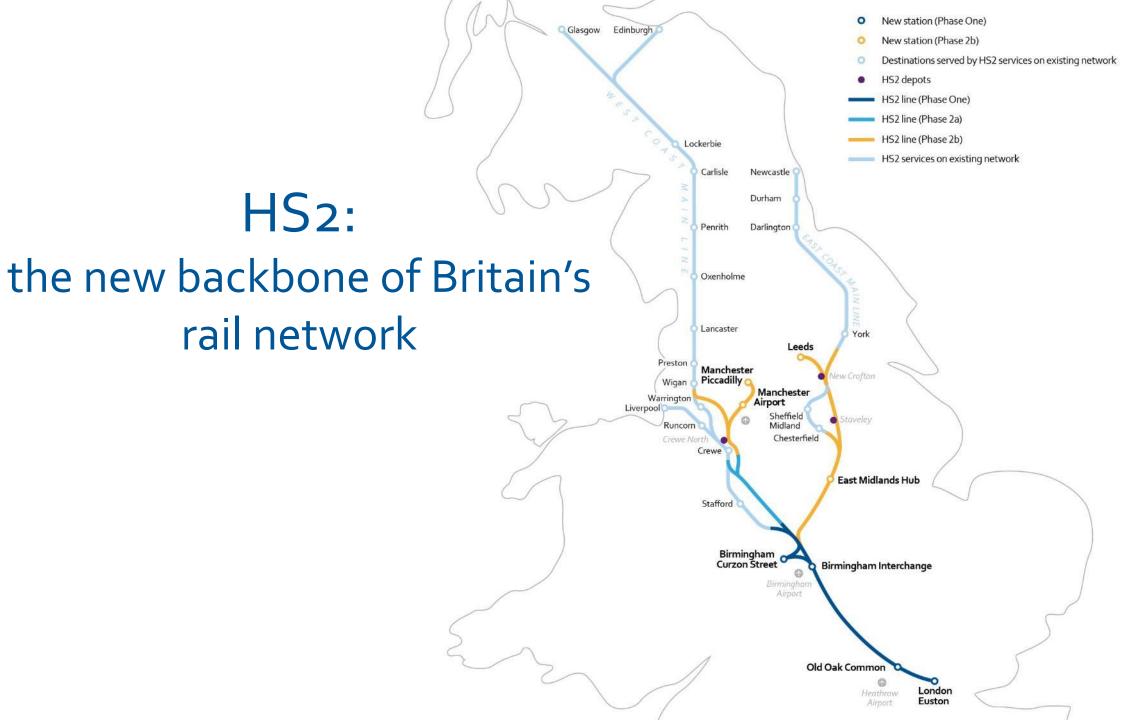


HS2 – Britain's new high speed railway Management of Risk

Jeremy Harrison, Director Risk & Assurance, HS2 Ltd 25 January 2018







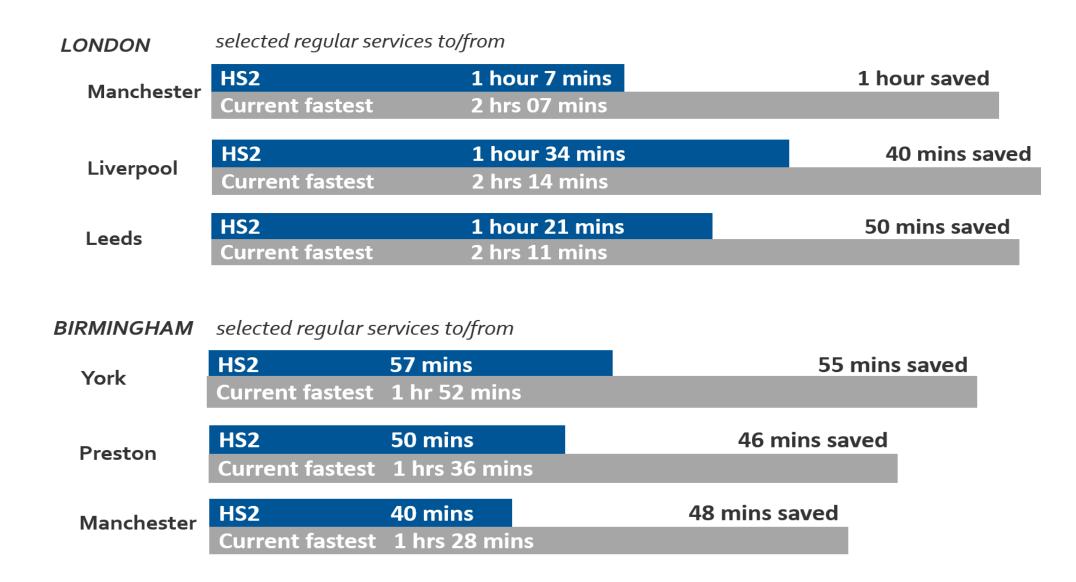
HS2:



