

ITA OPEN SESSION

Korean Risk Management Practices : a Contractor's Perspective

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Korea

- ✓ **Construction Industry : Contractor's Perspectives**
- ✓ **Risk Management in SK E&C**
 - ✓ **Marketing Phase : Q-Gate 1, 2, 3**
 - ✓ **Operation Phase : Q-Gate 4, 5, 6**
- ✓ **RM Cases #1 GB High-speed Railroad 13-3**
- ✓ **RM Cases #2 GB High-speed Railroad 14-3**
- ✓ **Conclusions**





1

Established : 1977

2

Output : US \$ 3.2 Billion

3

Capital : US \$ 0.6 Billion

4

Employee : 3,333

5

8 Overseas Branches



SK E&C's Biz Area



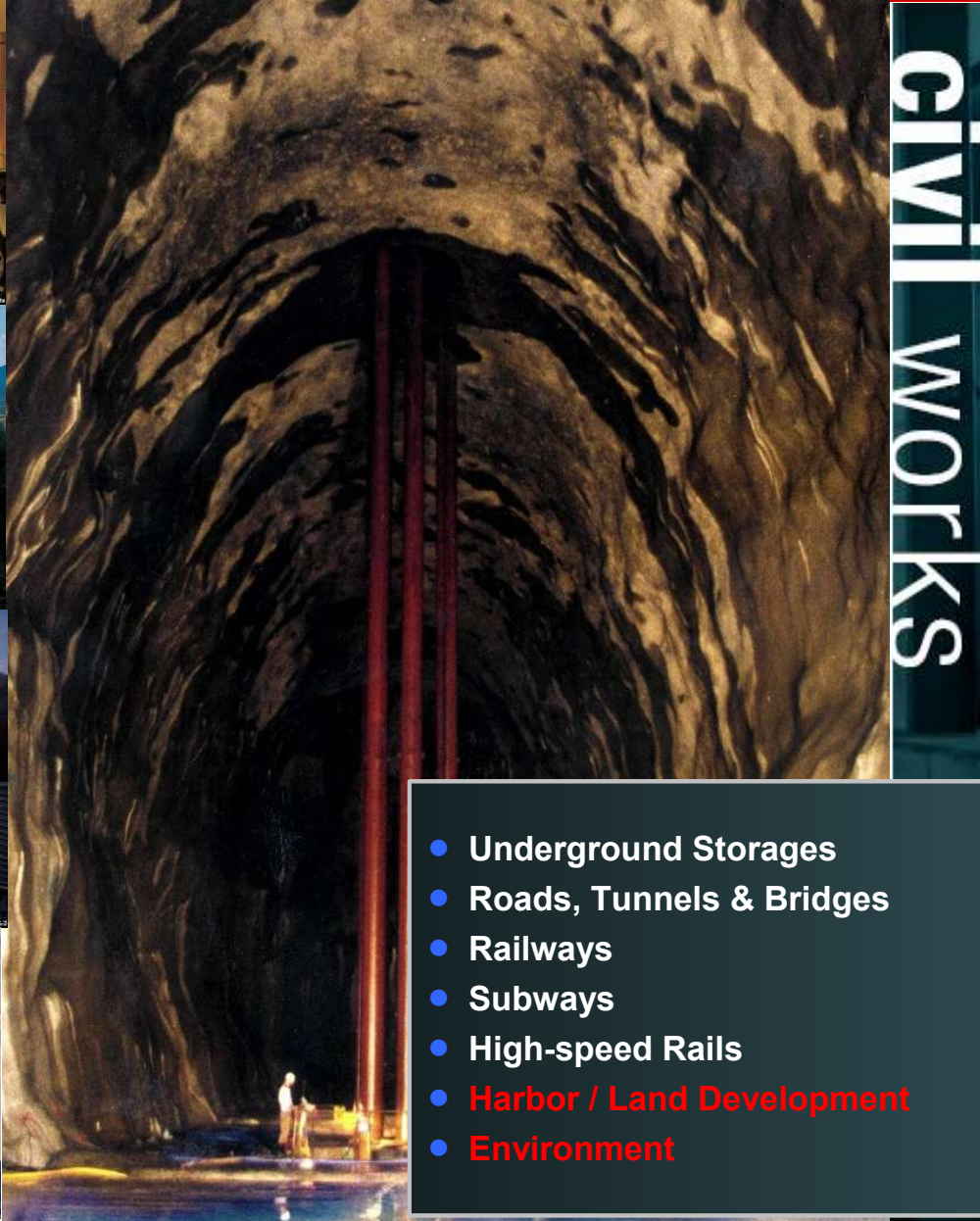
- Refinery
- Petrochemical
- Energy & Power Plant
- Telecommunication
- **Industrial Plant**

plant works





SK E&C's Biz Area



civil works

- Underground Storages
- Roads, Tunnels & Bridges
- Railways
- Subways
- High-speed Rails
- Harbor / Land Development
- Environment



SK E&C's Biz Area

- Office Building
- Sales & Business
- Remodeling
- Hotel
- Culture & Education
- Communication
- Housing



building works

Construction Industry : Contractor's Perspectives

Comparison

$$\text{PROFIT} = \text{REVENUE} - \text{COST}$$

Manufacturing/Service Industry

✓ **How to Increase Revenue**

- Investment
- Marketing
- Differentiation
- Customer Satisfaction

✓ **How to Reduce Cost**

- Productivity
- Operation Improvement

E & C Industry(Unique)

✓ **"Order Amount" determines Profit**

- Profit determined when Contracting
- High Risk & Low/No Return

- **Unique Project Based**

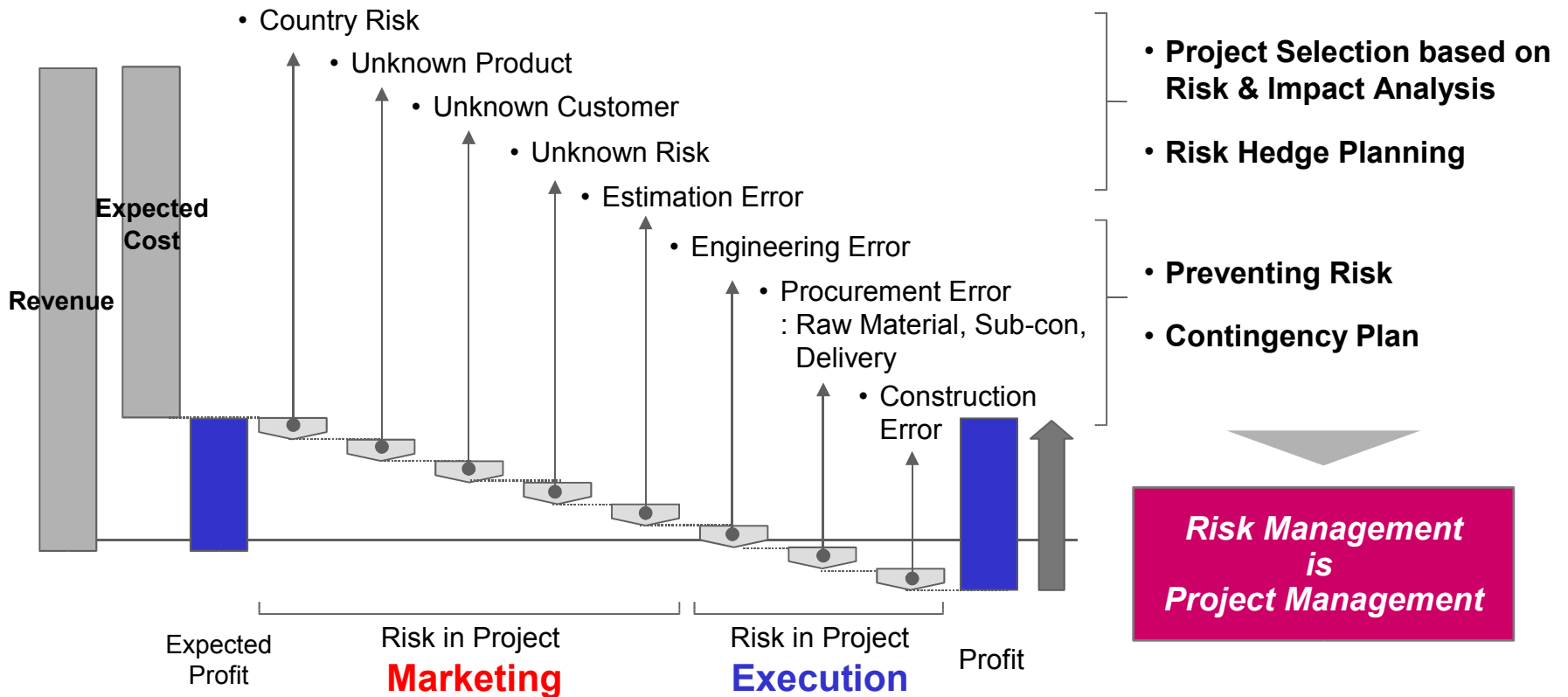
✓ **Risk Management through Project Execution**

