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# *2012 Americas School of Mines*

Managing Large-Scale Capital Projects  
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**pwc**

# *Agenda*

Overview of Mining Capital Programs

Megaproject Life Cycle & Risk Environment

Keys to Project Success

Illustrative Case Study

## *Overview of Mining Capital Programs*

The Top 40 announced more than \$300 billion of capital programs with over \$120 billion planned for 2011.

~70% of mining megaprojects fail to meet at least one key criterion of success.

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## ***Overview of Mining Capital Programs***

### **Market CIP**

**“To keep up with demand, the Top 40 have announced more than \$300 billion of capital programs with over \$120 billion planned for 2011, more than double the total 2010 spend.”**

### **-Mine 2011 – the Game has Changed**

<b>Company</b>	<b>Est. CapEx Budget</b>
• BHP Billiton plc	\$16B
• Vale, S.A.	\$21B
• Rio Tinto Ltd.	\$16B
• Anglo American plc	\$3B
• Xstrata plc	\$4B

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# ***Overview of Mining Capital Programs***

## **Megaproject Failure**

**~70% of mining megaprojects fail to meet at least one key criterion of success.\***

<b>Criteria</b>	<b>Failure threshold</b>
• Cost overruns	>25%
• Schedule overruns	>25%
• Cost competitiveness	>25%
• Schedule competitiveness	>50%
• Severe operational problems after 2 years	Yes

\*Source: Merrow, Edward W. (2011). *Industrial Megaprojects: Concepts, Strategies, and Practices for Success*. Hoboken, New Jersey: John Wiley & Sons, Inc.

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## ***Overview of Mining Capital Programs***

### **Price of Failure**

**The price of failure goes beyond the direct impacts associated with increased costs or schedule delays:**

- Loss of revenue associated with missed production targets
- Inefficient capital allocation and need for short term financing
- Loss of shareholder confidence and associated impact to share price
- Claims and disputes with vendors

**The CEO of an international resource extraction company recently suggested that the multi-billion dollar gap between its asset value and market cap was due to lack of shareholder confidence its ability to deliver it's capital projects.**

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# ***Overview of Mining Capital Programs***

## **Megaproject Failure**

**The causes of failure are common and fairly well understood...yet owners frequently repeat past mistakes.**

- Failure to properly allocate risks and rewards
- Over-reliance on contract's ability to mitigate risk
- Overly aggressive schedules
- Incomplete/misunderstood business objectives
- Underdeveloped project planning
- Lack of integrated project team and/or consistent leadership
- Imbalance between execution, oversight, and assurance functions
- Ineffective policies, procedures, and software tools

## *Megaproject Life Cycle & Risk Environment*

To protect shareholder value, owners of megaprojects need to understand and control their delivery risks.

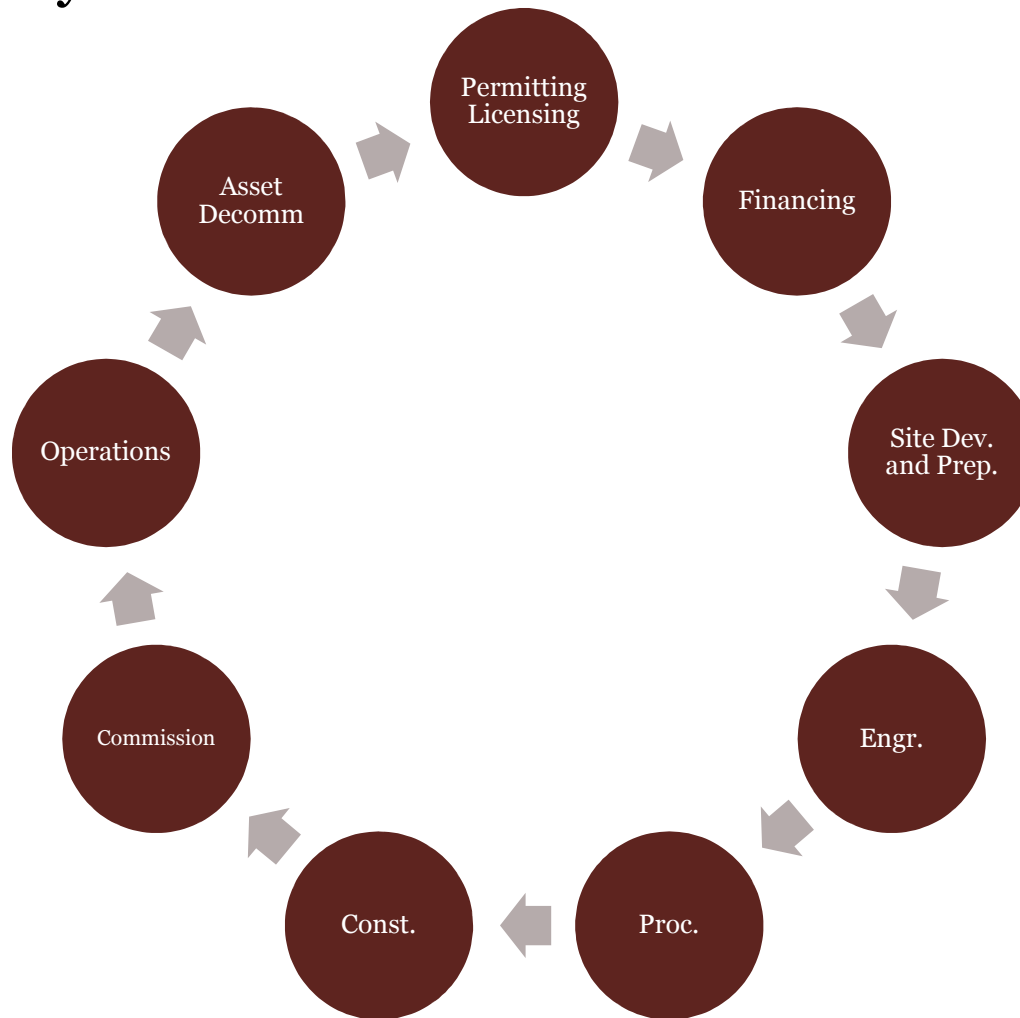
Quantitative Risk Assessments rely on empirical data to identify, assess, and assist in the mitigation of risks.