More than double the seats



Fast, frequent and reliable



HS2 opens up new economic opportunities for:

Trade & competition

Local & regional markets



New exports

New employment

New investment



HS2 strategic goals















www.gov.uk/hs2

25,000 during construction

2,000 new apprentices

HS2 will provide jobs for Britain:



1,200 NCHSR graduates a year

3,000 jobs to maintain and operate

100,000s jobs through regeneration/growth





Building HS2













DESIGN & SERVICES

TUNNELS

SURFACE ROUTE

STATIONS

RAILWAY SYSTEMS

ROLLING STOCK

Phase 1 construction statistics

230km ROUTE LENGTH

46km TUNNELS 74km
CUTTINGS

128 mt

EXCAVATED MATERIAL

(90% TO BE RE USED)

145
STRUCTURES
OVER BRIDGES

152
STRUCTURES UNDER BRIDGES

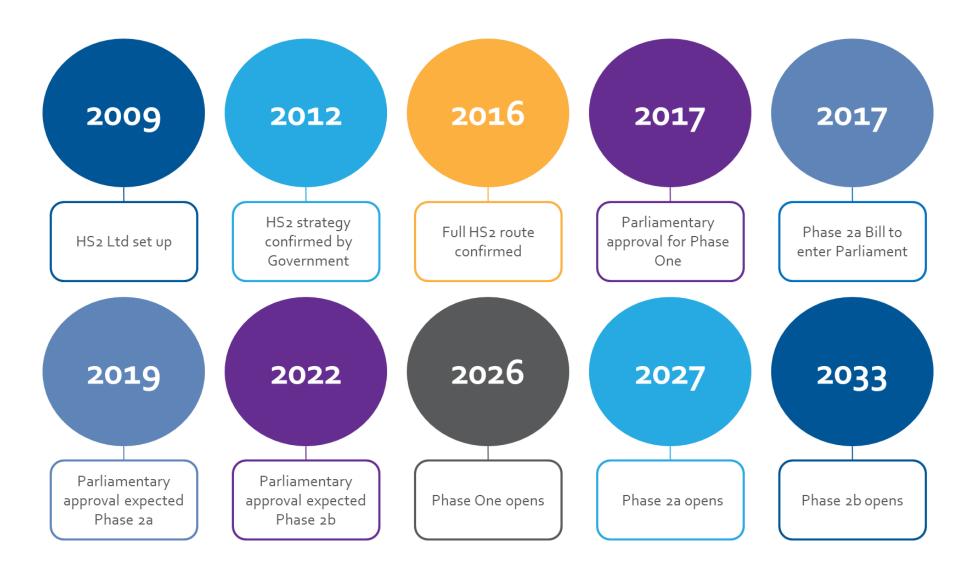
31

MAIN COMPOUNDS
FOR CONSTRUCTION

299

SATELLITE COMPOUNDS

HS2's timeline



Risk Management Principles

Principle 1: Risk management applies to all aspects of HS2.

Principle 2: Risks derive from objectives and stakeholders

Principle 3: Risk management is undertaken to reduce risk exposure, increase certainty, improve confidence and generate greater value.

Principle 4: Risk is multidimensional and values both soft issues and hard absolutes.

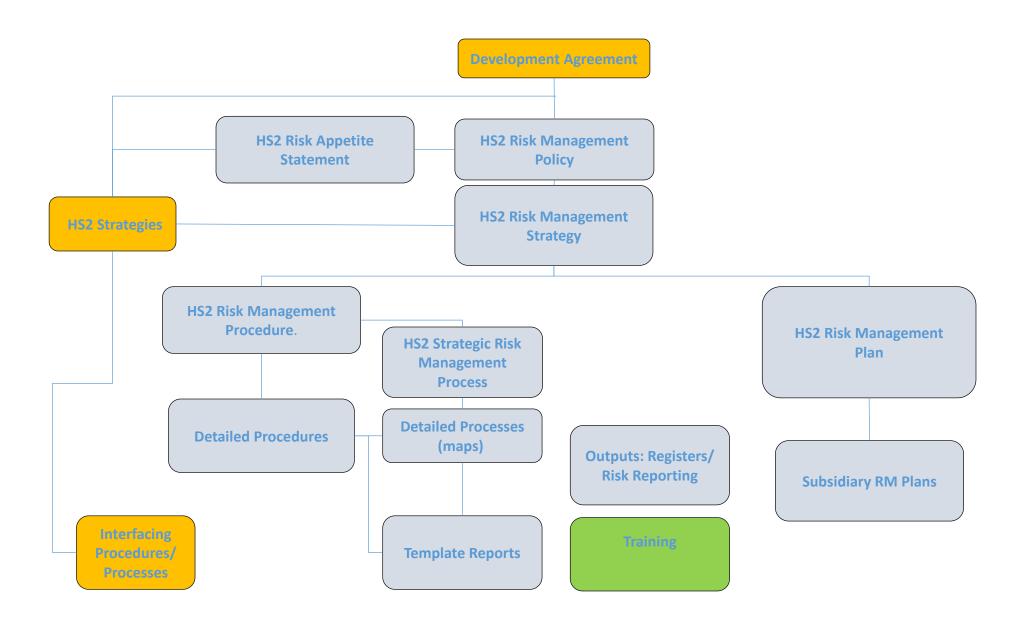
Principle 5: Ensure clear accountability for risk.