- Risk Minimization during **Long** construction period

Key Strategy for Project

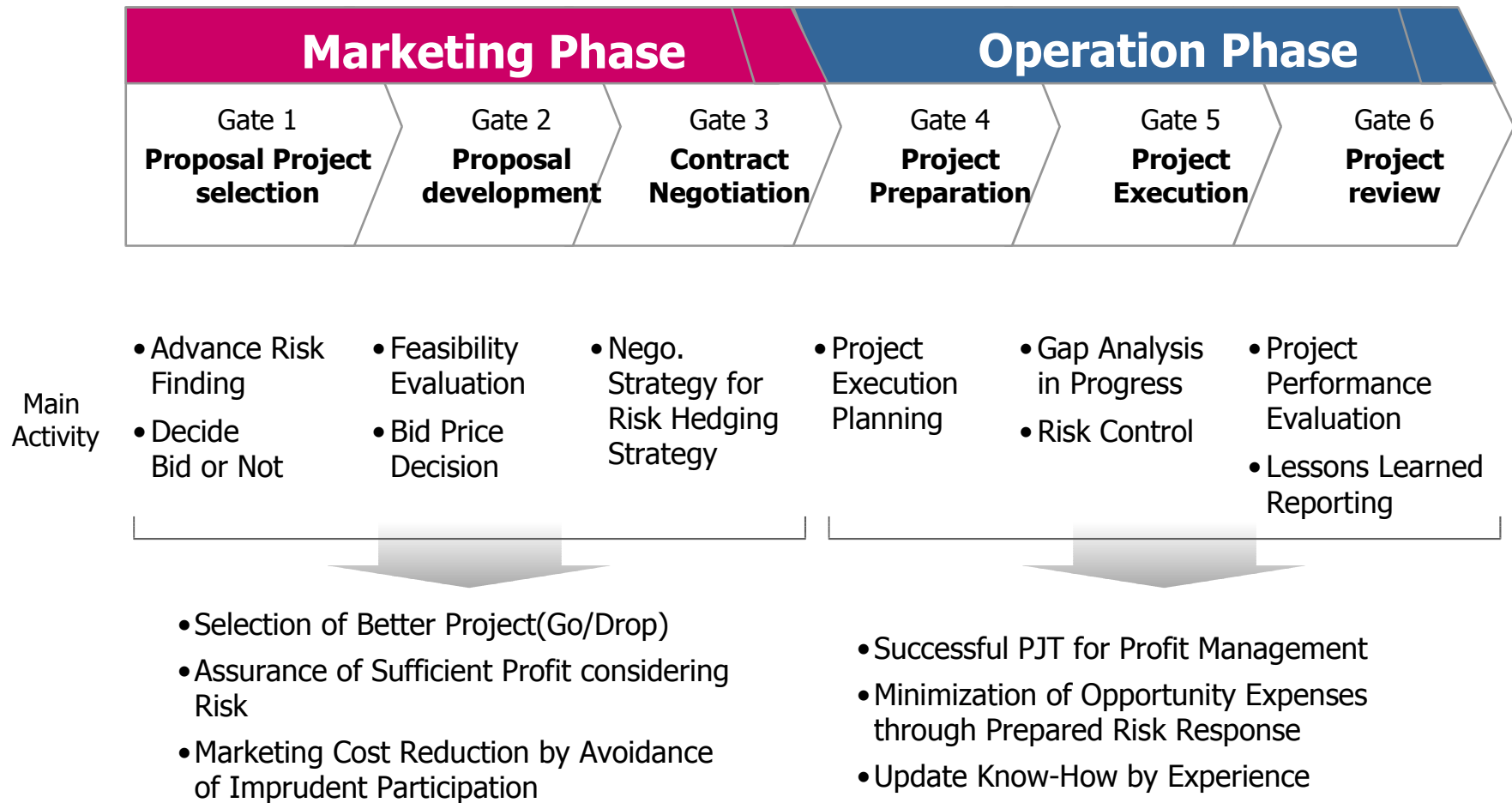
$$RM = PM$$

Risk Factors



Risk Management in SK E&C : Q-Gate System

Q-gate Sequences

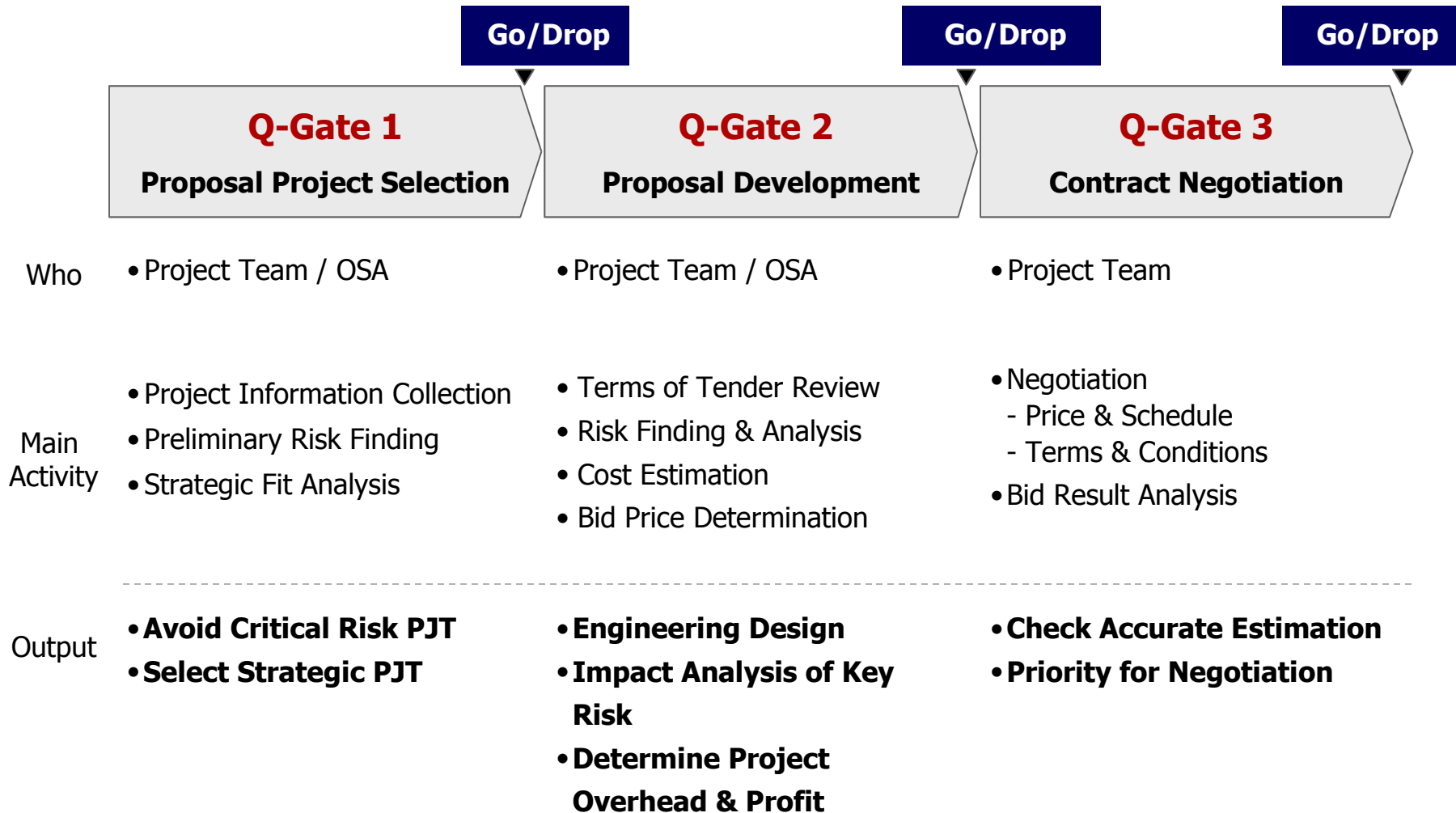


Marketing Phase : ***Q-Gate 1, 2, 3***

Goals : to Manage Bidding Risk

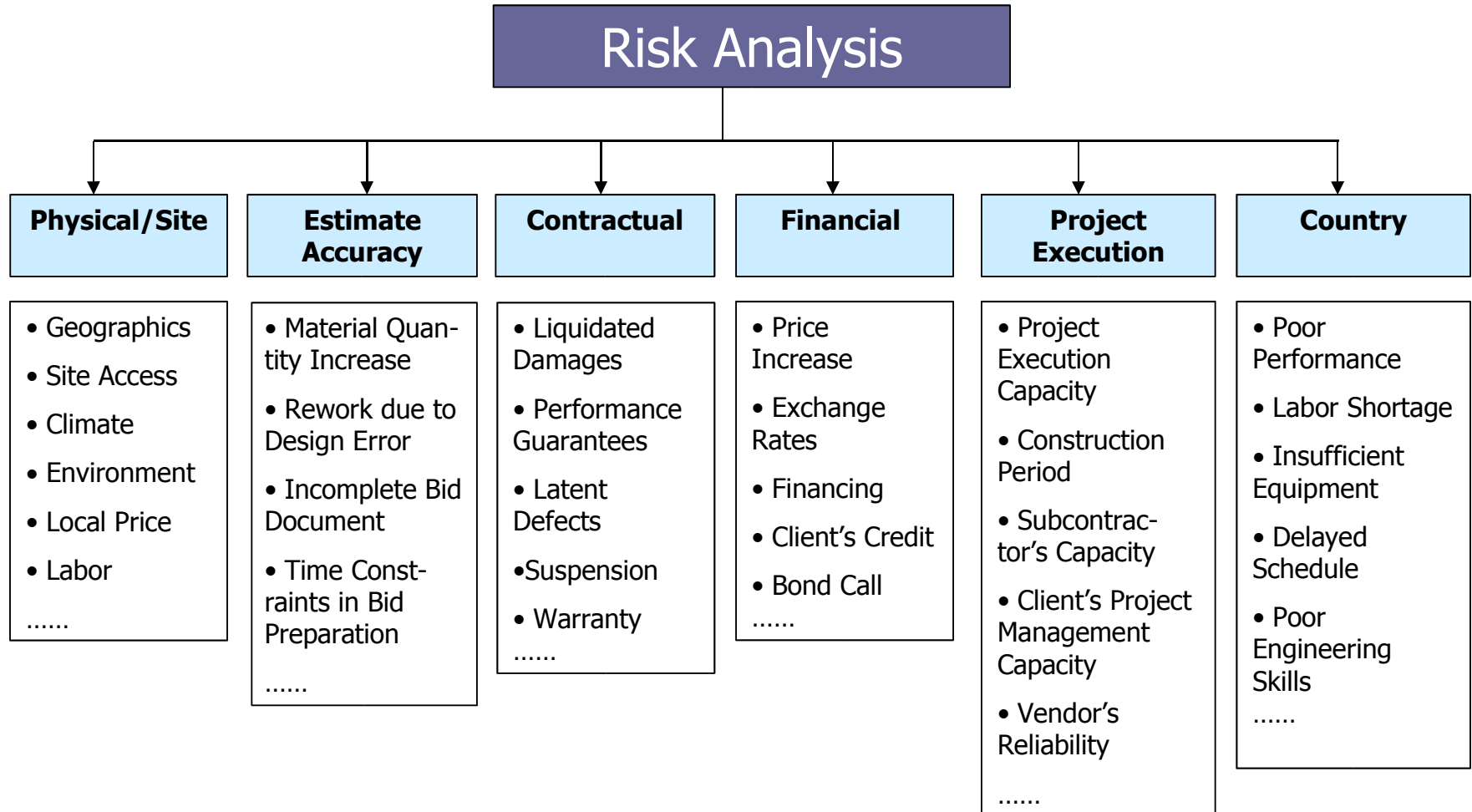
Marketing Phase

Who / Activity / Output



Q-gate 2

Checklist for Risk Analysis



Operation Phase : ***Q-Gate 4, 5, 6***

Goals : to Manage Execution Risk

Operation Phase

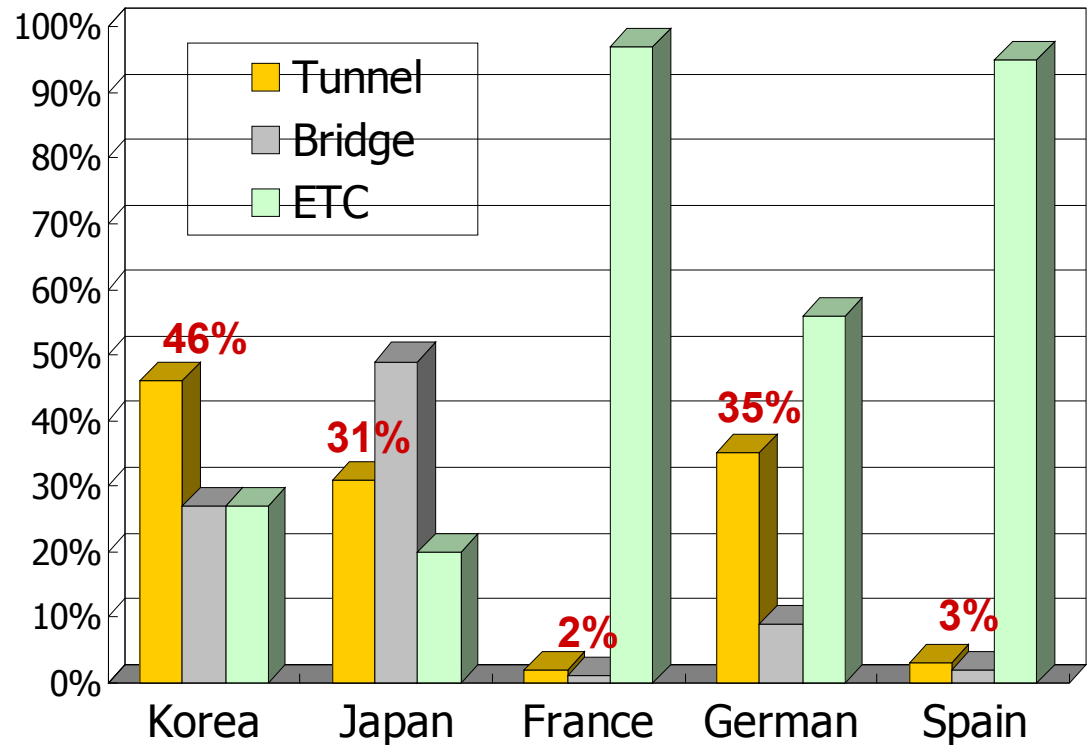
Who / Activity / Output

	Q-Gate 4 Project Preparation	Q-Gate 5 Project Execution	Q-Gate 6 Project Review
Who	<ul style="list-style-type: none"> • Project Team/Associated Teams 	<ul style="list-style-type: none"> • Project Team 	<ul style="list-style-type: none"> • Project Team
Main Activity	<ul style="list-style-type: none"> • Build Project Team • Set Project Execution Plan • Establish Risk Hedging Plan • Confirm Project Budget 	<ul style="list-style-type: none"> • Monthly Report • Track Key Issue & Resolve 	<ul style="list-style-type: none"> • Performance Evaluation • Lessons Learned Report