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# *Megaproject Life Cycle & Risk Environment*

## Project Life Cycle



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# ***Megaproject Life Cycle & Risk Environment***

## **Representative Risks**

**Risks are prevalent through each stage of the project life cycle.**

- Permitting Environmental and land use issues
- Financing Competition for limited capital
- Site Development Easements, rights of way
- Engineering Scope control
- Procurement “Overheated” market impacts on price
- Construction Resource availability
- Commissioning Insufficient integration and training
- Operations Talent availability
- Asset Decommissioning On-going environmental monitoring

# Megaproject Life Cycle and Risk Environment

## Risk & Control Framework

		Project Life Cycle →					
		Planning	Design	Implementation	Testing	Turn-over	M&O
Project Elements ↑	Organization Design & HR Management	Project Management Plan and Staffing			Staff Reductions / Transfers	Operations Staff Planning	Ongoing Requirements / Skills Review
	Procurement & Contract Management	External Contracting Options	Vendor Qualification / RFP Process (EPC Contract Evaluation)	Vendor Selection / Contracting	Contract Compliance Review	Trouble-shoot & Punch List	Vendor Qualification / Selection
	Scope & Change Management	Definition of Project Elements and Benefits	Design Project Components (Phase 1 Transition Plan)	Change Control Process		User Acceptance Process	Operations Acceptance Process
	Cost Management	Capital Budgeting and Ratemaking Approach	Cost & Schedule Forecast	Cost Control		Final Payment / Retention Release	M&O Budget Process
	Schedule Management	Project Schedule Requirements	Baseline Project Schedule (WBS & Consolidated Pre-deployment schedule)	Detailed Schedule Management		Schedule Completion Check List	Ongoing Maintenance Schedule
	Business Systems & Technology	Project Purpose funding & approval	Business Needs Assessment & Technology Framework	Integration & Executive Oversight		Continuous improvement and reasonableness reviews	
	Risk & Issue Management	Project Risk & Issue Management Planning	Risk & Issue Tracking & Resolution			Confirm Issue Resolution	Ongoing Issue Management Process
	Reporting & Regulatory Requirements	Project Reporting Requirements (Project Communication Strategy)	Project Status and Regulatory Filings	Project Cost, Schedule & Budget Variance	Project Quality Performance	Project Close-out Performance	Financial Reporting

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# ***Megaproject Risk & Control Environment***

## **Quantitative Risk Assessments**

### **Frequently Asked Questions**

- How confident are you that we will complete this project on budget?
- How have you quantified the risk inherent in constructing a megaproject?
- How are you managing project cost contingencies?
- What will happen to the total project cost if one of our significant risks comes to fruition?

**Quantitative risk assessments are attractive to Management because they indicate a project outcome in terms of a range not a single point – this is much closer to reality**

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# ***Megaproject Risk & Control Environment***

## **Quantitative Risk Assessments**

### **Tools & Techniques**

- Stochastic tools to analyze risks on megaprojects and establish / monitor the implications of project risks
- Test the sensitivity of each assumption underlying their baseline estimates and potential changes to the baseline estimates
- Sensitivity analyses recalculating the cost estimates with different quantitative values potential events or scenario parameters
- Compare results to baseline estimates to determine if any individual cost element's parameter, risk or assumption yields a significant change in the overall cost estimate

**These 'sensitive' elements can then be identified, addressed through improved scope definition, or closely monitored and managed within a risk and contingency management plan**

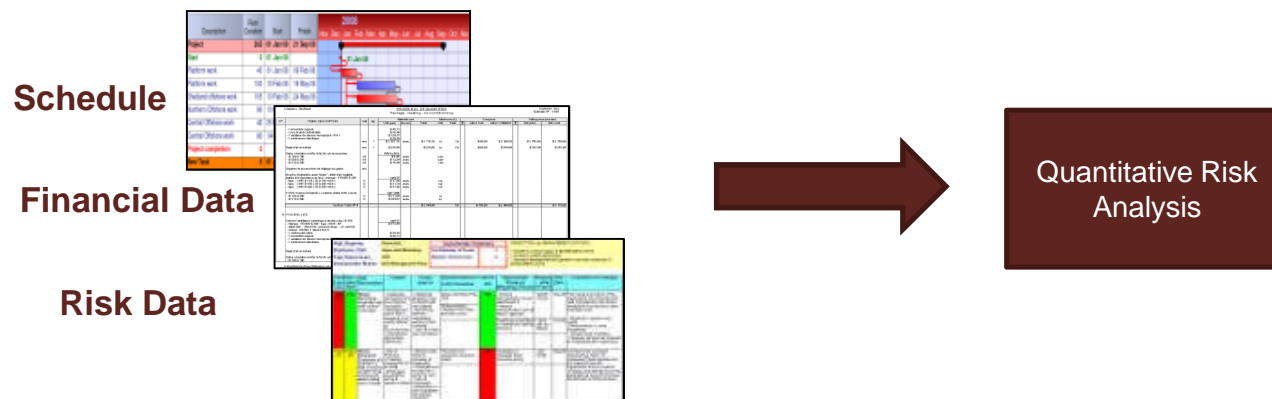
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# *Megaproject Risk & Control Environment*