Principle 6: Provide the right information to the right people at the right time.

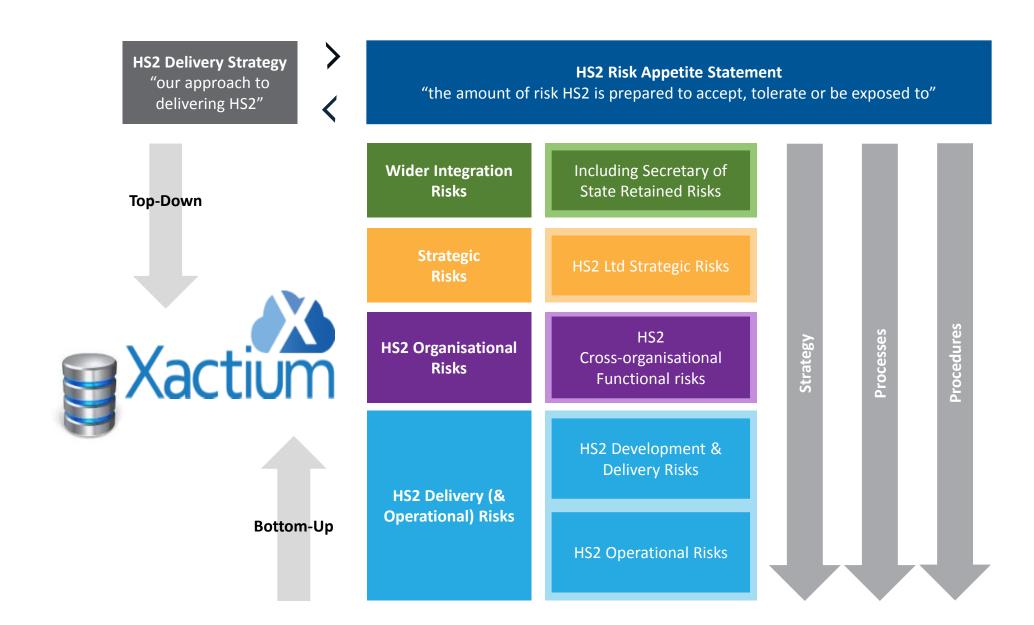
Principle 7: Implement a pragmatic risk management solution.

Principle 8: HS2 Ltd risk management is based on continuous improvement.

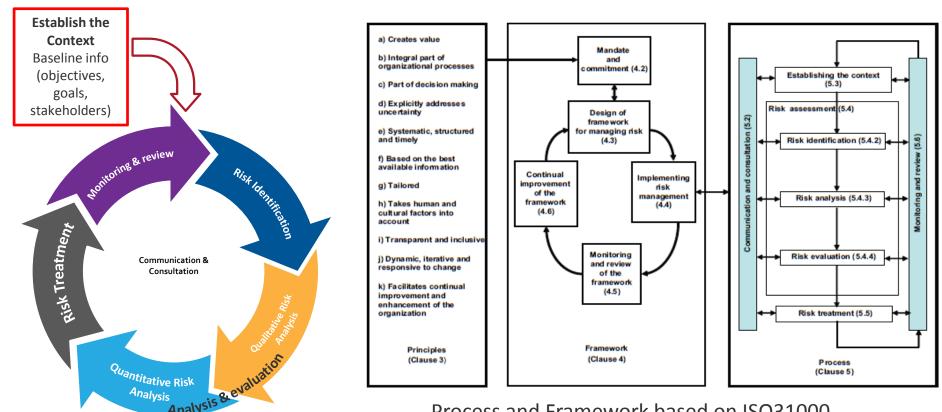
Enterprise Risk Management Documentation: Theory into Practice