Output	<ul style="list-style-type: none"> • Recheck Critical Risk • Set up Project Operation Plan 	<ul style="list-style-type: none"> • C, S • QSE 	<ul style="list-style-type: none"> • Accumulation of Project Know-how

RM Cases #1

GB High-Speed Railroad 13-3

High-speed Rail



From Seoul to Busan

1st Phase(Current) : 2 hours 40 minutes

2nd Phase(after 2010) : 1 hour 56 minutes

KB Highspeed Railroad 13-3



- ✚ Owner : KRNA(Korea Rail Network Authority)
- ✚ Bidding : Design & Build(Turn-Key contracts)
- ✚ Duration : 60 Month
- ✚ Location : Ulsan area, Korea
- ✚ Main Jobs : NATM, Long Tunnel at Mt. Area (13.27km)
- ✚ Intimacy : +
- ✚ Strategy : +
- ✚ Credits : +
- ✚ Value Chain : +

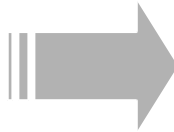
Q-gate 1

OK! Go

Q-gate 2

Risk Assessment

QG2
Risk Analysis



Risk Details

1. Physical/Site Risk
2. Estimate Accuracy Risk
3. Contractual Risk
4. Financial Risk
5. Project Execution Risk
 - A: Project Management
 - B: Construction Risk
6. Country Risk