## Quantitative Risk Assessments

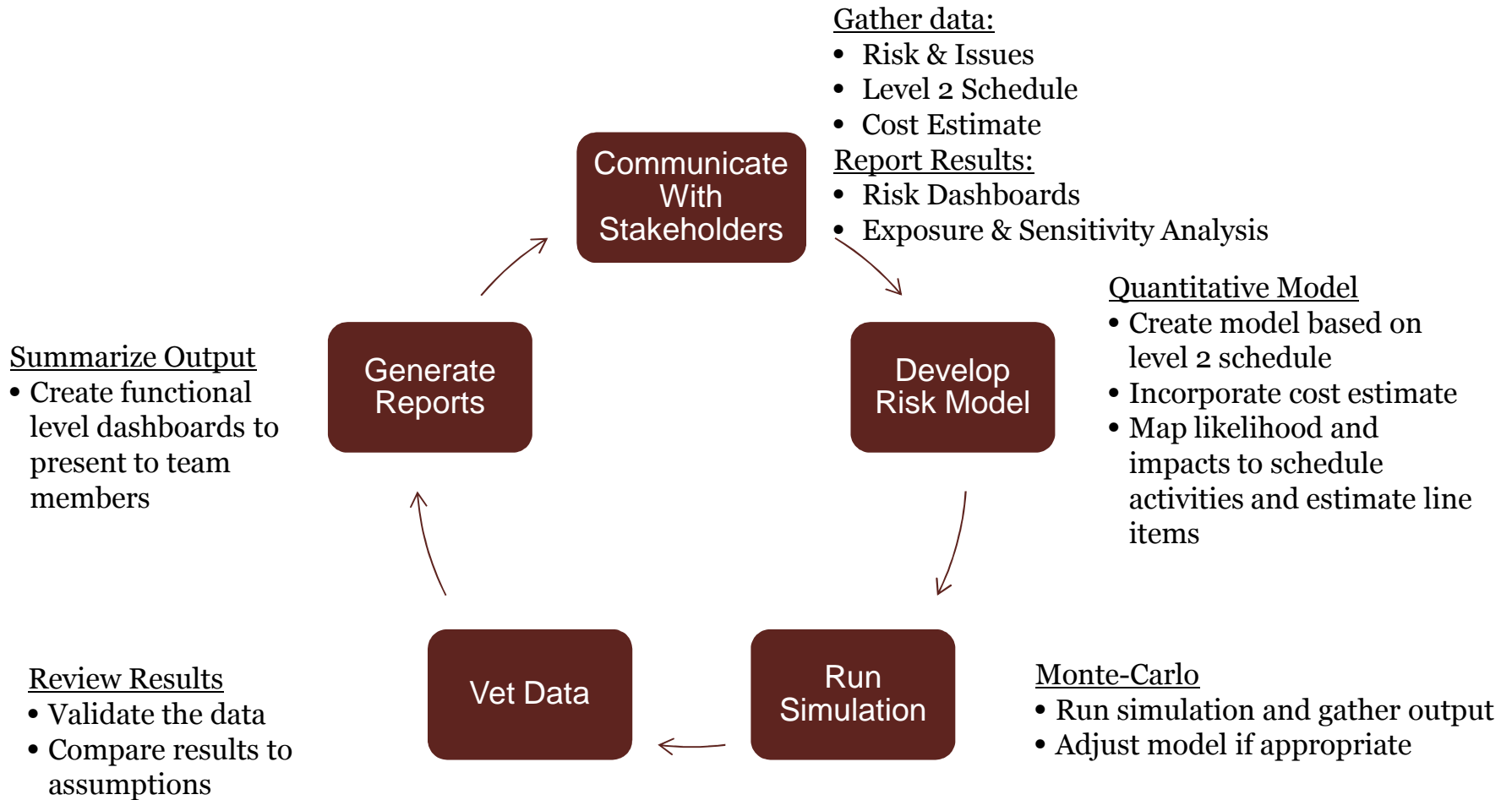
Using QRA, the project team is able to integrate cost, schedule and risk data to model possible project outcomes in terms of both cost and schedule. Specific objectives include:

- Determine discrete impacts of various risks and threats as they relate to the project cost and schedule
- Address the degree of uncertainty present in schedules and cost estimates
- Provide a level of confidence for current project schedule and cost estimate
- Provide tools for better informed decision making



