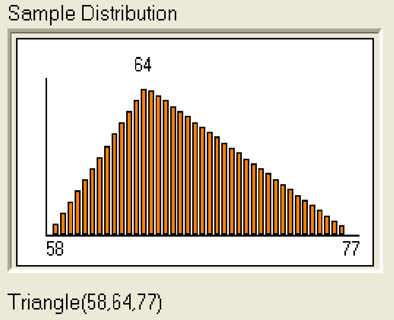
- The overwhelming first choice for the cause of project failure is inadequate definition of scope:
  - Either under-estimating the quantity of project work or
  - Under-estimating the complexity / difficulty of the work to be done, or under-estimating quantity and difficulty
- Combined with the above is setting pre-determined and unrealistic time and cost targets
- This combination arises from failure to invest enough effort in front-end planning of the project
  - Called Front End Loading / FEL by Independent Project Analysis, Inc. (IPA)

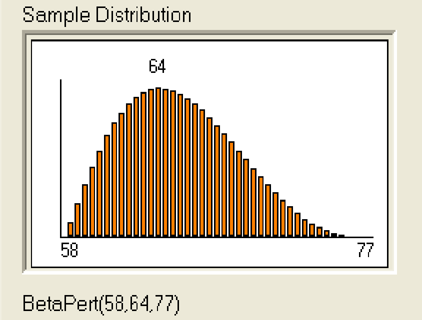
Cause 2: Single value estimates optimistic

- Project planning tools require single values for task durations; software determines dates by critical path method, thus called deterministic
- But durations rarely known exactly; more like the daily trip from home to office:
  - In summer holidays, fine weather, only takes 20 mins;
  - In winter during peak period, may take 50 mins;
  - If an accident or road under repair, could take 75 mins;
  - Most of the time, around 30 mins
- Many project tasks like this, but planners can only assign one value. Under pressure, likely optimistic.

Understanding Optimism through Monte Carlo Method

- Approach to run projects many times to explore a full range of project outcomes from optimistic to pessimistic
- Uses a mathematical technique to range and randomise Project Parameters within pre-selected limits:
  - Selection of Task Durations within probability distributions: so-called 3-point distribution





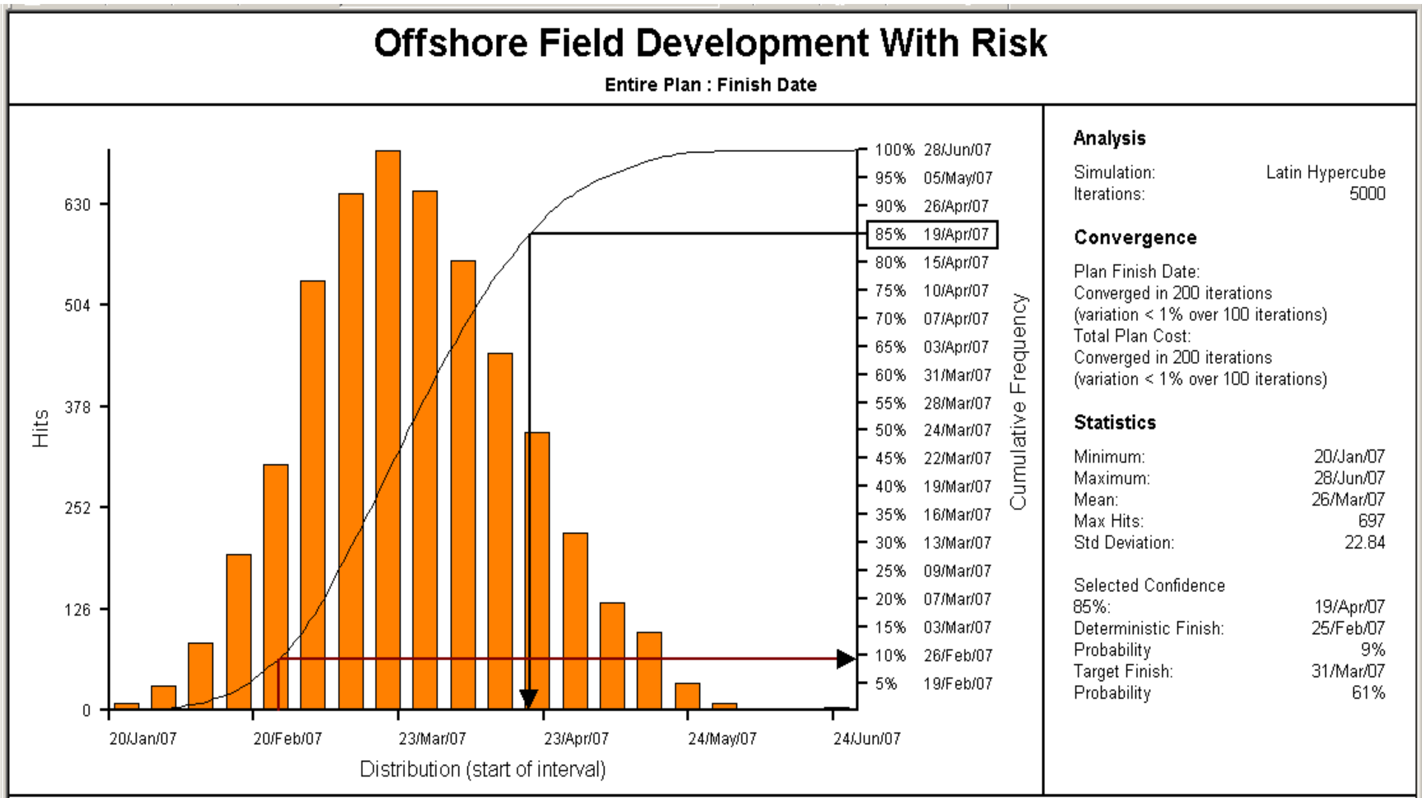
- Addition of activities with pre-selected probabilities of occurring of < 100% – called risk events

Use of Scenarios to counter optimism

- 3 point estimates - Optimistic, Most Likely and Pessimistic - developed by breaking project into sections and considering each section in turn
  - Record assumptions and sources of uncertainty;
  - Describe in words Optimistic, Most Likely & Pessimistic scenarios, based on assumptions & uncertainties;
  - Assign three point values to durations or costs of all WBS section activities or cost line items, based on above scenarios
- Approach helps divorce the duration/estimate line item assignments from overall target pressures