Cost Estimation



Bidding



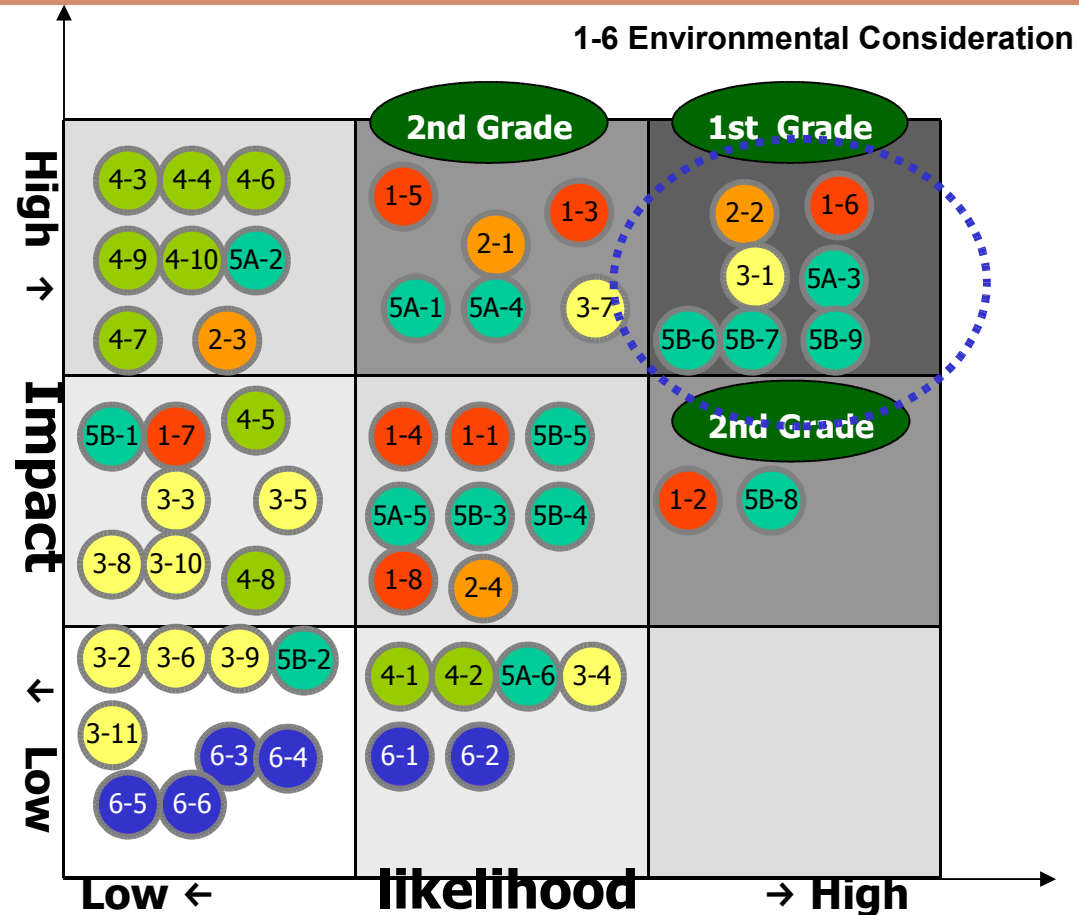
 **65 Checklists**
Geological Uncertainties
Environmental issues etc

Q-gate 2

Risk Allocation

Risk Checklist

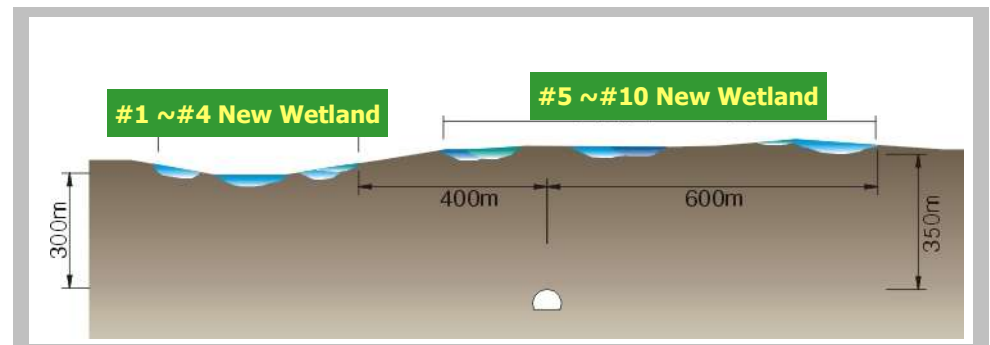
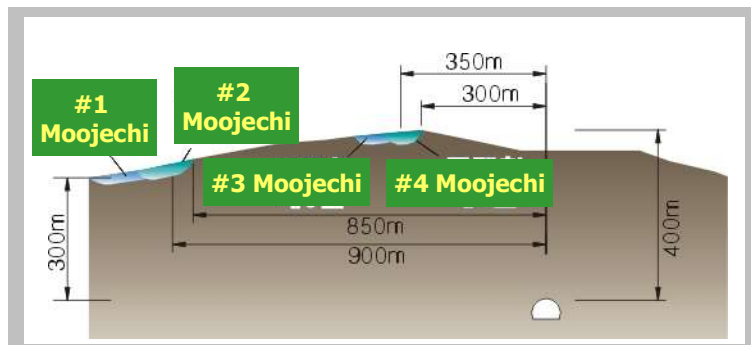
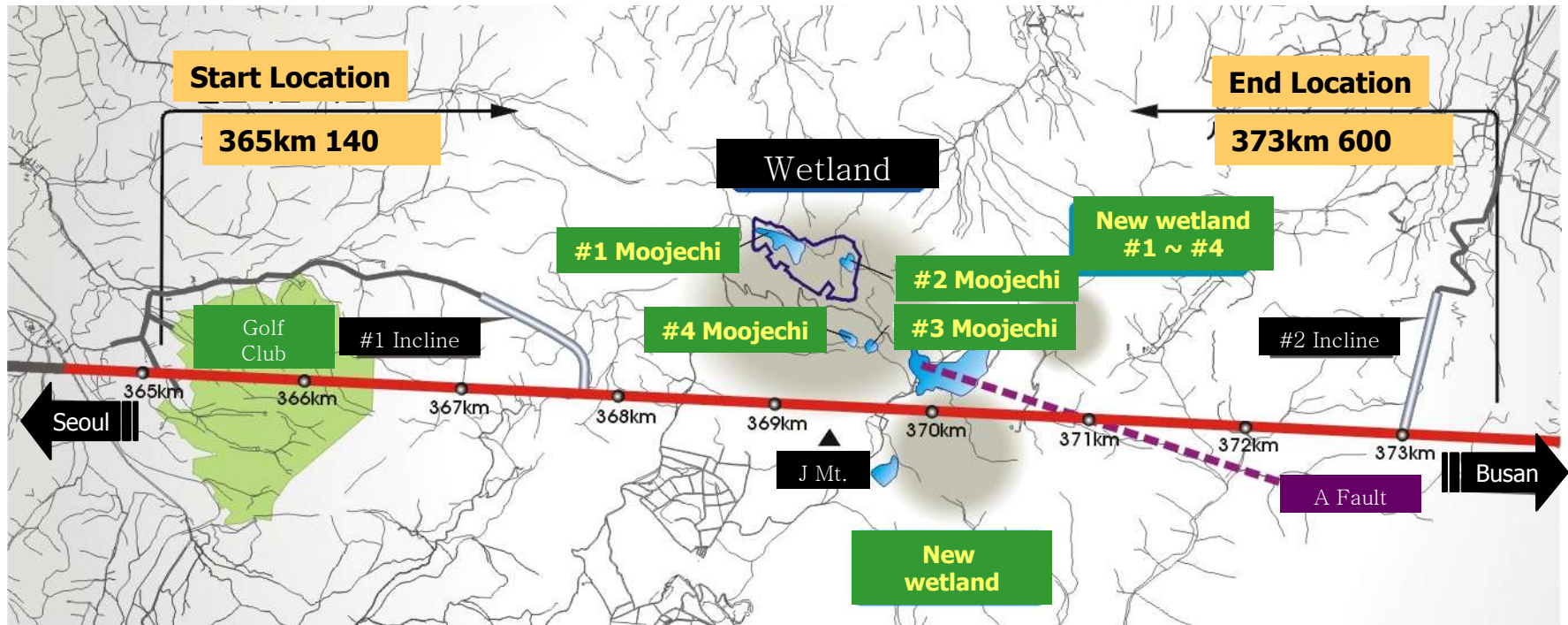
- 1. Physical/Site Risk(10)
- 2. Estimate Accuracy Risk(6)
- 3. Contractual Risk(14)
- 4. Financial Risk(9)
- 5. Project Execution Risk
 - A: Project Management(9)
 - B: Construction Risk(9)
- 6. Country Risk(8)