# Megaproject Risk & Control Environment

## QRA - The Process

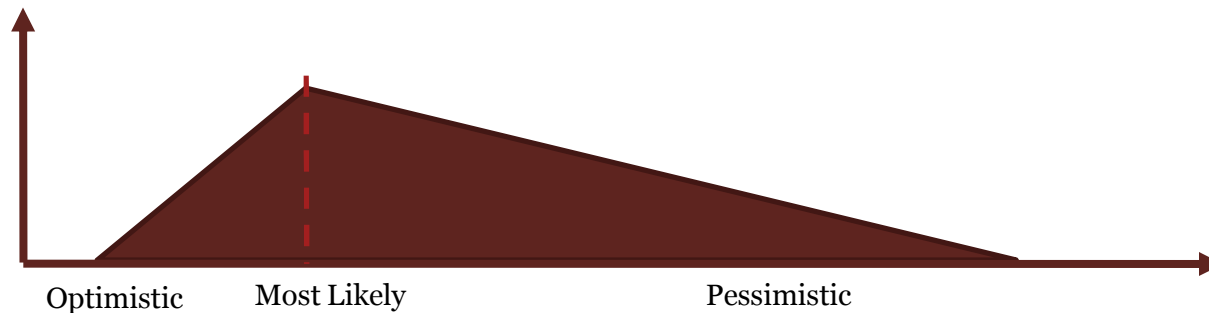


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# ***Megaproject Risk & Control Environment***

## **QRA - Modeling risks using Monte Carlo**

- Based on the probabilities and ranges assigned to the model, the simulation software runs several thousand random iterations
- Probabilities are used as triggers for the risk events
- Impact ranges are typically assigned on a three-point estimate basis which are defined as follows:
  - Optimistic – The best possible outcome if the risk occurs
  - Most Likely – The most likely outcome if the risk occurs
  - Pessimistic – The worst possible outcome if the risk occurs
- The inputs are typically modeled into a triangular distribution – things can only marginally improve but could get much, much worse.





# Megaproject Risk & Control Environment

## QRA - Quantifying cost and schedule risks

### Likelihood

Probability Rating & Description		Probability/Likelihood of Occurrence	Model Likelihood	Chance*
5	Almost Certain	81 – 100%: The risk event is expected to occur in most circumstances	100%	1
4	Likely	51 – 80%: The risk event will probably occur in most circumstances	80%	1
3	Possible	21 – 50%: The risk event will probably occur in some circumstances	50%	0
2	Unlikely	6 – 20%: The risk event could occur in some circumstances	20%	0
1	Rare	0 – 5%: The risk event may occur in exceptional circumstances	5%	0

\*Chance – A binomial distribution is used to model the chance of a risk event occurring based on the likelihood of that event. If the chance is a 1, the model assumes that the risk event occurs and will impact the mapped activity or group of activities based on the impact criteria below.

### Impact

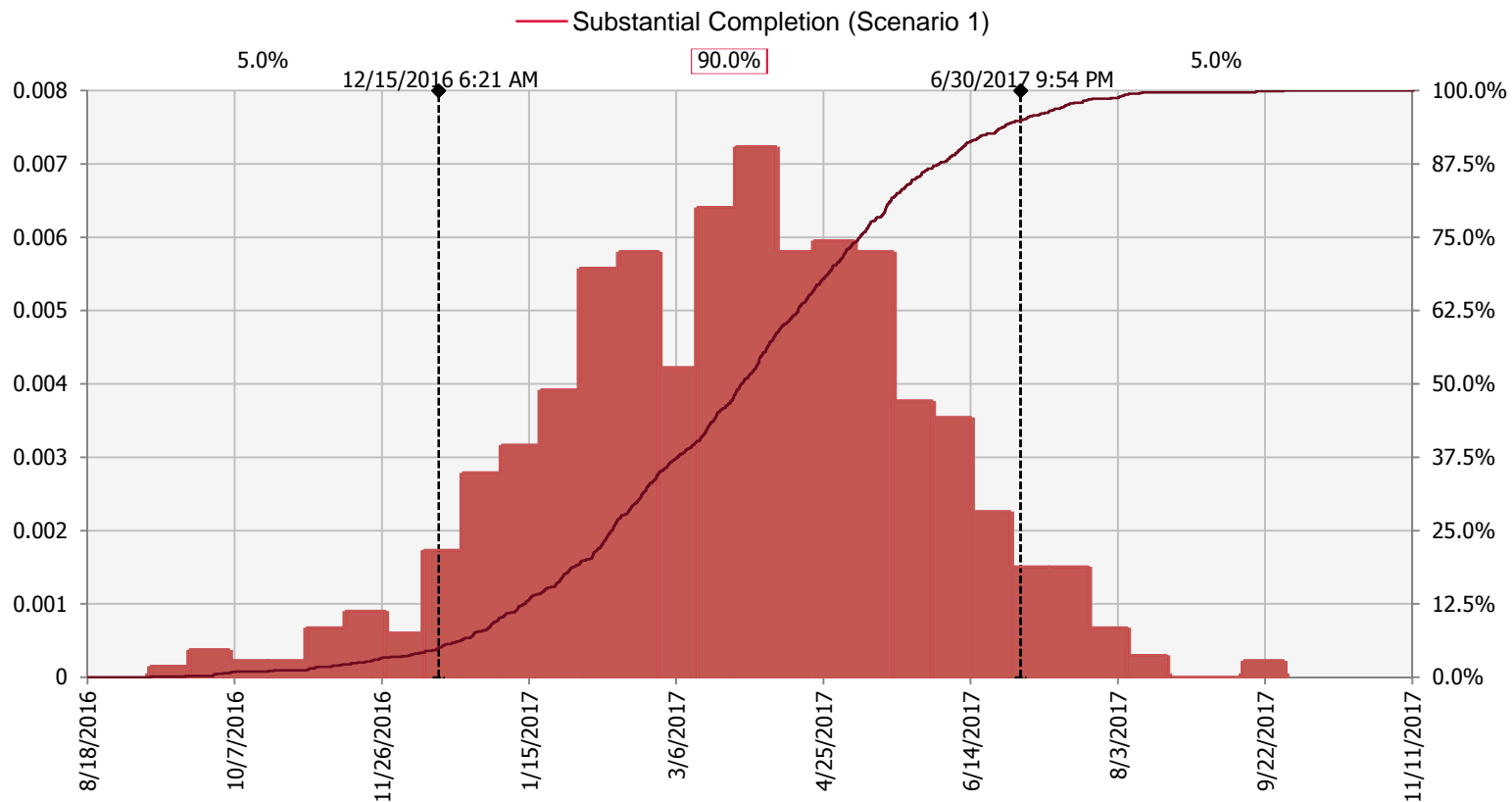
Impact Rating & Description		Impact Ratings		Model Impact*		
		Cost	Schedule	Optimistic	Most Likely	Pessimistic
5	Critical	Cost increase of \$50M or greater	Critical schedule delay of 6 weeks or greater	5 weeks	7 weeks	10 weeks
4	Severe	Cost increase of less than \$50M but more than \$10M	Critical schedule delay of 3-6 weeks	3 weeks	5 weeks	7 weeks
3	Significant	Cost increase of less than \$10M but more than \$2M	Critical schedule delay of 1-3 weeks	1 weeks	2 weeks	4 weeks
2	Moderate	Cost increase of less than \$2M but more than \$100k	Critical schedule delay of up to 1 week	0 weeks	1 weeks	2 week
1	Minor	Cost increase of less than \$100k	No critical schedule delay	0 weeks	0 weeks	0 weeks