Monte Carlo Tool Gives Range of Outcomes

- Tool such as Primavera Risk Analysis™(PRA) uses duration/cost ranges to simulate most combinations and produce probability histograms and cum curves:



New Information from Range Analysis

- From the Histogram and Cum Curve, we can learn:
  - An optimistic finish or cost (~P10 or 10% probable)
  - A likely finish date (P50)
  - A conservative finish date (P80 or P90)
  - How likely the project is to finish by the planned (deterministic) date (often quite unlikely)
  - The range of probable dates for every activity in the schedule
- Also analytical tools to show us what drives project to be late (and also to overrun budget)
- Gives us a means of considering ranges of time and cost rather than single values and avoiding optimistic bias

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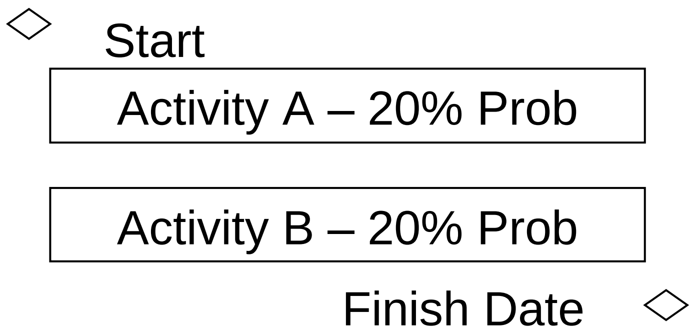
- But there are still two other causes of unrealistic planning

Cause 3: Failure to allow for converging logic

- If we have two identical strings of activities and resources to do them, each with a 20% probability of being finished by the target finish date, what is the probability of both being finished by that date?



P_A x P_B = 4% Probability

- This is known as Merge Bias effect and it is reason why it is so hard to finish a project on time when many strings of activities converge into finish and delays have occurred.
- Deterministic planning does not show up this effect, but probabilistic planning does.

RISK Integration Management

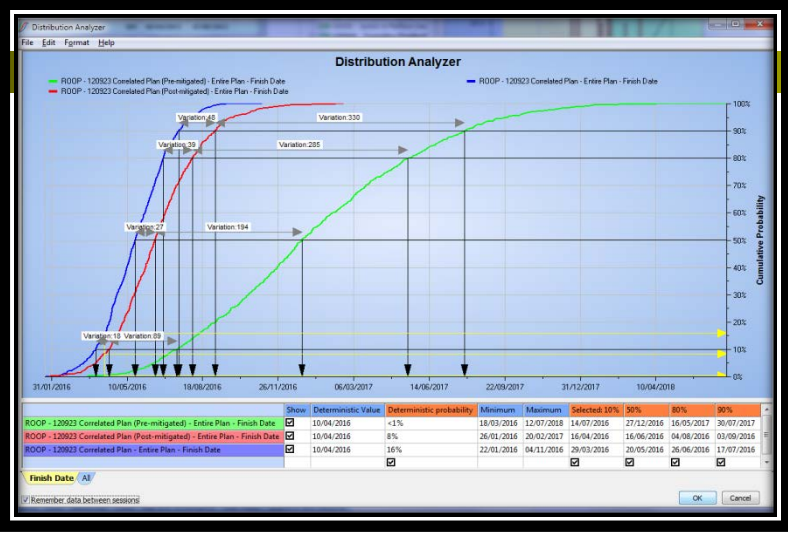
Cause 4: Failure to allow for risk events

- Failure to consider the possible effects of risk events – things like the traffic accident on the road to work – is the third cause of unrealistic schedules and unrealistic cost estimates
- To deal with this we need to bring in risk events from the risk register and model their probabilistic effect on the project
- While any one risk event is not certain to occur, over the whole project, provided the process has been thorough, risks in the register will occur in a pattern similar to the forecast
- Weather is a special set of risk events to model

Cause 5: Failure to allow for market risk

- Many failures are due to external changes adversely affecting return on the asset created by the project
- During the concluding resources boom in Australia, rising markets compensated for project overruns
- More recently, falling market prices for coal and iron ore have caused the cancellation of projects and even sale of assets to reduce debt in operating companies
- The higher A$ and lower prices for gas sourced from Russia and USA for China threaten future LNG sales for Australia and thus future projects

Countering causes of failure helped by realistic project modeling



Countering causes of failure first requires effective modeling

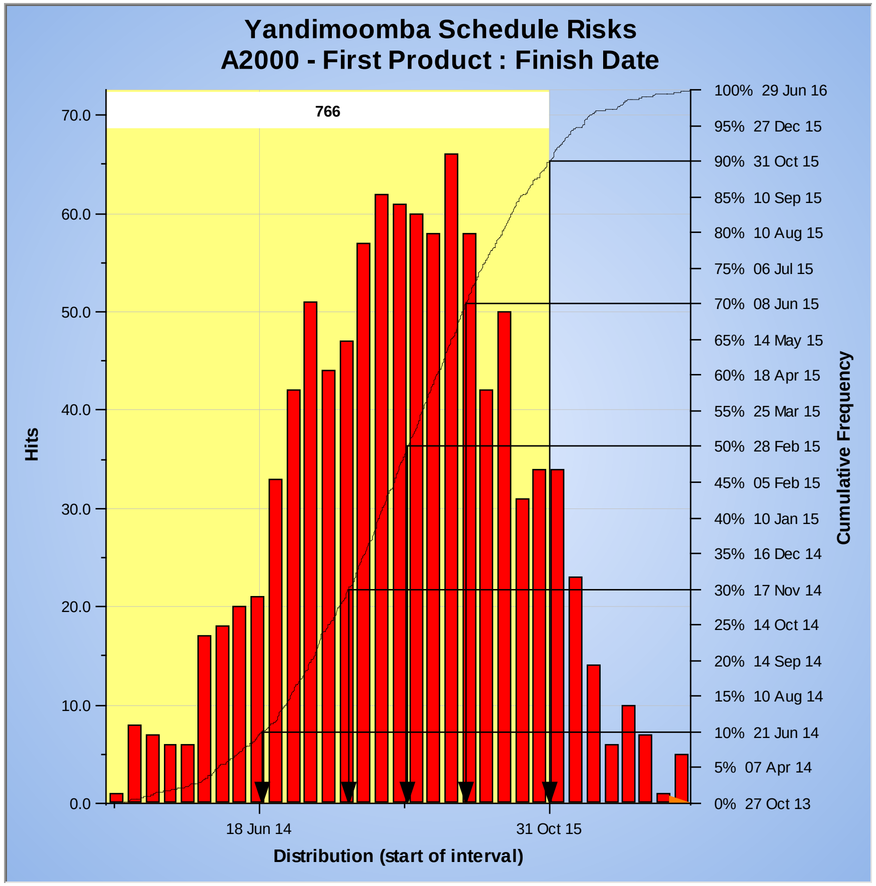
- We want to model the behaviour of the project and see what drives outcomes in order of importance
  - If the time dependent costs can be applied to the schedule in activities that overlay the corresponding scope activities and vary in duration according to the duration of the scope activities, those costs will be accurately captured. Uncertainty in rate identified in range workshops can also be incorporated
  - If the time-independent costs are also overlaid or mapped into the appropriate scope sections, with their uncertainty expressed in ranges identified in workshops, these costs will also be accurately assessed