- 1. Physical/Site Risk
- 2. Estimate Accuracy Risk
- 3. Contractual Risk
- 4. Financial Risk
- 5. Project Execution Risk
 - A: Project Management
 - B: Construction Risk
- 6. Country Risk

Q-gate 2

Main Risk : Wetland Protection



Q-gate 3

Contract Negotiation

QG3
Negotiation



Review Contract
Terms



**Design & Build Project
(Turn key Project)**



Contractor is in charge of the Whole Process from Engineering, Procurement, to Construction within Estimated Bidding Price

Q-gate 4

Project Preparation

QG4
Project
Execution Plan



* Project Execution Plan

- 1) Work Scope
- 2) Project Organization
- 3) Schedule Organization
- 4) Cost
- 5) Engineering Plan
- 6) Procurement Plan
- 7) Construction Plan
- 8) Training Plan
- 9) Commissioning & Set-up Plan
- 10) Coordination Plan
- 11) Risk Management Plan

Risk Checklist
Risk Register
Risk Management Plan



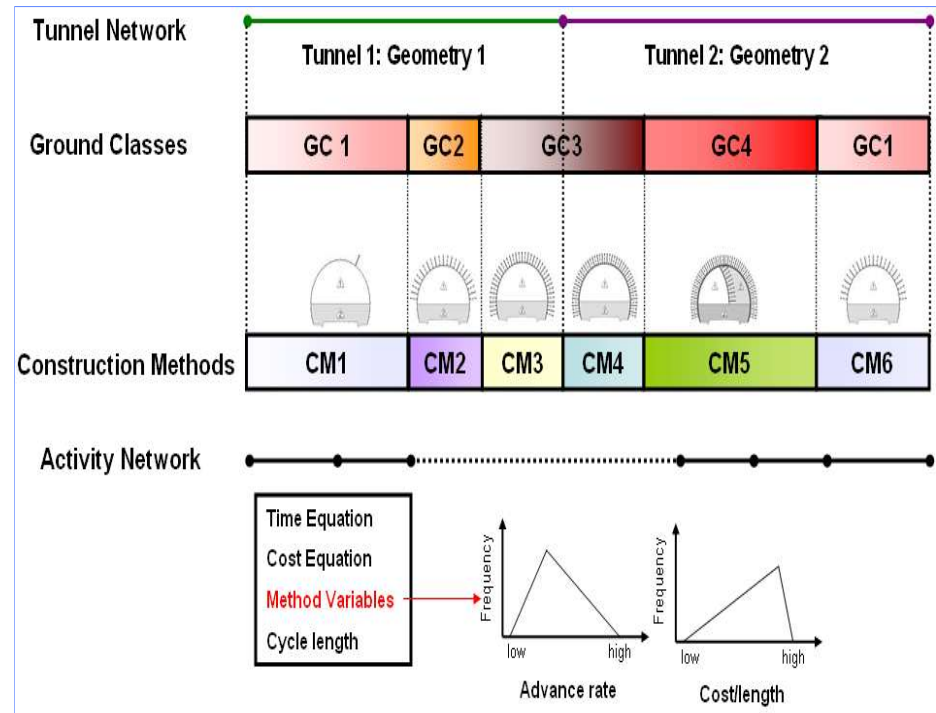
Q-gate 4

DAT(Decision Aids for Tunneling) Simulation

Quantitative Analysis

Ground Parameters		Ground Parameter States			
Rock type		Granite	Shale	Schist	
Water		Little		Much	Little
Ground Classes		GC 1	GC 2	GC 3	GC 4

Generation of the Ground Class Profile

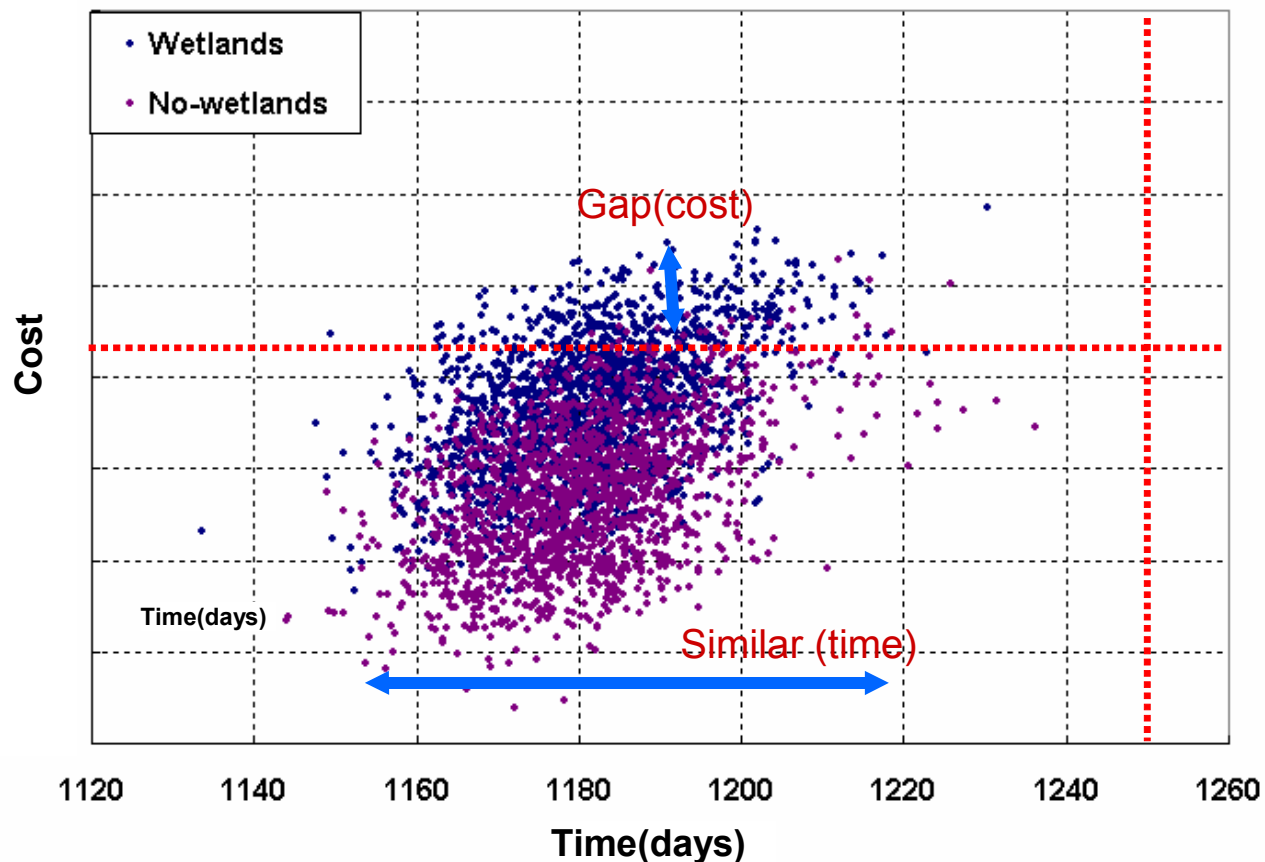


Simulation of the Construction Process

The geologic module generates the ground class profile and the construction module simulates the construction process in that particular ground class profile by associating the construction methods with the ground classes

Q-gate 4

Effects of Wetland (Scattergram)