Enterprise Risk Management Framework

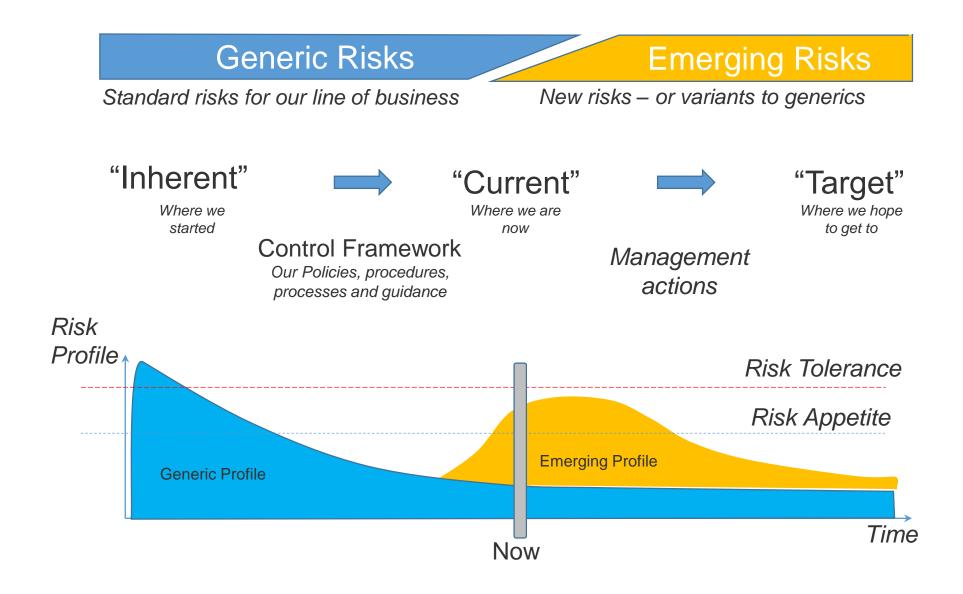


Risk Process

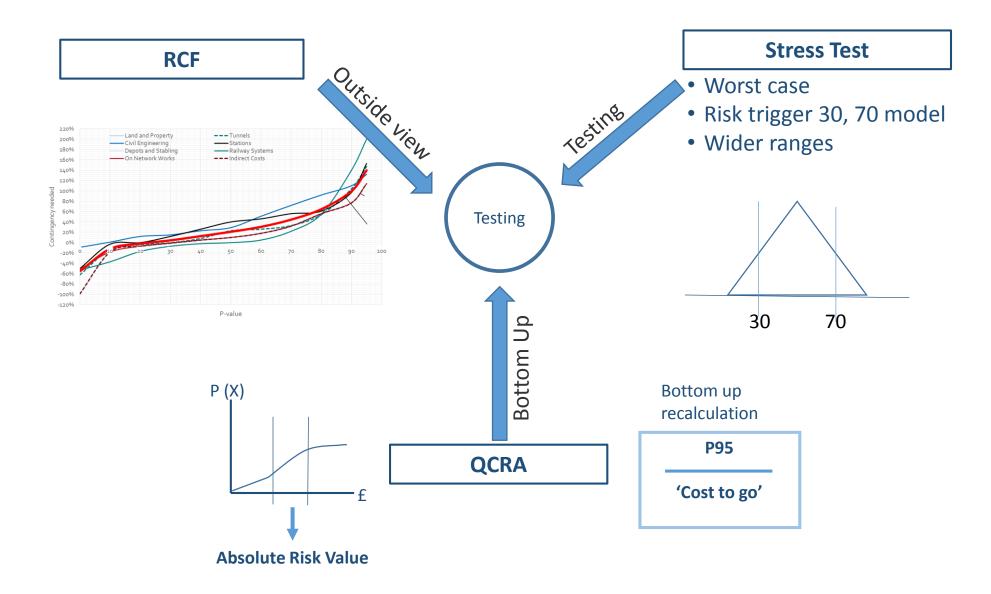


Process and Framework based on ISO31000

Differentiating between Generic and Emerging Risks and Inherent, Current and Target States