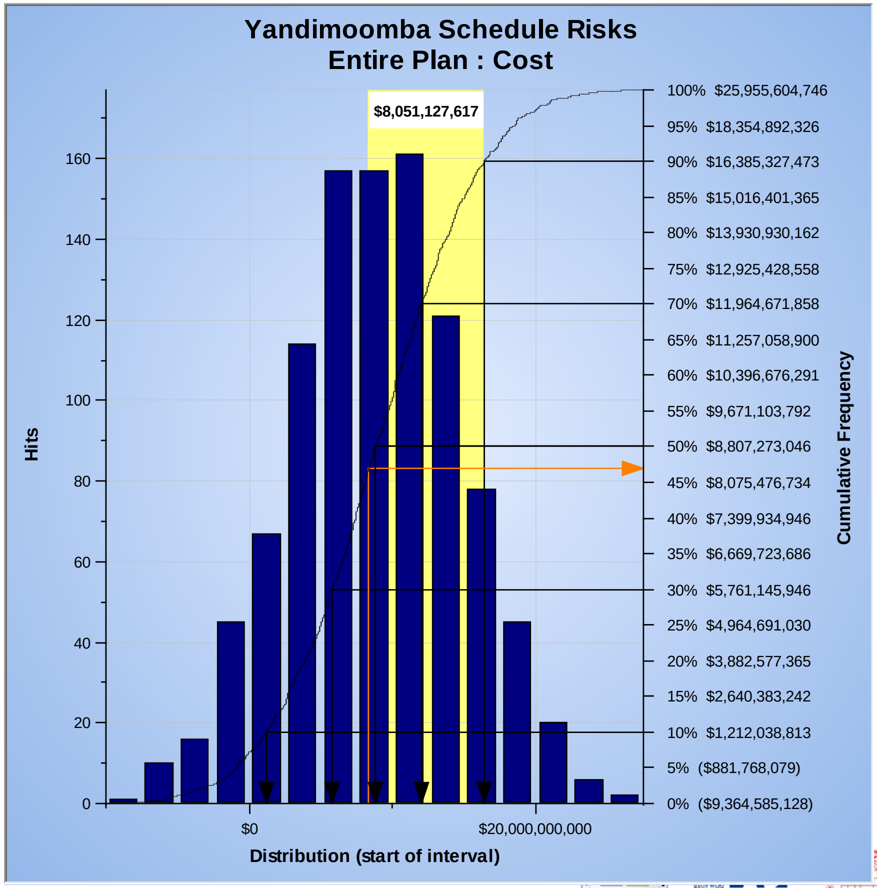
Integrated Cost & Schedule Risk Analysis (IRA)

- Combining time and cost uncertainty makes sense:
  - Construction equipment & labour are time-dependent costs
  - Project materials and equipment are time-independent costs
  - Risk events with time and/or cost impacts will affect costs
- Overlaying project estimate on schedule enables MCM analysis of all time & cost uncertainties at once by:
  - Splitting fixed and variable costs
  - Linking cost item 'hammock' tasks to their driving tasks
  - Adding risk events with time and/or cost impacts
  - Applying probabilistic weather calendars (not to hammocks)
- IRA enables time drivers of project cost to be:
  - Identified and ranked with cost uncertainties
  - Included in risk optimisation by Quantitative Exclusion Analysis

Benefits of IRA: Time & Cost Forecasting

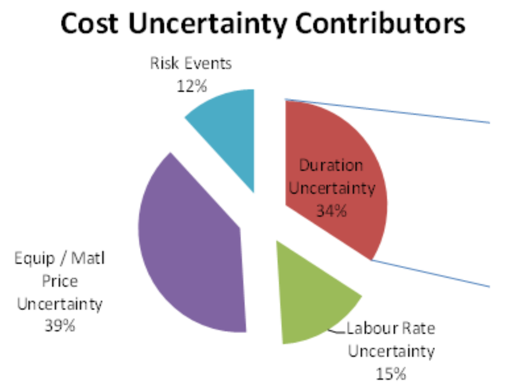
- IRA methodology & software enable time and cost analysis of Master Control Schedules and detailed cost estimates for major & mega projects