PwC \*Model Impact – The Optimistic, Most Likely and Pessimistic durations will be modeled in a triangular distribution and mapped to the activities or group of activities on the Level 2 Schedule that the risk event would impact should it occur.

# Megaproject Risk & Control Environment

## QRA – Sample Output

Shows a distribution of different forecasted completion dates and a cumulative curve demonstrating the confidence level of completing the project on each date.



## *Keys to Project Success*

Projects don't have to fail. Owners can, and have, exercised prudent management action to mitigate risks and improve likelihood of project success.

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## ***Keys to Project Success***

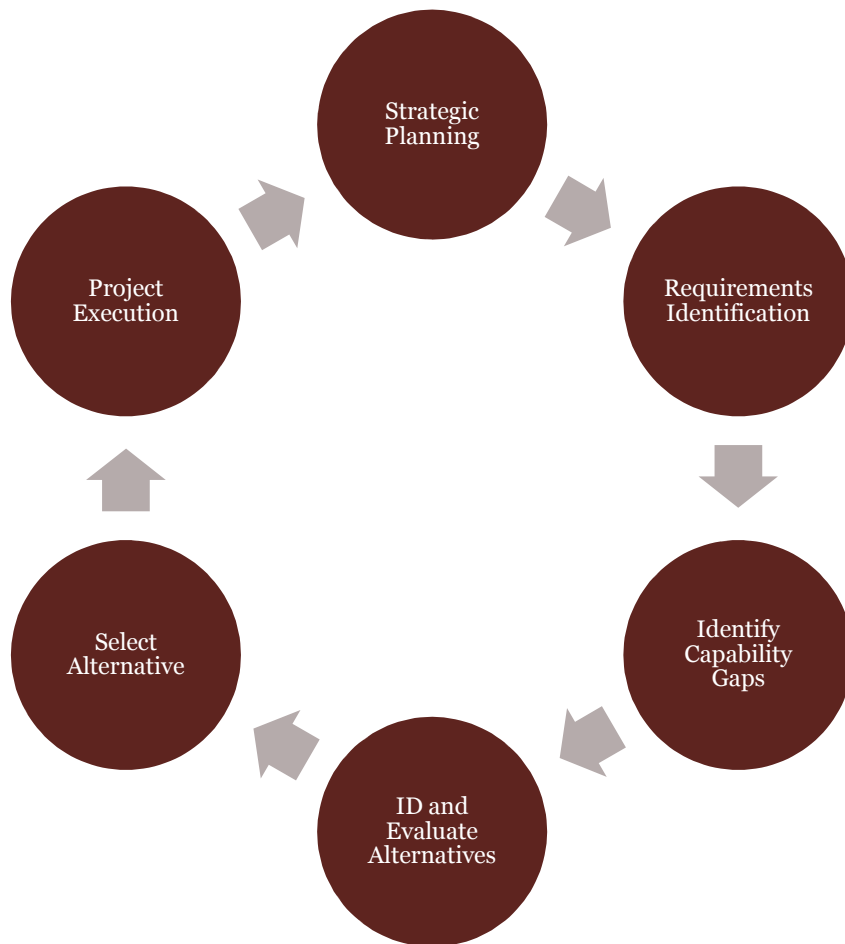
### **Steps to improving likelihood of project success.**

- Capital investment planning
  - “Pick the right projects”
- Select contract strategy
  - “Keep your friends close, and your [vendors] closer”
- Develop and integrate project management team
  - “There’s no ‘I’ in ‘team’.”
- Establish policies and procedures
  - “Get everyone on the same page”
- Establish robust governance function
  - “You get what you inspect, not what you expect”

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# ***Keys to Project Success***

## Capital Investment Planning



**Projects are not constructed for the sake of construction. They are undertaken to meet a defined business objective.**

**Without understanding the company's business objectives, and how the selected project will fulfill that objective, the project will fail.**

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# ***Megaproject Risk & Control Environment***

## **Select Contract Strategy**

**Contracts are risk allocation tools, but not all risks can or should be transferred to vendors.**

Failure to understand and incorporate the results of the QRA and Risk Management Plan in the selection of the contract strategy impairs the contract's effectiveness in allocating risks.