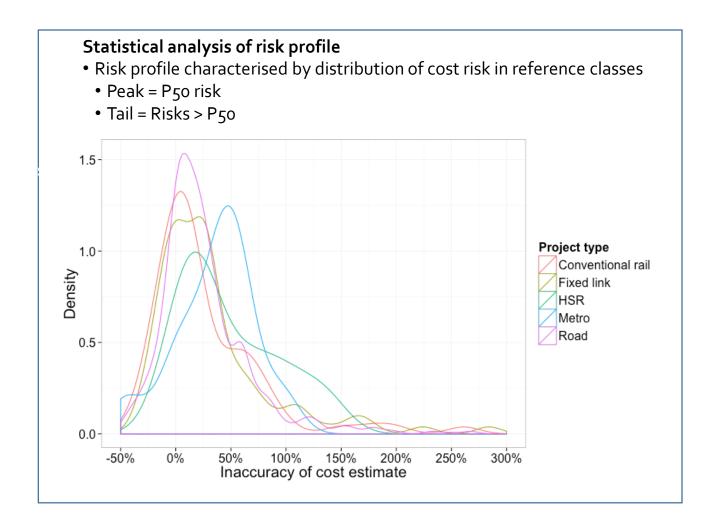
Creating confidence



Reference Class Forecasting – in 3 steps

- 1. Identify relevant **reference class** of past, similar projects
- 2. Establish **probability distribution** for the selected reference class
- 3. Compare specific project with distribution, in order to establish **most likely outcome**

Building a Reference Class



^{*} The p-value of statistical tests indicates the strength of the evidence, if p < 0.05 the test is significant – here indicating that there is strong statistical evidence that these project types are different from HSR Source: Oxford Database, August 2015 (Sample of n=361 projects)

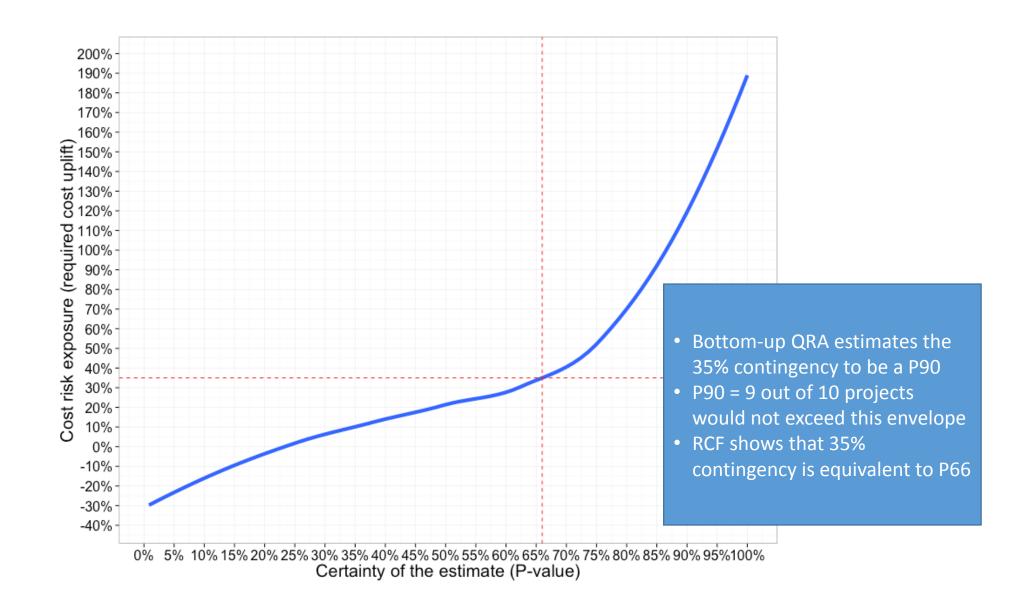
Building a Reference Class

- Selecting past similar projects, based on **statistical similarity**
- Testing whether average, median (P50), P80, P90, P95 are statistically significantly different from HSR

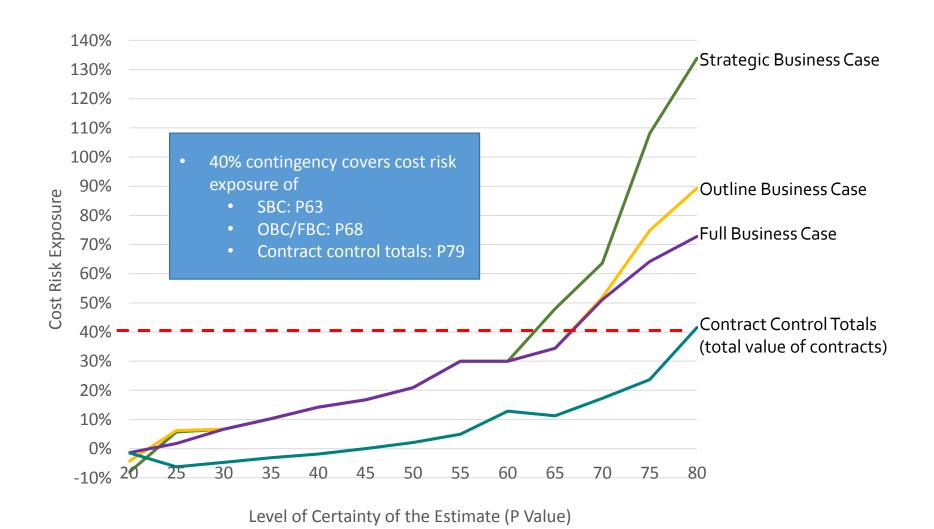
Is this project type a suitable comparator for HSR projects? (n=39)	Average	P50	P8o	P90	P95	X Statistically significant difference✓ No statistically
Conv. rail (n=113)		√		√	√	significant difference
Fixed link (n=132)	✓	√	√	✓	✓	
Metro (n=196)	✓	✓		✓		
Road (n=658)		✓			✓	_