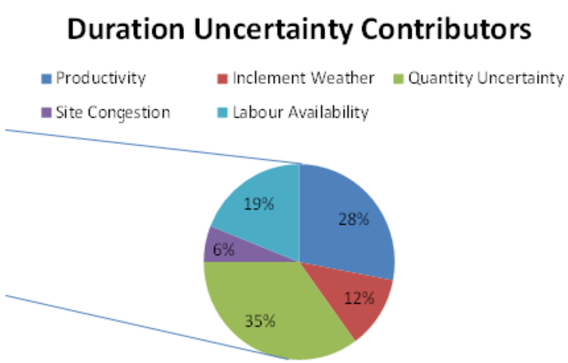


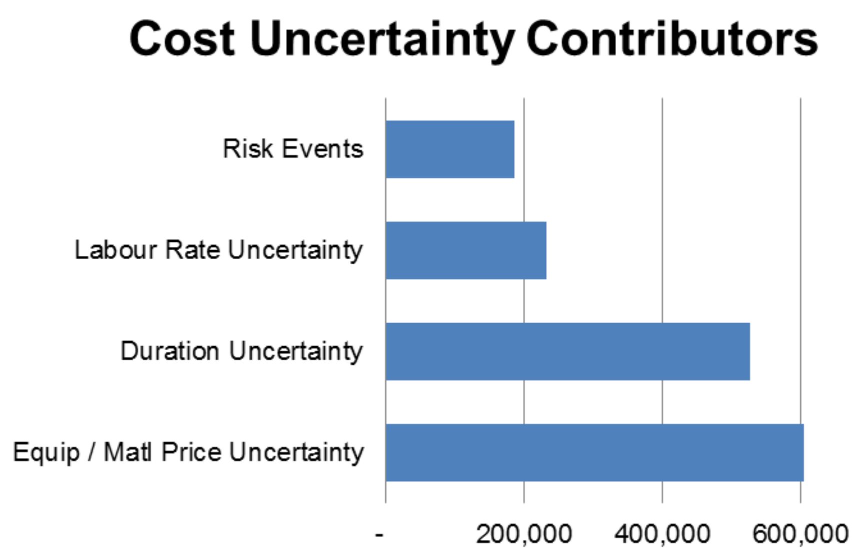


Benefits of IRA: Analysis of drivers

- Simultaneous analysis of time and cost using risk factors, risk events and time and cost uncertainties enables combined rankings of delay and cost drivers using Quantitative Exclusion Analysis







Further benefits of IRA

- Adding in risk events from the project risk registers with time and cost impacts incorporates the known risks that could affect the project goals
- IRA produces realistic forecasting of time and cost outcomes due to their simultaneous risk and uncertainty impact interactions
- IRA also enables the identification and ranking of the main drivers of project schedule and cost, whatever their source: duration, cost or risk
- Its value has been proven for pre-FID, tendering and project execution
- And on projects from <\$5m to >\$15b

Conventional SRA to CRA

- Combining time and cost uncertainties and risks has been seen as too hard for various reasons:
  - SRA and CRA Practitioners were and are different – former from planners and engineers, latter from quantity surveyors, estimators and cost engineers
  - SRA and CRA tools tend to be different – former built on project planning tools, latter on spreadsheets
- Practice has evolved of
  - performing SRA on a summarised schedule, then
  - feeding schedule contingency cost allowance into CRA at an assumed “cost burn rate”
  - Serial SRA to CRA or “SRA2CRA”

Disadvantages of Serial SRA to CRA

- Assumed cost/unit time takes no account of when and where schedule changes occur
  - When – before, during or after peak expenditure rate?
  - Where – delay costs may be real but not delay the finish
  - What, why and how assumptions between schedule and estimate must be aligned to produce valid consequences in costs from duration changes
- Serial process divorces delay cause from cost effect and prevents integrated analysis of drivers of cost

IRA	SRA to CRA
More rigorous if done correctly	Less rigorous
Harder to do correctly	Easier to perform
Can provide key driver information, unifying schedule and cost drivers in one ranking as influences on project cost	Cannot reveal cost consequences of schedule delays – schedule drivers are separate from cost drivers

Dealing with scepticism for Quantitative Risk Analysis

Reasons for MCM Scepticism

- Lack of published evidence of value of QRA
- Immaturity of QRA discipline in projects
  - Project users don't know what makes QRA effective
  - Project users don't know how to specify QRA
  - Project users don't know what to look for in QRA results
  - "Snake oil merchants" provide inadequate or incorrect QRA results
- Misuse by some practitioners of QRA by skewing ranges to produce "desired results" has resulted in cynicism toward MCM from some, particularly in the financial sector

Examples of improved forecasts through QRA

- LNG train completions in Australia and Middle East - SRAs
- Oil Refinery Enhancement Project - SRAs
- Coal Seam Gas LNG Project Key Milestones
- O&G Exploration in PNG - IRAs
- Some details of two of these follow

SRA of Middle East LNG Train Completion - 1

- About four months from planned plant startup, the project owner was concerned completion would be late, as:
  - Contractor progress was slipping, control of subcontractors in doubt
  - Shipment of LNG in month after planned startup was in jeopardy
- Schedule Risk Analysis was requested. Current Project Schedule was assessed for SRA, but:
  - Schedule was high level, did not show at system handover level from construction to commissioning
  - Detailed commissioning schedule was not connected to the construction schedule

SRA of Middle East LNG Train Completion - 2

- Schedule converted to hourly to increase ranging accuracy
- Pseudo tasks created based on final test pack pressure testing dates for each handover system to link construction to commissioning schedule
- Conservative ranging assumptions based on experience to date were made for System Mechanical Completion and Intermediate RFSU Punch Listing and Clearing
- Four successive analyses made, adding a night shift for air blowing pipes and changing punchlisting and clearing systems, improving forecasts as shown below

	DETERMINISTIC	P50	P80
INITIAL ANALYSIS	08NOV	14DEC	20DEC
CONSERVATIVE SCENARIO	07NOV	07DEC	12DEC
OPTIMISTIC SCENARIO	07NOV	29NOV	04DEC
REFINED PUNCH CLEARING	**31OCT**	**14NOV**	**19NOV**

SRA of Middle East LNG Train Completion - 3

- Final report recommended tracking actual performance versus refined schedule.
- An email was later received advising RFSU was signed off on 13Nov, the day before the refined P50 date, but the celebration cake was iced with the P50 date!