### **Risk allocations should consider:**

- Which party is best capable of mitigating risks?
- How will compensation terms be established based on risk allocation?
- Is the owner willing to transfer authority to mitigate risk along with accountability for occurrence of risk?
- What controls are necessary to monitor risks allocated to others?

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# ***Megaproject Risk & Control Environment***

## **Select Contract Strategy**

### **Traditional**

- Full and Open Competition
- Low Price
- Sealed Bid
- Fixed Price
- Isolated Process
- Rigid Change Management

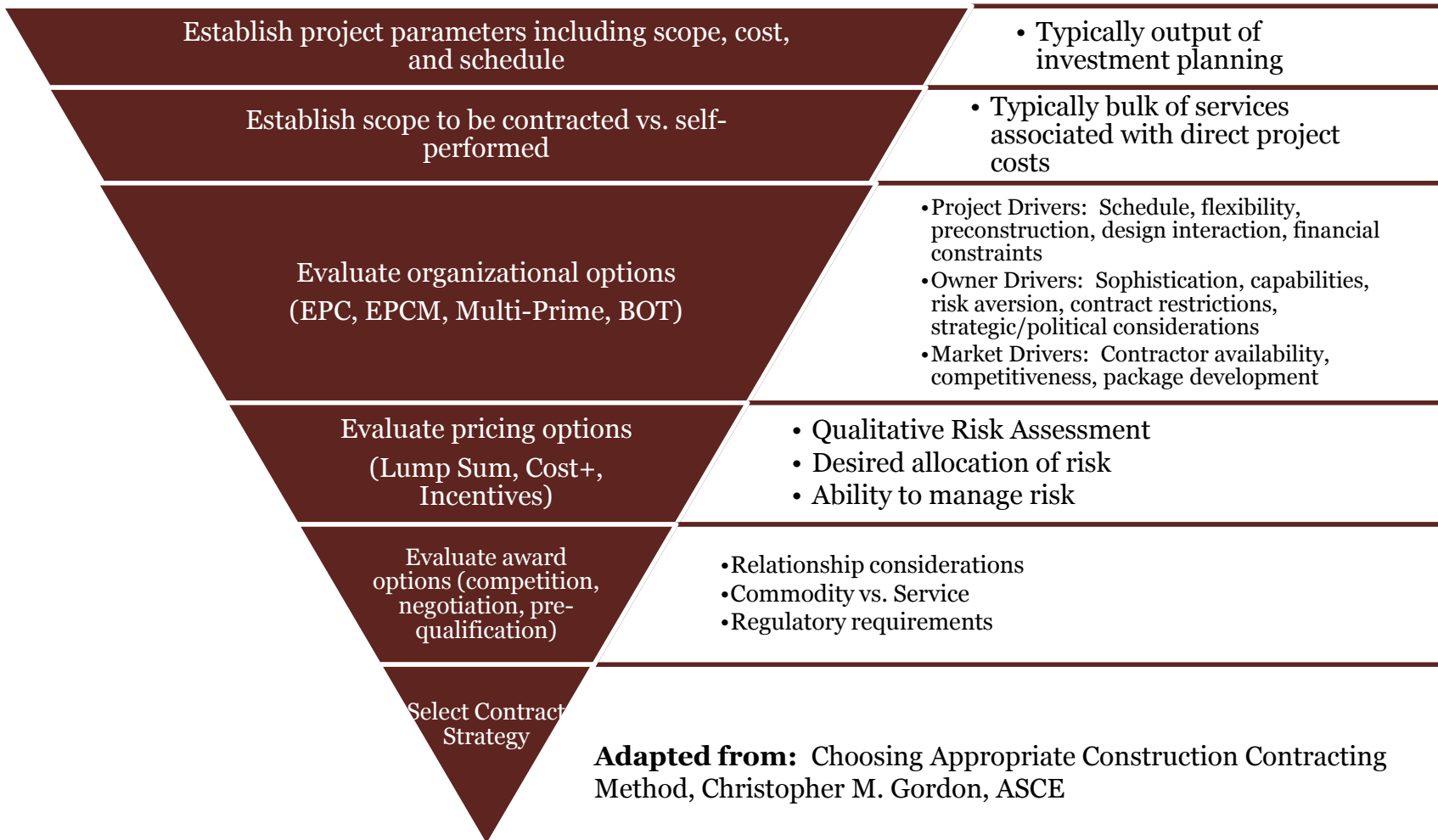
**Traditional procurement decisions are typically price-driven, have limited flexibility, and rely on strict contract and process compliance for project success.**

### **“Best Value”**

- Vendor Pre-Qualification
- Price Reasonableness
- Negotiations and BAFO
- Variable Pricing Arrangement
- Integrated with Engr. and Const.
- Flexible Change Management

**“Best Value” procurement decisions seek to reduce the Total Cost of Ownership through a holistic understanding of all project considerations – schedule, risk, operational efficiency, vendor relationships – not just compliance and low price.**