- Only fixed links are comparable for the full range of estimates from P50-P95
- Final selected reference class included 39 high-speed rail projects and 132 fixed links = 171 projects

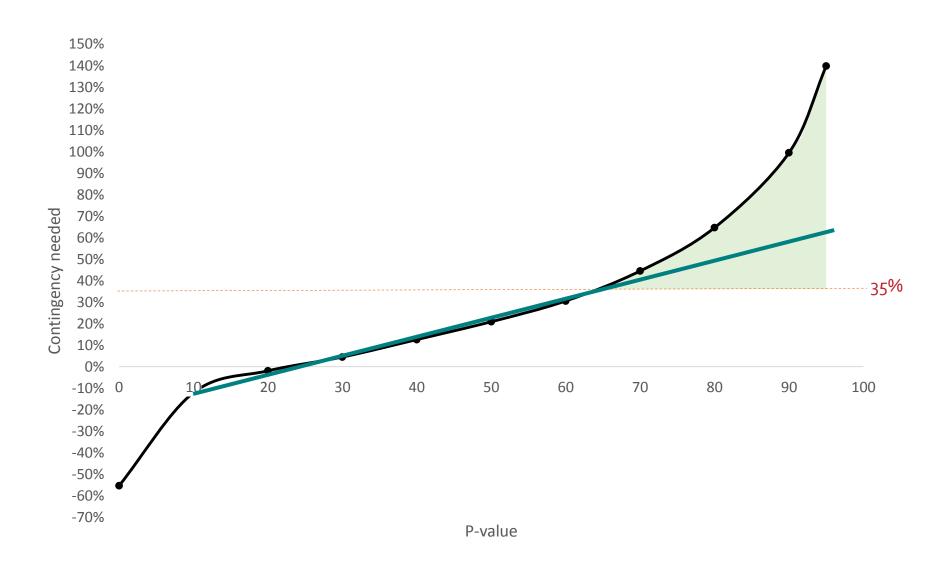
Building a Reference Class for HS2



Comparison of the Different Reference Classes for Different Points of the Estimate for Levels of Certainty between P20-P80



Key Concern is the Tail Risk



Causes in the Tail

Stated causes

- Early delays (procurement, political decision making)
- (Late) design/scope changes, e.g. changes discovered during testing and commissioning; station changes triggered by local government; environmental mitigation
- Geological risks (sinkholes, archeological finds, water tables, ground levelling, ...)
- "Rare" risks, e.g. contractor bankruptcy, political influence (for example on contractor selection), fraud by contractors (for example using poisonous sealants)
- Nominal cost increases due to
 - Unforeseen Inflation
 - Reduced number of rolling stock
- Quality risks and resulting rework
- Cutting of funding
- Unknowns in the design (particularly of safety and operations systems)
- Intermodal integration (long distance bus, commuter rail)

Responses to Raise Maturity

Area	Description	Response			
Design	Late design changes due to external demands	Hybid Bill process controls scope			
Funding	Problems with funding causing changes to profile. Including excessive interest payments.	Agreed funding profile up front and funding mechanisms including necessary insurance strategy.			
Amplification	Problems on critical path escalate rapidly without 'damping'	Designing schedule to create higher confidence at critical points eg end of pre-construction. Early contractor involvement in design			
Integration	Failing to appreciate and understand scale of integration required to deliver	Structure of contracts. Assurance approach. Technical specification and assurance			
Quality	Problems with quality of work completed	Assurance design. Hand over points control.			
Archaeology	Significant volumes of archaeology and geology issues	An allowance made and base case is towards the worst case			
Inflation	Inflation greater than expected	Specific recognition and approach to this issue.			