PNG Oil & Gas Exploration Forecasting - 1

- Talisman Energy (TE) has been exploring for gas and condensate in Western Papua New Guinea since 2009
- Extremely difficult terrain, climate, logistics and community relations made deterministic planning and estimating unachievable in first couple of years. Costs were too high.
- We offered IRA for forecasting time and cost outcomes.
- TE's Operations VP broke the Exploration process into 'Lean Manufacturing Unit Operations' of Seismic Survey, Seismic Interpretation, Drilling Site Preparation, Drilling Rig Move & Assembly and Drilling
- Schedules and estimates were prepared for each stage (except Interpretation) and schedule and cost ranges plus risk events were workshopped (except for Rig Move)

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PNG Oil & Gas Exploration Forecasting - 2

- Photo shows the K-1 drill site as construction was completed
- During the move and assembly of the drilling rig
- Indicates density of the tropical rain forest

PNG Oil & Gas Exploration Forecasting - 3

- Following tabulated results compare forecasts with actual results for two recent wells drilled by TE
- Rig Move planning and budgeting deterministic
- Drilling planning and estimating was probabilistic
- In both cases, actual drilling costs were lower than forecast probabilistically, but actual rig move costs were greater than planned deterministically

K-1 Well:

	Rig Move (Un-risked)		Act/Plan	Drilling (Risked)		Act/Plan	Actual
	Plan	Actual	%	Plan	Actual	%	Cf Forecast
Total days	21 days	40 days	190%	51 days	53.8days	105%	P87
Total cost	$5.79m	$7.9m	136%	$16.2m	$15.4m	95%	P45

M-1 Well:

	Rig Move (Un-risked)		Act/Plan	Drilling (Risked)		Act/Plan
	Plan	Actual	%	Plan	Actual	%
Total days	35 days	45 days	129%	31 days	29.5days	95%
Total cost	$8.23m	$9.63m	117%	$10.2m	$9.7m	95%

Extend IRA to full Project and Asset Lifecycle - IRRA

Include full project and asset lifecycle

- IRA does not risk-assess a major part of the Total Cost Management framework: the Asset being created by the project to realise benefits, usually including target financial returns
- If IRA is extended to the operation of the Asset through its economic life including Asset Closure, risk analysis can be broadened to include:
  - Opex uncertainties and risks
  - Revenue uncertainties and risks
- Modeling must be capable of representing the full range of uncertainties and risk factors including costs of borrowing and varying DCF rates

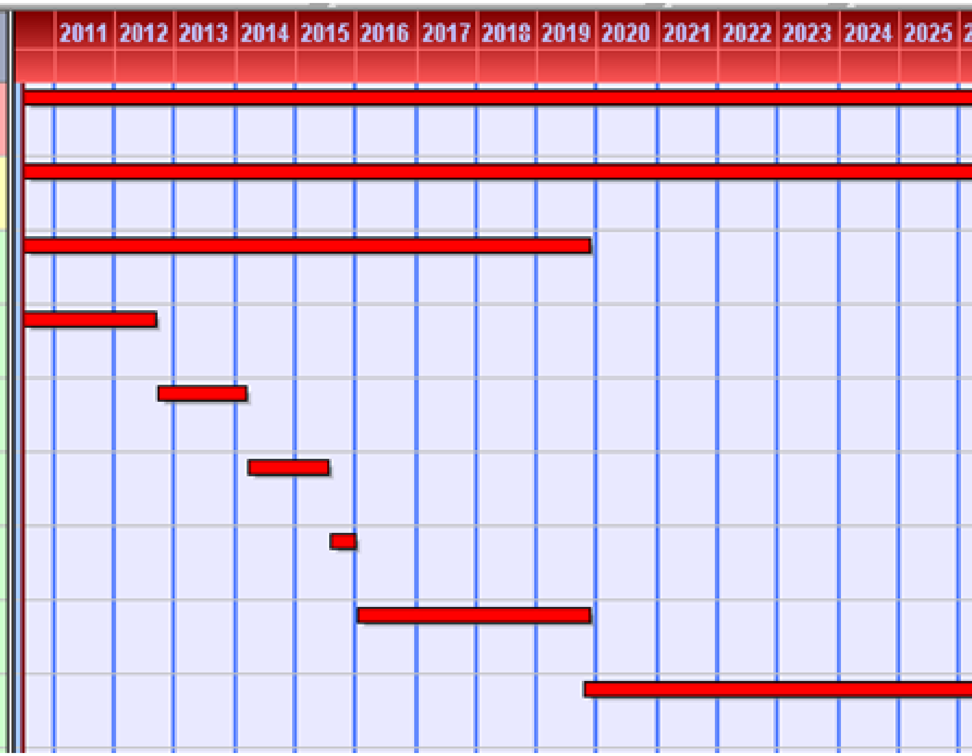
Integrated Costs, Schedule & Revenue Risk Analysis (IRRA)

- We have developed a Floating LNG project model of this extended IRA methodology: Integrated Costs, Schedule & Revenue Risk Analysis – IRRA
- A summarised representation of an FLNG Project and the first few years of production of the asset are shown on the following screen
- Phases from concept to asset closure are included

IRRA Model of an FLNG Project

- Key dependencies from engineering to procurement, fabrication, installation are included in the ~200 activity model

Description	Rem Dur	Start	Finish
FLNG Project	12693	01/07/10	31/03/45
From Concept to Field Closure & FLNG Redeployment	12693	01/07/10	31/03/45
Milestones	3438	01/07/10	28/11/19
Concept Phase	801	01/07/10	08/09/12
Pre-FEED	547	09/09/12	09/03/14
FEED	505	10/03/14	27/07/15
Financial Closure	160	28/07/15	03/01/16
Project Execution	1425	04/01/16	28/11/19
Revenue - Operations & Redeployment	9305	10/10/19	31/03/45