Project Execution / Review

QG5
Project Execution



- Cost
- Schedule
- Quality
- Safety
- Environment



QG6
Project Review

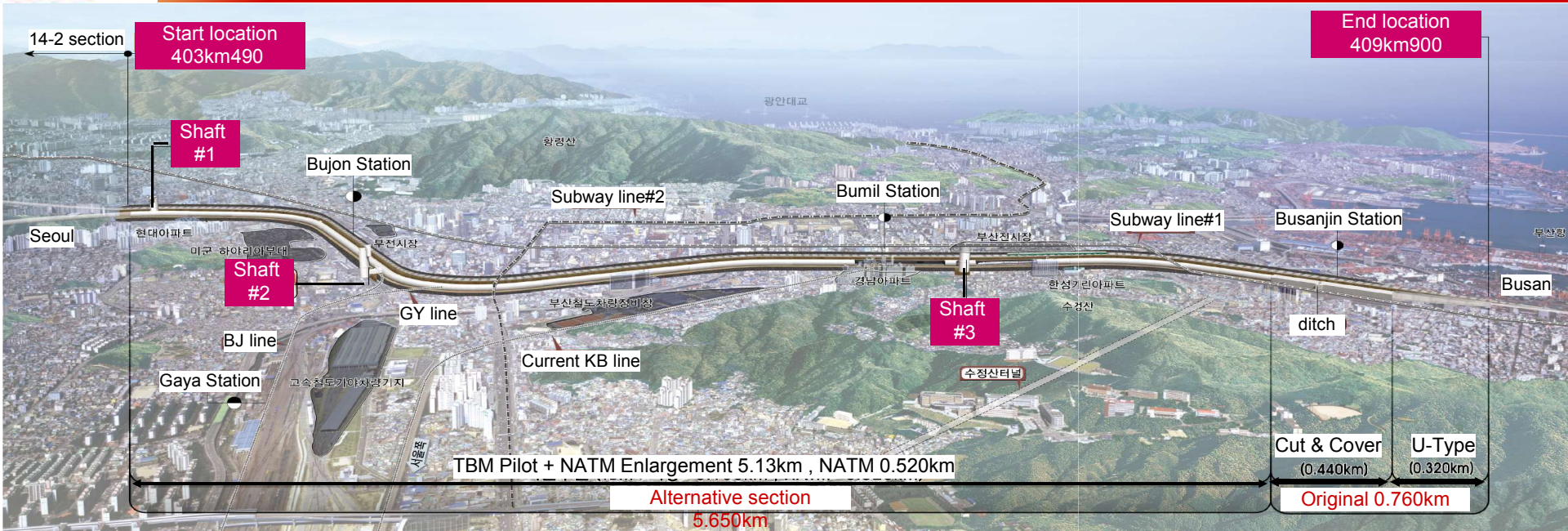


- Performance Evaluation
- Lessons Learned
- Data-Based

RM Cases #2

GB High-Speed Railroad 14-3

KB Highspeed Railroad 14-3



- Owner : KRNA(Korea Rail Network Authority)
- Bidding : Design & Build(Turn-Key contracts)
- Duration : 60 Month
- Location : Busan area, Korea
- Main Jobs : **TBM+NATM**
Long Tunnel at Urban Area (~6km)
- Intimacy : +
- Strategy : +
- Credits : +
- Value Chain : +

Q-gate 1

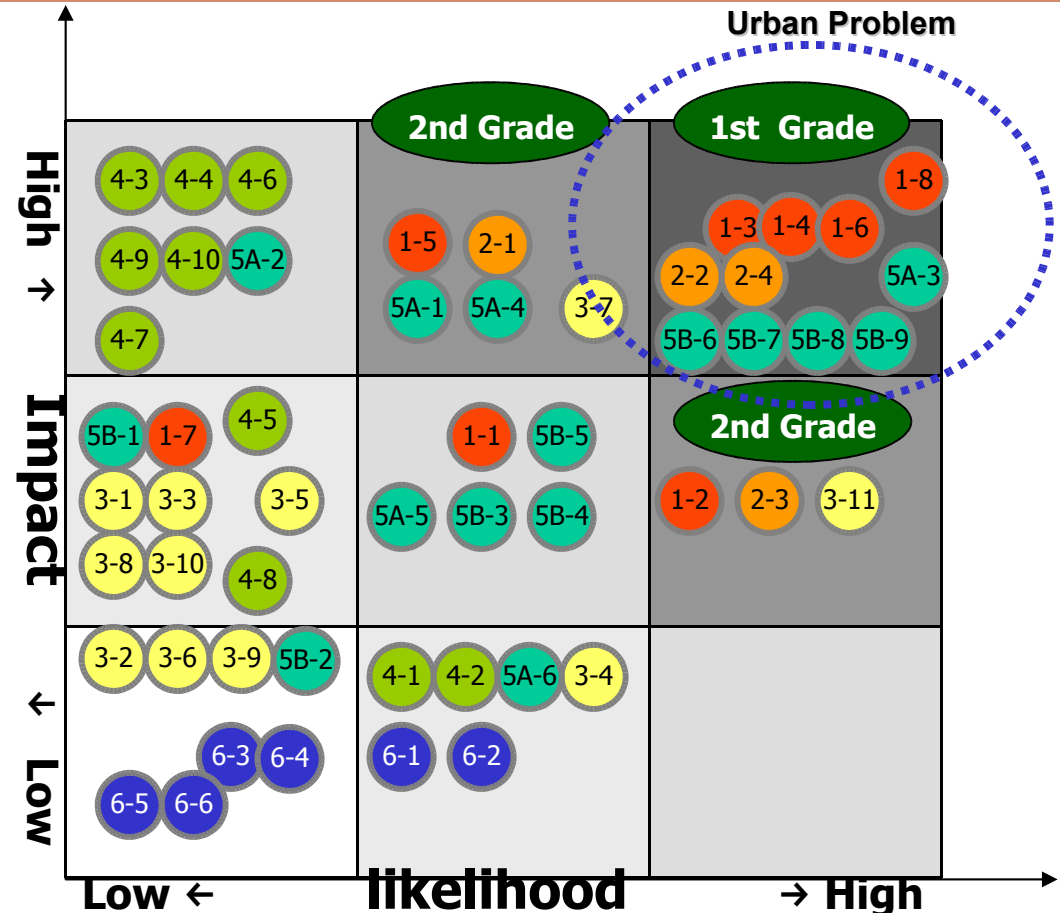
OK! Go

Q-gate 2

Risk Allocation

Risk Checklist

- 1. Physical/Site Risk(10)
- 2. Estimate Accuracy Risk(6)
- 3. Contractual Risk(14)
- 4. Financial Risk(9)
- 5. Project Execution Risk
A: Project Management(9)
B: Construction Risk(9)
- 6. Country Risk(8)

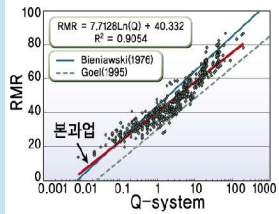


- 1. Physical/Site Risk
- 2. Estimate Accuracy Risk
- 3. Contractual Risk
- 4. Financial Risk
- 5. Project Execution Risk
A: Project Management B: Construction Risk
- 6. Country Risk