# Contract Strategy Selection



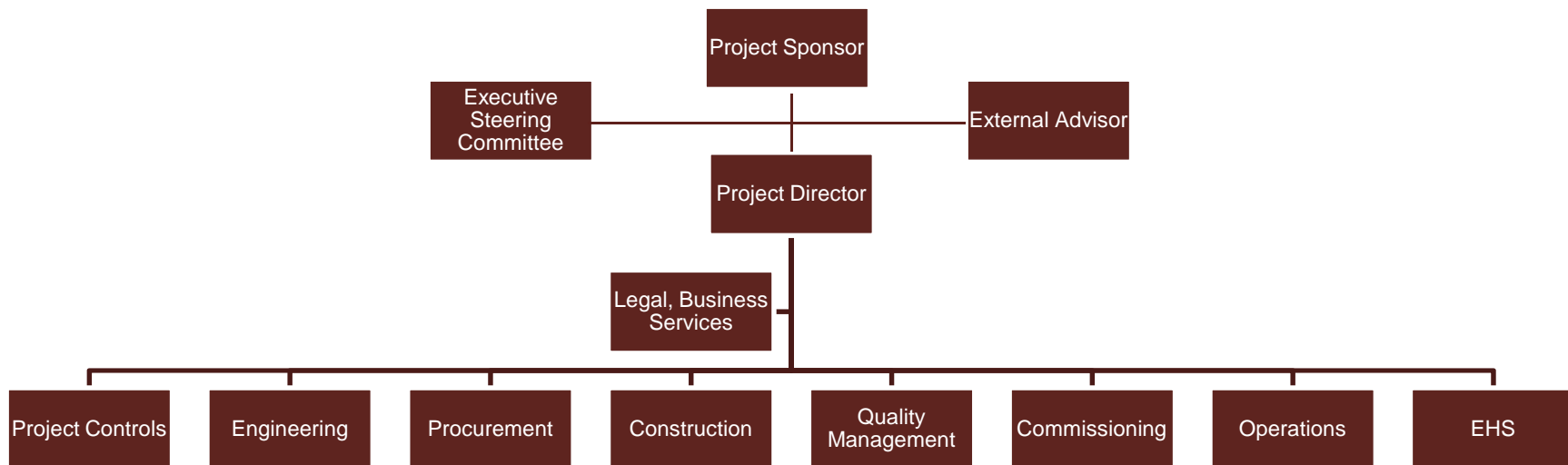


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# ***Megaproject Risk & Control Environment***

## **Develop and Integrate Project Management Team**

### **Representative Project Management Team Functions**



**Integrated Project Teams consider the life cycle of the project and bring together representatives from the business sponsor through operations and asset management.**

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## ***Megaproject Risk & Control Environment***

### **Develop and Integrate Project Management Team**

**Owners frequently rely on vendors to augment their capabilities. Outsourced or co-sourced project teams require:**

- Strong owner oversight and involvement
- Clear delineation of roles & responsibilities
- Understanding of potential conflicts of interest
- Alignment of individuals' responsibility, accountability, and authority
- Contract language that allocates rewards and provides remedies
- Understanding of cultural and experiential differences between owner and contractor staff – each will approach projects in a fundamentally different way

**Certain duties and obligations cannot be outsourced – they must be performed by the owner.**

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# ***Megaproject Risk & Control Environment***

## **Policies & Procedures**

### **Representative Policies & Procedures Manual Contents**

- Operations and Governance Model
- Scope and Change Management
- Cost Management
- Schedule Management
- Earned Value Management
- Procurement Management
- Quality Management
- Risk Management
- Reporting
- Data and Information Management

**Consider software and data tools. Onerous procedures without appropriate tools can undermine controls.**

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## ***Megaproject Risk & Control Environment*** **Policies & Procedures**

### **Contracts are not substitutes for robust policies and procedures.**

- If a contract incentivizes cost performance (e.g., a fixed fee pricing arrangement), an owner may need to implement enhanced quality control procedures.
- If a contract incentivizes schedule performance, the owner should closely track productivity rates and the associated cost of labor.
- If a contract rewards performance based on an earned value management system, the owner needs to understand underlying assumptions, budgeted unit rates, and how quantities are tracked.

**The contract strategy, team structure, and policies and procedures must be complementary and aligned to mitigate risks identified during the QRA.**

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# ***Megaproject Risk & Control Environment***