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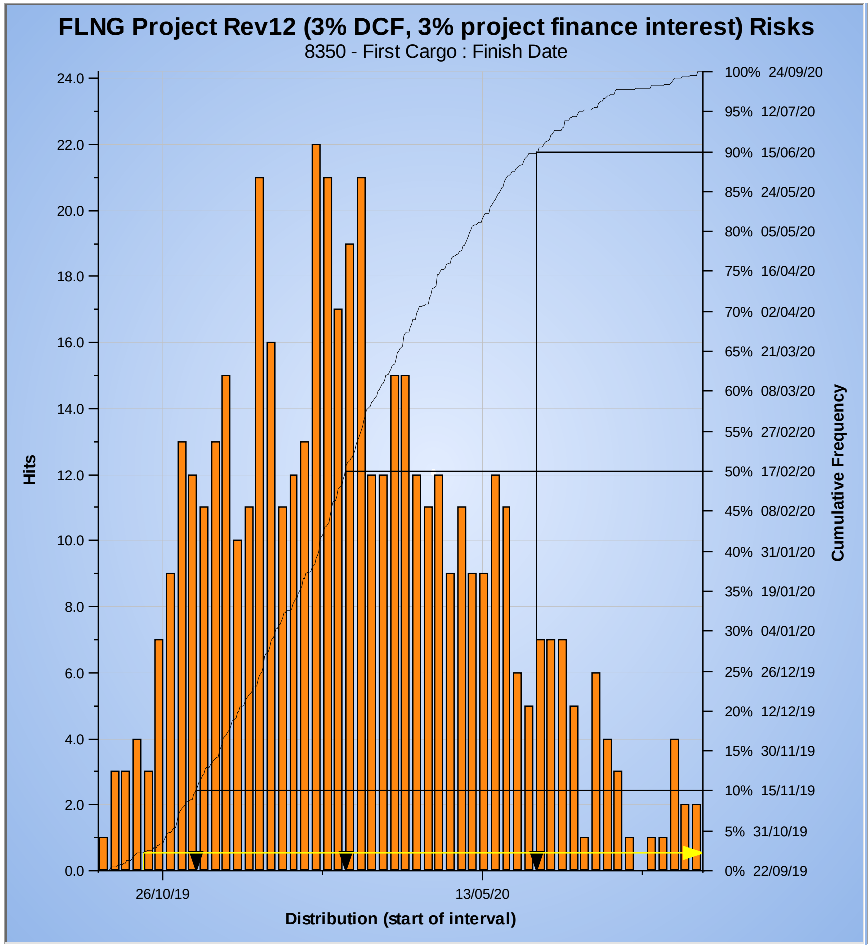
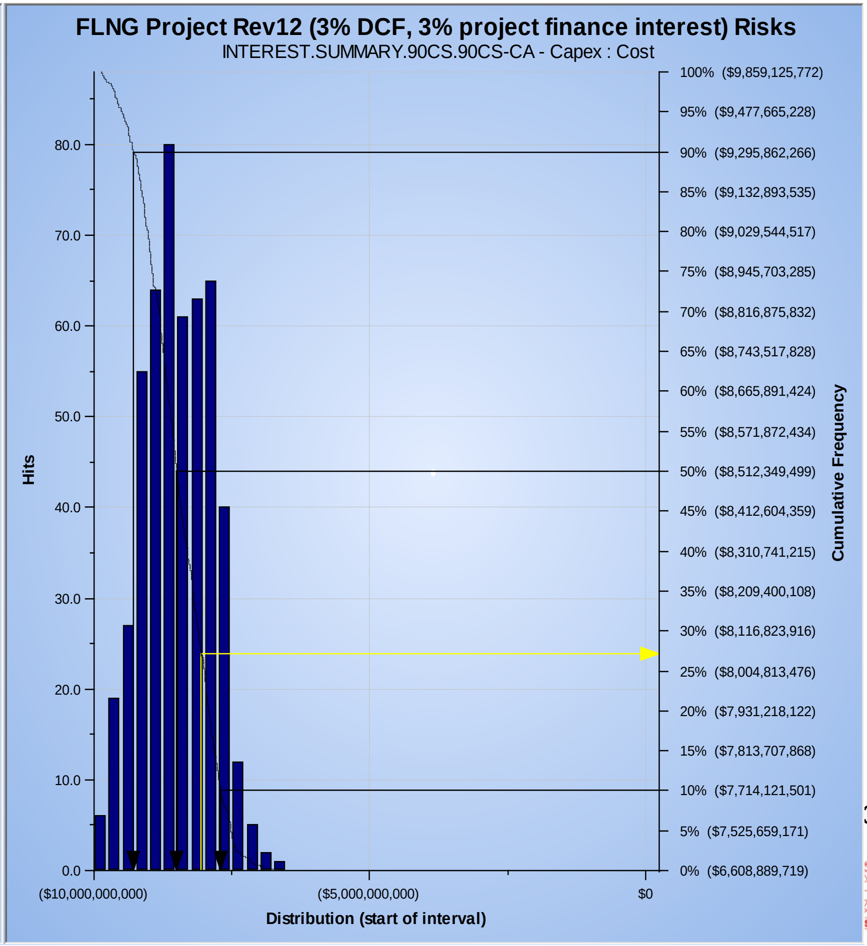
Probabilistic Project Forecasts