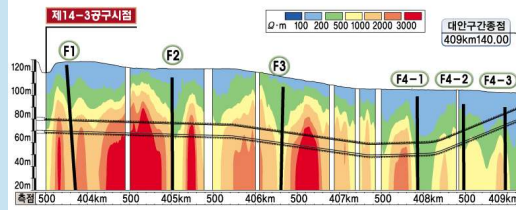
Q-gate 2

Ground Class

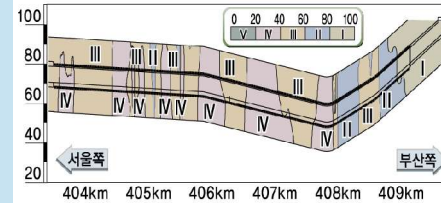
1st: Rock Classification



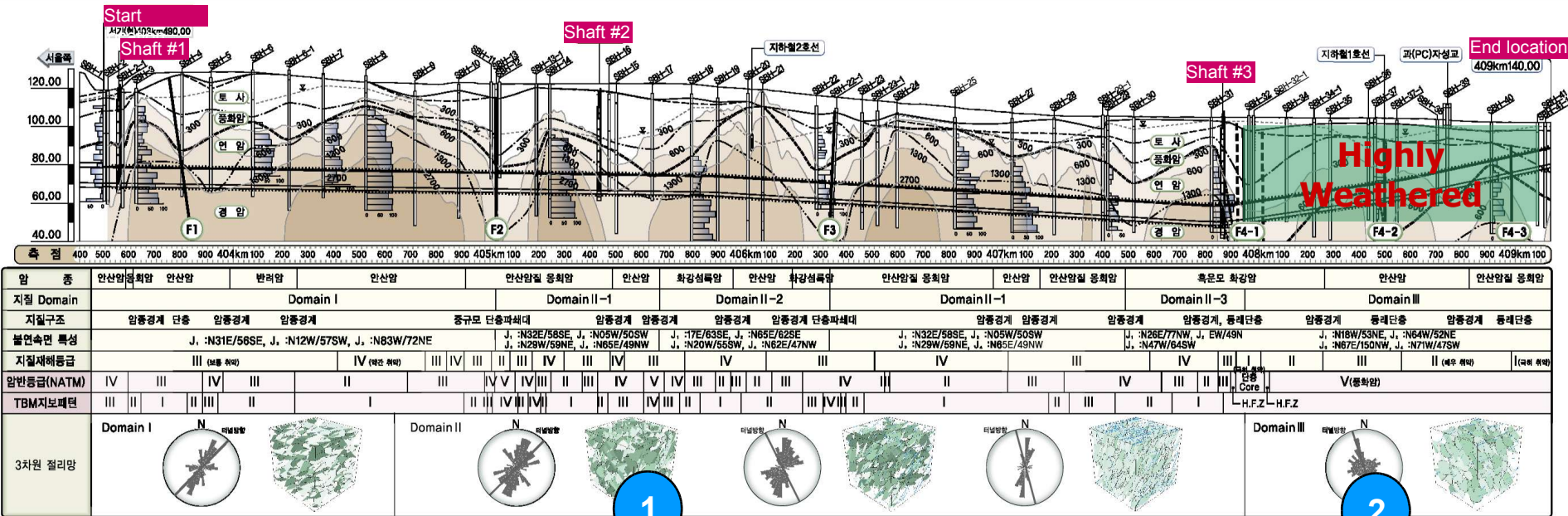
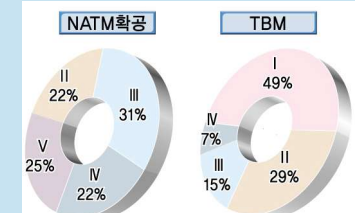
2nd : Geophysical Survey



3rd: Geological Structure



4th: Final Ground Class



TBM? / NATM? / TBM+NATM?

NATM

Q-gate 2

Main Risk : Excavation Method in Urban Area

	Tunneling Methods
Alternative 1	Full face TBM (13.2m Diameter)
Alternative 2	NATM Tunneling
Alternative 3	TBM Pilot Tunnel(D=4.5m) with NATM Enlargement

Q-gate 2

Qualitative Risk Analysis

Level of Risk = Likelihood x Consequence

Likelihood	Rating	Description
Frequent	5	Likely to occur repeatedly during construction of the tunnel
Probable	4	Likely to occur several times during construction of the tunnel
Occasional	3	Likely to occur at least once during construction of the tunnel
Remote	2	Unlikely to occur during construction of the tunnel
Improbable	1	Extremely unlikely to occur during construction of the tunnel

Consequence	Rating	Description
Catastrophic	5	Loss of whole section of tunnel or potential loss of production for more than 2 months
Critical	4	Major damage to tunnel or plant, major environmental impact causing potential delays of up to 2 months.
Serious	3	Some damage to tunnel or plant, some environmental impact causing potential delays of up to 1 week
Marginal	2	Minor damage / routine maintenance repair to tunnel causing minor delays.
Negligible	1	No significant consequence or delays.

Q-gate 2

Risk Index Matrix

	(5) Catastrophic	(4) Critical	(3) Serious	(2) Marginal	(1) Negligible
(5) Frequent	25 (VH)	20 (VH)	15 (VH)	10 (H)	5 (M)
(4) Probable	20 (VH)	16 (VH)	12 (H)	8 (M)	4 (L)
(3) Occasional	15 (VH)	12 (H)	9 (M)	6 (M)	3 (L)
(2) Remote	10 (H)	8 (M)	6 (M)	4 (L)	2 (L)
(1) Improbable	5 (M)	4 (L)	3 (L)	2 (L)	1 (L)

Hazards Categories

Hazards Categories (31 elements)

1. Ground Stability (8 elements)
2. Tunnel Excavation & Support (13 elements)
3. Impediments due to Geological and Other Site Consideration (4 elements)
4. Effect on the Public & Environment (6 elements)



- 1) Roof falls and sidewall instability < 5 in highly weathered and jointed rock mass
- 2) Roof falls and sidewall instability < 20 in highly weathered and jointed rock mass
- 3) Local face instability, 5-10 in highly weathered and jointed rock mass
- 4) Roof falls and sidewall instability < 5 in fault / mixed face zones or soft ground
- 5) Roof falls and sidewall instability < 20 in fault / mixed face zones or soft ground
- 6) Local face instability, 5-10 in fault / mixed face zones or soft ground
- 7) Excessive lining deformation requiring reprofiling and/or additional rock support
- 8) Major instability / Collapse, 500 in fault / mixed face zones / soft ground

Q-gate 2

Ground Stability (Alternative 3)

Alternative 3 : TBM Pilot+ Enlargement

No	Hazard	Initial Risk Level			Mitigation Measures TBM PILOT	Mitigation Measures ENLARGEMENT	Residual Risk Level			Remarks
		Likelihood	Consequence	Risk			Likelihood	Consequence	Risk	
1	1) Roof falls and sidewall instability < 5 in highly weathered and jointed rock mass	4	3	12	<ul style="list-style-type: none"> •Smooth outer face of cutterhead • Recessed cutting disks to reduce risk of cutterhead becoming stuck •Probing ahead of face •Pre-injection grouting •Install rock support (shotcrete + rock bolts) behind cutterhead without delay •Additional rock support and/or advance support (forepoling) 	<ul style="list-style-type: none"> •Apply appropriate support pattern •Probing ahead of face (essentially by pilot drive) •Advance grouting from pilot tunnel •Install rock support without delay •Adjust advance length and/or excavation sequence •Additional rock support and/or advance support (forepoling) •Adjust blasting scheme 	3	2	6	Exploration of ground conditions for NATM enlargement is provided by TBM pilot drive.

Q-gate 2

Risk Assessment of Tunnelling Methods

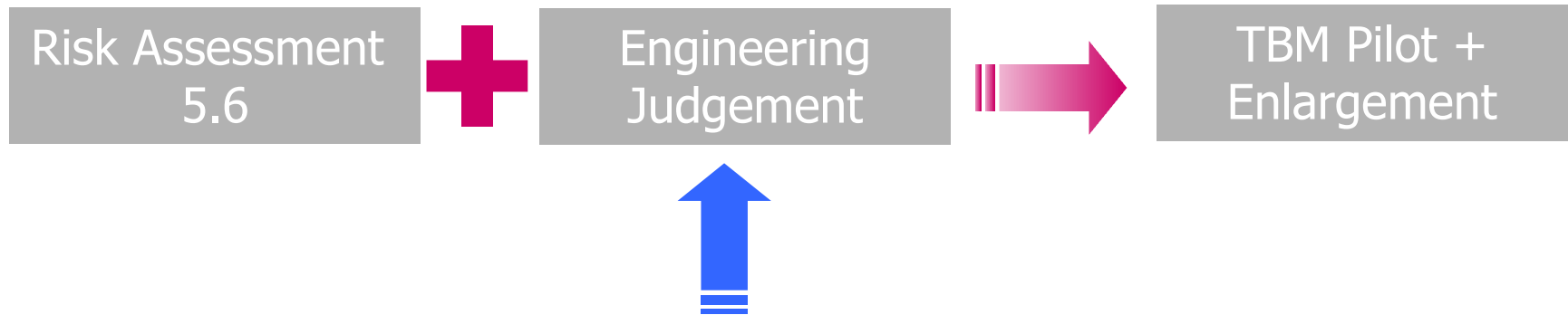
Before Mitigation

Risk Level			BEFORE MITIGATION								
			Alternative 1: Full-face TBM			Alternative 2: NATM			Alternative 3: TBM Pilot tunnel with NATM Enlargement		
			Number of hazards	Average score	Total Average	Number of hazards	Average score	Total Average	Number of hazards	Average score	Total Average
	From	To									
Very high risk	15	25	10	15.5	11.9	5	15.2	11.4	8	15.4	11.7
High risk	10	14	12	11.5		10	11.6		11	11.6	
Medium risk	5	9	6	8.0		5	7.2		6	7.0	
Low risk	1	4	1	4.0		0	4.0		0	0.0	

After Mitigation

Risk Level			AFTER MITIGATION								
			Alternative 1: Full-face TBM			Alternative 2: NATM			Alternative 3: TBM Pilot tunnel with NATM Enlargement		
			Number of hazards	Average score	Total Average	Number of hazards	Average score	Total Average	Number of hazards	Average score	Total Average
	From	To									
Very high risk	15	25	0	0	6.7	0	0.0	5.9	0	0	5.6
High risk	10	14	3	11.3		1	10		2	11.0	
Medium risk	5	9	17	7.4		14	6.5		12	6.8	
Low risk	1	4	9	3.8		5	3.2		11	3.4	