Front-End Capability Maturity Model

(Said Business School, Oxford – Prof Bent Flyvbjerg)

3. Reference **Class Forecasting**

No systematic approach to taking the outside view

- Variability between projects' and subprojects' ability to reduce bias
- Ignorance of unknownunknowns
- Incentives to de-risk projects and safeguard contingencies not aligned in supply chains

5. Master Builder Leadership

Wide range of capabilities with few pockets of excellence

- Careful balance between individual and organisational capabilities
- High-powered experts lack understanding of way of working
- Lack of empowerment of experts (stifled by process)
- No culture of excellence but a culture of heroes

2. Due Diligence

1. Benchmarking Projects planned with an inside view only

Optimism bottom-up in estimates unchecked

No internal capability to • challenge cost and schedule forecast of contractors

- No capability to identify 'low balled' bids
- No understanding of the uncertainty of estimates

Has the project taken a systematic view to compare itself to other projects?

How mature is the risk management (if any) and other PM disciplines to manage the front-end process? Has the project analysed its sources of complexity?

4. Black Swan

Slow management

information leads to

Biased and narrow

Overly complex

(ie sources of

complexity)

uncertainty and

Tight coupling and

interactive complexity

make project fragile

predictable surprises

deaf to weak signals

and time complexity)

with management of

symptoms not causes

management reporting -

projects (social, political-

Management

- Have complexities been actively managed or mitigated?
- How compressed is the schedule?
- How confident is the project in the capability of its leaders?
- How mature are the PM processes?
- Do the project and supply chain share understanding of success factors?

- Is the project conducting internal and external benchmarks?
- What level of realism does this show?
- Have lessons learned been incorporated?
- How is the procurement strategy and early contractor involvement structured?
- What are the incentives for forecasters?
- consistently?

 Is probabilistic forecasting used

27

Risk Maturity Level

Maturity Level	Area	Problem factors	Potential response (examples)
1	Bench marking	Inside view only with optimism bias unchecked	 Programme of learning from others. Benchmarking against other projects, industries and sectors
2	Due diligence	No challenge to cost, schedule forecasts of contractors. Minimal understanding of uncertainty in estimate	Internal assessments of costs, schedules.Separate estimating from contractors
3	Reference Class Forecasting	No systematic outside view. Variability between projects and subprojects ability to align and reduce bias. Ignorance of 'unknown unknowns'; lack of exploration.	 Systematic and ongoing Reference Class Forecasting across different aspects of programme. Exploration of scenarios to understand 'unknown unknowns'. Understand characteristics of tail
4	Black Swan (predictable surprises)	Slow management information communication. Management of symptoms not causes. Tight coupled system. Overly complex	 Quick, clean, independent management information reporting Amplification of weak signals. Recognise complex scenarios and break down
5	Leadership	High powered experts lack understanding of how to work effectively. No culture of excellence rather one of heroes. Lack of empowerment of experts	 Identify necessary pockets of excellence and encourage culture. Continuous learning. Focus on ways of working Leadership engage in scenario planning Increase reliance on 'qualitative' (needs more development)

Maturity Model

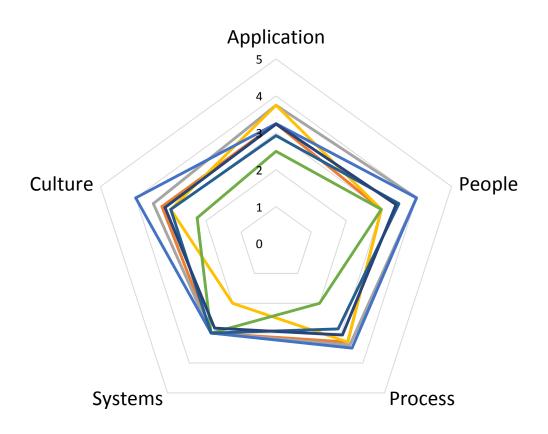
- Based on ISO31000 with reference to other maturity models
- Pushes boundaries for "leading" ERM practice
- Covers enterprise-wide maturity:
 - Document review (25%)
 - Evidence based application (75%)
- Initial qualitative assessment at "Level 1"
- Drill down to L2 and L3
 quantitative assessment using
 weighted scoring
- L4 will be a behavioural questionnaire similar to psychological profiling