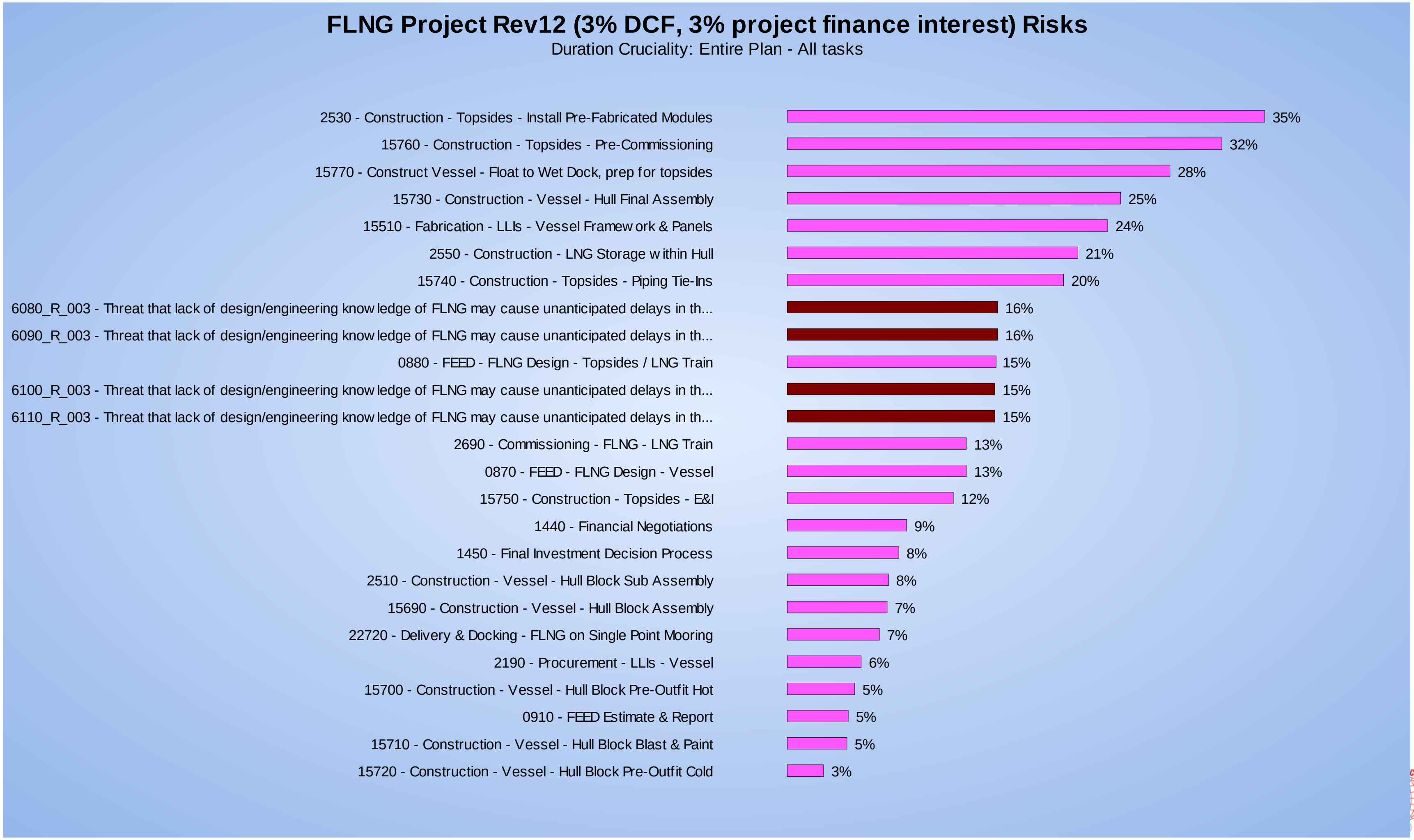
- The usual forecasts of time and cost outcomes can be made, enabling contingencies to be assessed, taking into account all known uncertainties, risk events and factors





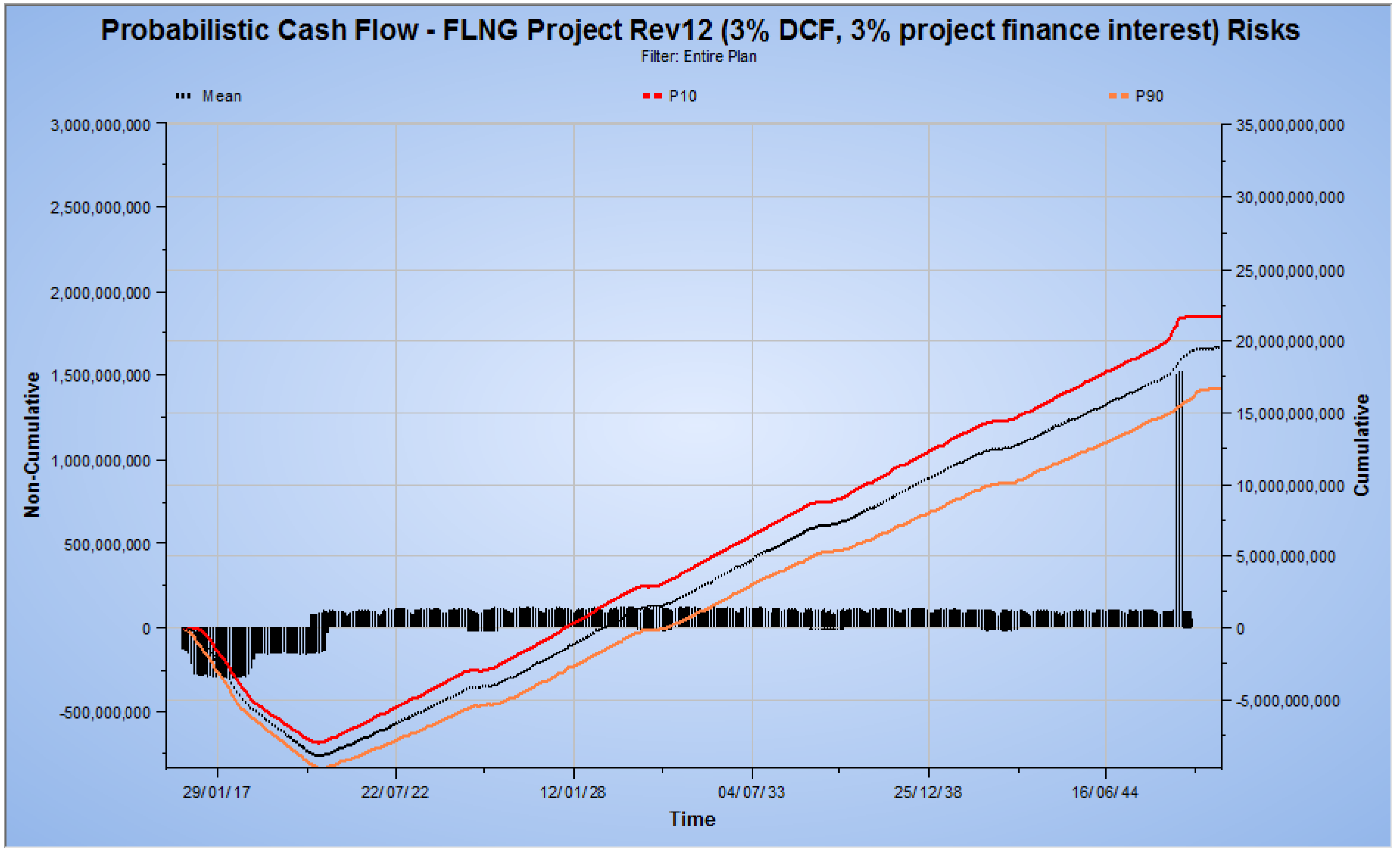
Drivers of Project Outcomes

- As importantly, the drivers of project timing and cost can be identified and ranked to prioritise efforts to optimise risk