Risk Assessment of Tunnelling Methods

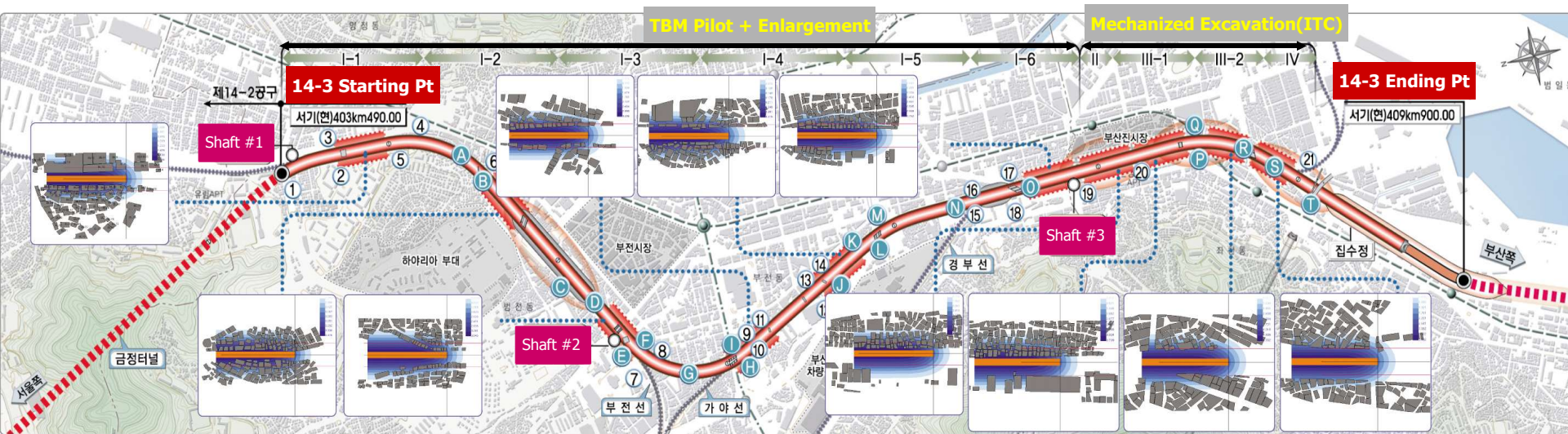


- Detailed Investigation of the tunneling conditions for the main drive
- Facilitation of the drill & blast excavation of the main drive with the reduction of ground vibrations due to blasting
- Pre-treatment of the ground for stabilization and groundwater control when necessary

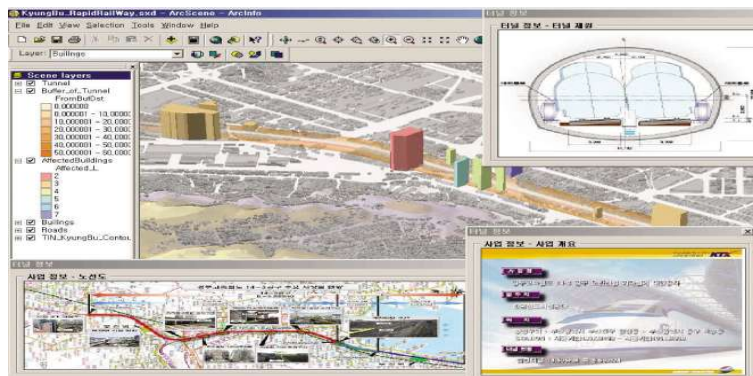
Q-gate 4

Instrumentation Plan

Selection of Critical Control Zone



GIS-Based Integrated RM System





Internet-Based Integrated RM System




Conclusions

Conclusions

Through Introduction & Settlement of Q-Gate System ;

-  1 Reflection of Biz Strategy
- 2 Agreement on Risk Factors
-  3 Integrated Decision Making System
- 4 Agreement on Minimum Level of Profit
- 5 Intranet System



- ✓ Maintain Profitable Backlog
- ✓ C, S, QSE Control Considering Risks

***Thank you
for your attention!!!***

1. Reflection of Biz Strategy



Market Analysis

Business Strategy Set-Up

Q-Gate

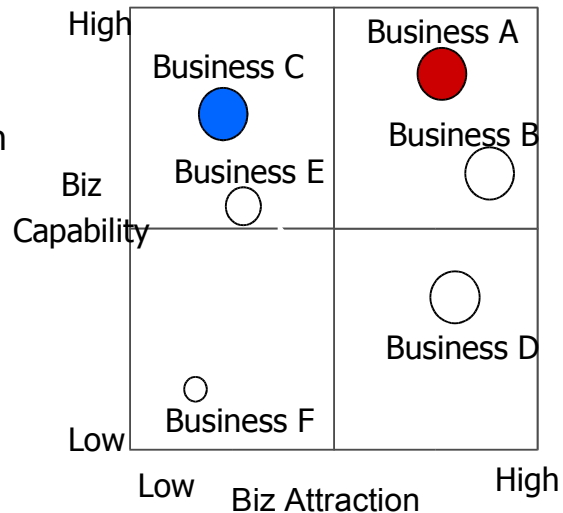
Response to Market Environment Change



Set Realistic Goals for Each Biz and Aim to Attain them

Q-Gate Operation for Performance Target

- Business A • Stable
- Business B • Rapid Growth
- Business C • Downside
- Business D • Slow Growth
- Business E • New Competitors Come In
- ...



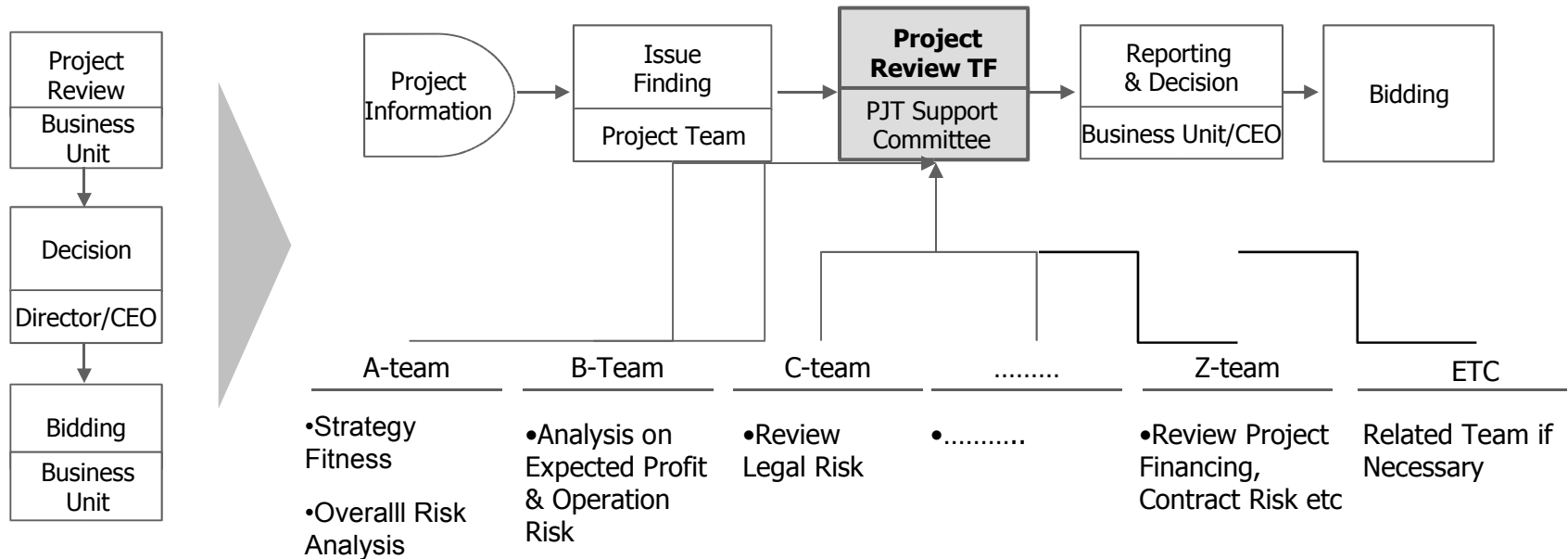
- Business A • Risk Taking
- Business B • Aggressive Risk Taking
- Business C • Selective
- Business D • Rigid
- Business E • Selective
- ...

3. Integrated Decision Making System

Transparent Procedures & Decision Making



Procedure for Decision on PJT Bidding or Not



**High Risk Probability
due to Limited
Review**

**Promote Preliminary Risks Review & Effective Decision Making by
PJT Information Sharing and Whole Risk Analysis**