			Weighting					
			Primary	PI-	Davidantas	Freshilan	Advanced	t di
				Basic 1-2	Developing 2-3	Evolving 3-4	Advanced 4-5	Leading >5
-				1-2	2-3	3-4	4-5	>5
	HS2 Aggregate Maturity		100					
documenta	ERM Framework		25	No ERM Framework, if RM is utlised in some areas it is improvised and provides minimal direction.	ERM is starting to be developed. Pockets of focused ERM exist.	A Framework is signed off supporting a RM Policy Statement.	ERM is systematic throughout the organisation	ERM is embedded and drives decision making.
view of written o	Implementing risk management			Risk skills and capabilities not understood or developed	Risk skills and capabilities understood and developed but only for certain types of risk	Risk skills and capabilities understood across all organisational risk types	Risk skills and capabilities are recognised and regularly reviewed.	Capability continuously reviewed, evaluated and evidence of recent modifications to suit evolving risk environment.
Re		Capability:						
Impl	nplementation of the Framework		75					
		Culture, behaviours, engagement, contin		No clear risk culture within the organisation and little understanding of what risk culture should be. Corporate culture has little risk management accountability.	Risk culture exists only for certain types of risk. Risk culture is enforced by policy interpreted as compliance.	Clear organisational risk culture but not consistantly embedded in behaviours	Consistent organisational risk culture and behaviours. Risk culture is associated with career advancement.	Continuously improving organisational risk culture and behaviours. Risk culture is analyzed and reported as a systematic view of evaluating risk.
	The ERM F	amework is being efficiently and effectiv	e 50					
Evidenced		Corporate/ strategic risk		Minimal if any formal identification of corporate/ straegic risks. No identification of risks to strategic plan	Corporate/ strategic threats identified. Risks to plan identified Informal EWI's, not alligned to KPI's	All corporate/ strategic risks (threats, opportunities and uncertainties) all formally captured and under active management. Emerging risks to plan identified EWI's defined to KPI's	corporate/ straegic reports and risk management information. All uncertainties in strategic plans identified and managed. EWI's embedded in business processes	Risk management information drives decision making. Opportunities are realised. Uncertainty modelling and risk adjusted KPI's in use as beneficial to drive management. Portfolio of correlated EWI's tied to uncertainty drivers
		Operational risk		Minimal if any formal identification of operational risks	Some operational risks actively managed.	All operational areas have a relevant RM Process actively implemented.	All operational areas use risk management proactively to improve management of the business with all threats, opportunities and uncertainties identifed and managed.	Continuous controls monitoring and analytics are used to support the RM process. There is a clear linkage between risk management and reduced operational incidents.
		Organisational risk		Minimal if any formal identification of organisational risks	Organisational risks captured in primary business risk areas (e.g. finance, HR, IT)	All organisational areas have a relevant RM Process implemented.	All organisational areas demonstrate use the ERM Framework and RM Process to enhance delivery of their objectives with frequent and effective communication on risks (threats, opportunities and uncertainties).	KRIs in use across all organisational areas with clear evidence that risk information is drivign decision making and enhancing the ability of the organisation to succeed.
	Delivery ris	k		Major programmes not subject to risk assessment	Adhoc, non standard programme risk assesssment;	Consistent RM framework utilised for all delivery areas. Criteria for programme risks implemented.	Advanced risk analysis undertaken on all delivery programmes to demonstrate confidence of delivery to objectives.	Risk adjusted view available for all programmes with RM information driving decision making. Clear evidence that the likelihood of achieving delivery objectives is improving over time.
				ļ				
	Developme	intrisk		Development objectives not subject to risk assessment	Adhoc, non standard approach to risk assesssment;	Consistent RM framework utilised for all deveopment areas. Criteria for development risks implemented.	Advanced risk analysis undertaken on all development areas with key criteria for measuring success in development opportunities.	Risk adjusted view available for all development opportunities with RM information driving decision making. Clear evidence that the likelihood of achieving objectives is improving over time.
	Business ch	nange risk		Business change projects are not subject to risk assessment	Adhoc, non-standard business change project risk assesssment in use.	Consistent RM framework utilised for all business change projects. Criteria for specific business change risks implemented.	Advanced risk analysis techniques (quantitative &/ or qualitative) undertaken on all business change projects to drive success criteria.	Risk adjusted view available for all business change projects with RM information driving decision making. Clear evidence that the likelihood of achieving delivery objectives is improving over time.

Maturity Model

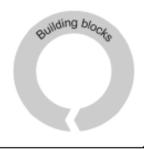
- All orgs all areas score varies between 2 and 4
- Most orgs strong on 3 areas and weak on 2
- Further analysis on particular questions to follow...

Risk Maturity Scores



Management of Risk in Government (Manzoni & Cheshire, Jan 2017)





Essential building blocks include:

- Creating positive risk management behaviours and culture
- Establishing roles and responsibility
- Communicating risk information
- Building risk capability, including training for risk practitioners



Essential routine processes include:

- Identifying risks, including those responsible for managing them
- · Assessing risks and establishing tolerance
- Addressing risks, including contingency arrangements
- Reviewing and monitoring risks, including 'deep dives'
- Reporting on risk



Recommended periodic activities include:

- Assuring the board that risk is being properly managed
- Assuring risks from arm's length bodies
- Scanning the horizon/ environment, including National Risk Register risks
- Building risk maturity
- Peer reviews
- Learning lessons
- Exploiting data and data analytics
- Building and testing resilience frameworks

Thank you

Any Questions?