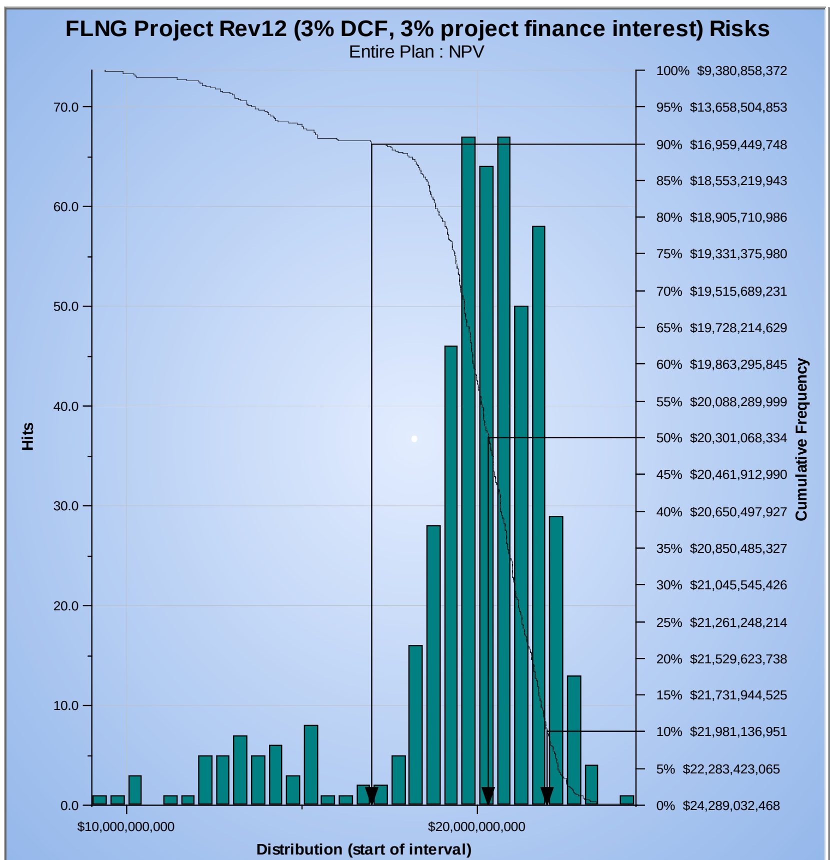
Add in Whole of Asset Life Risk

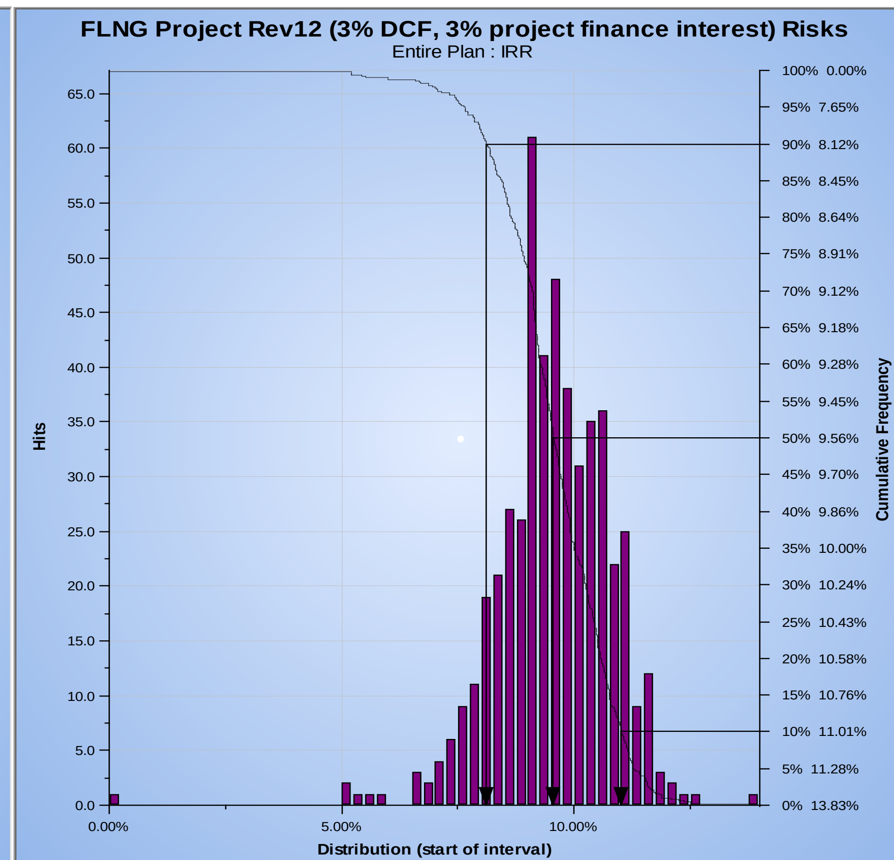
- FLNG projects involve tradeoffs between capex and opex
- But such choices also have different risk profiles
- By incorporating revenue and opex uncertainties and risks, we can model the financial riskiness of each option



Asset Probabilistic NPVs and IRRs

- Each FLNG option can be modelled with all risk factors and risk events as well as capex and opex uncertainties
- When revenue uncertainty and risks are also modeled, the full riskiness of the investment decision can be assessed





Conclusions and Recommendations - 1

- Project QRA outputs are only meaningful if the methodology is valid, the model represents the project accurately and the inputs are realistic
- Project QRA is useful where:
  - Scope is defined enough for meaningful schedules, estimates and risk registers to be available
  - Subject Matter Experts (SMEs) can provide informed input to duration and cost ranges and to risk definition
  - Methodology for realistic analysis is able to be well-defined and specified to obtain competent submissions
  - Potential QRA service providers have been well pre-qualified to deliver reliable analyses

Conclusions and Recommendations - 2

- IRA & IRRA methodologies have a rigorous basis in the Integrated Master Control Schedule or equivalent comprehensive and technically acceptable schedule
- IRA / IRRA inputs are auditable and available with the final report
- IRRA methodology can be used to optimise risk treatments, operational availability and reliability, depreciation and taxation arrangements to maximise project objectives
- IRA has been used on projects <$5m to >$15b
- Failure of major projects is not inevitable; using IRA & IRRA, success rates can be materially improved