## **Governance**

**“Project Governance” encompasses the management decisions and activities to support project success.**

**Governance requires clearly defined roles for:**

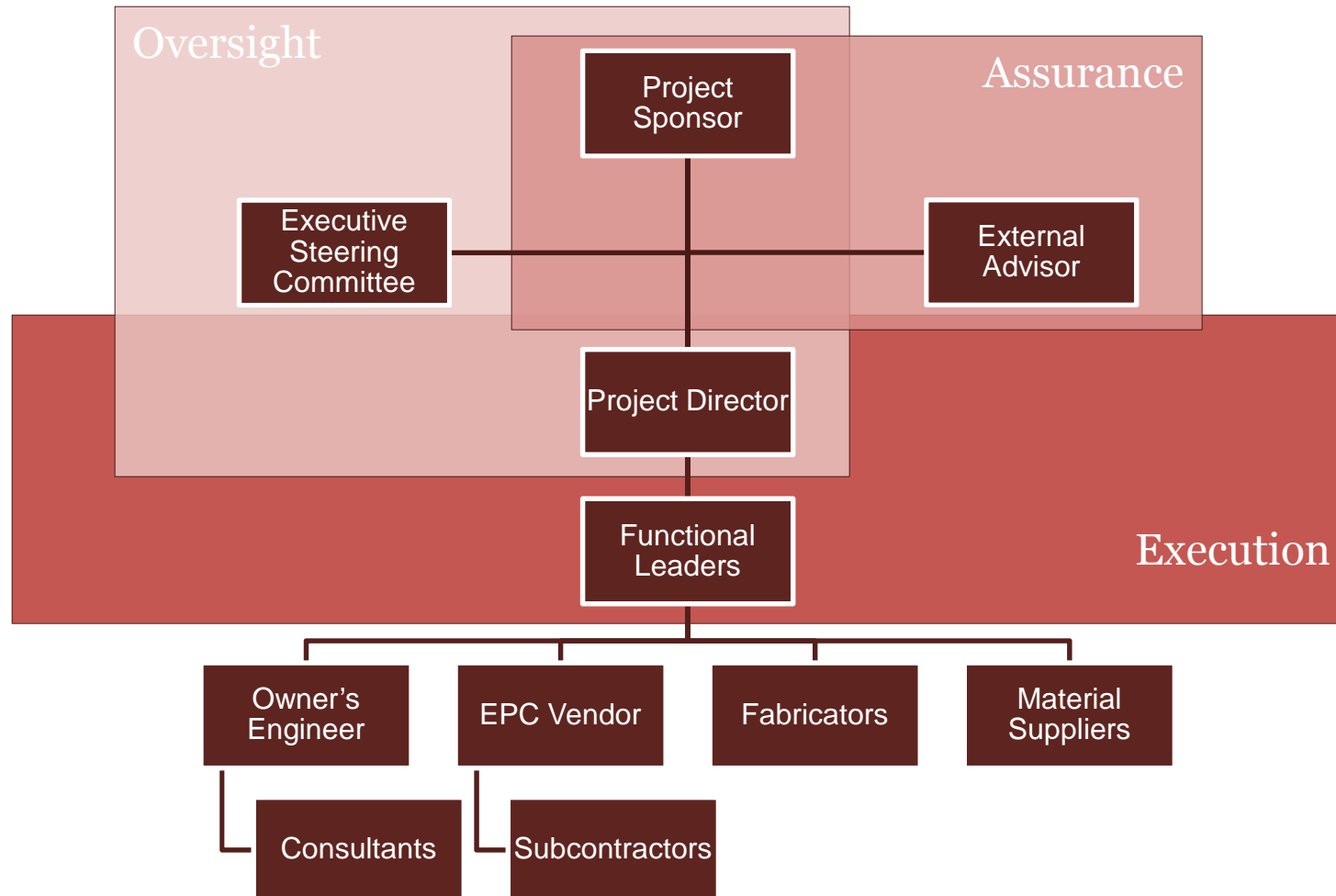
- Execution
- Oversight
- Assurance

### **Project Governance Objectives**

- Transparency
- Accountability
- Audit Trail

# Megaproject Risk & Control Environment

## Governance



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# ***Megaproject Risk & Control Environment***

## **Governance**

### **Project Governance activities include**

#### Execution

- Implement policies and procedures
- Manage contracts and monitor vendor performance
- Identify issues and risks

#### Oversight

- Empower management team
- Evaluate and question reported data
- Overview and participate in periodic risk management updates

#### Assurance

- Periodically test project controls
- Trust but verify – establish a “no surprises” mentality

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# *Megaproject Risk & Control Environment*

## Summary

### **Summary**

Summary



# *Case Study*

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## ***Illustrative Project***

### **Project Size**

Approx. \$1B

### **Project Scope**

Complete replacement of equipment, substantial site work to update tailing ponds and delivery lines to current environmental standards in a major watershed area.

### **Challenges**

- Limited owner experience in managing a multi-prime project delivery
- High turnover of workforce in local market
- Fast-track engineering and design
- Uncertain schedule priorities due to volatile commodity price

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# ***Rare Earth Mining Renovation Project, cont'd***

## **Project Performance vs. Keys to Success**

### ***Capital Investment Planning***

- Project business case was based on fluctuating commodity price, resulting in opportunistic rather than strategic approach and inconsistent corporate sponsorship.

### ***Contract Strategy***

- The owner was forced into a multi-prime delivery strategy due to lack of capacity of preferred EPC vendors. Market conditions became the driver for the contract strategy.

### ***Develop and Integrate Project Team***

- The project had sufficient owner and outsourced staff, but positions were often duplicated resulting in misunderstood or poorly aligned responsibility, accountability, and authority.

### ***Policies and Procedures***

- Policies and procedures were well developed but inconsistently understood and implemented.
- Outsourced staff did not consistently follow owner policies and procedures and used their own cost monitoring and reporting systems.

### ***Governance and Oversight***

- Schedule monitoring and reporting was suspended as the handoff to commissioning approached, resulting in unclear estimates for final completion.

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## ***Rare Earth Mining Renovation Project, cont'd***

### **Significant Project Outcomes**

Cost overruns on time and materials contracts (~20% versus budget) due to lack of engineering and construction oversight

Schedule delay (+25% versus baseline) due to limited schedule monitoring and reporting against expectations, as well as quality issues discovered late in commissioning

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# *Questions?*

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## ***Contact Information***

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