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
SK E & C

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
SK E&C’s Biz Area

- 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
Construction Industry: Contractor’s Perspectives
Comparison

PROFIT = REVENUE - 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

- Country Risk
- Unknown Product
- Unknown Customer
- Unknown Risk
- Estimation Error
- Engineering Error
- Procurement Error: Raw Material, Sub-con, Delivery
- Construction Error

- Project Selection based on Risk & Impact Analysis
- Risk Hedge Planning
- Preventing Risk
- Contingency Plan

Risk Management is Project Management
Risk Management in SK E&C: Q-Gate System
Q-gate Sequences

Marketing Phase
- Gate 1: Proposal Project selection
- Gate 2: Proposal development
- Gate 3: Contract Negotiation

Operation Phase
- Gate 4: Project Preparation
- Gate 5: Project Execution
- Gate 6: Project review

Main Activity
- Gate 1: Advance Risk Finding, Decide Bid or Not
- Gate 2: Feasibility Evaluation, Bid Price Decision
- Gate 3: Nego. Strategy for Risk Hedging Strategy

- Gate 4: Project Execution Planning
- Gate 5: Gap Analysis in Progress, Risk Control
- Gate 6: Project Performance Evaluation, Lessons Learned Reporting

- Selection of Better Project (Go/Drop)
- Assurance of Sufficient Profit considering Risk
- Marketing Cost Reduction by Avoidance of Imprudent Participation

- Successful PJT for Profit Management
- Minimization of Opportunity Expenses through Prepared Risk Response
- Update Know-How by Experience
Marketing Phase:
Q-Gate 1, 2, 3

Goals: to Manage Bidding Risk
Marketing Phase

Who / Activity / Output

Q-Gate 1: Proposal Project Selection
- Who: Project Team / OSA
- Main Activity:
  - Project Information Collection
  - Preliminary Risk Finding
  - Strategic Fit Analysis
- Output:
  - Avoid Critical Risk PJT
  - Select Strategic PJT

Q-Gate 2: Proposal Development
- Who: Project Team / OSA
- Main Activity:
  - Terms of Tender Review
  - Risk Finding & Analysis
  - Cost Estimation
  - Bid Price Determination
- Output:
  - Engineering Design
  - Impact Analysis of Key Risk
  - Determine Project Overhead & Profit

Q-Gate 3: Contract Negotiation
- Who: Project Team
- Main Activity:
  - Negotiation
    - Price & Schedule
    - Terms & Conditions
  - Bid Result Analysis
- Output:
  - Check Accurate Estimation
  - Priority for Negotiation

Go/Drop
Q-gate 2
Checklist for Risk Analysis

Risk Analysis

- Physical/Site
  - Geographics
  - Site Access
  - Climate
  - Environment
  - Local Price
  - Labor
- Estimate Accuracy
  - Material Quantity Increase
  - Rework due to Design Error
  - Incomplete Bid Document
  - Time Constraints in Bid Preparation
- Contractual
  - Liquidated Damages
  - Performance Guarantees
  - Latent Defects
  - Suspension
  - Warranty
- Financial
  - Price Increase
  - Exchange Rates
  - Financing
  - Client’s Credit
  - Bond Call
- Project Execution
  - Project Execution Capacity
  - Construction Period
  - Subcontractor’s Capacity
  - Client’s Project Management Capacity
  - Vendor’s Reliability
- Country
  - Poor Performance
  - Labor Shortage
  - Insufficient Equipment
  - Delayed Schedule
  - Poor Engineering Skills
Operation Phase: Q-Gate 4, 5, 6

Goals: to Manage Execution Risk
Operation Phase

Who / Activity / Output

Q-Gate 4
Project Preparation

- Project Team/Associated Teams
- Build Project Team
- Set Project Execution Plan
- Establish Risk Hedging Plan
- Confirm Project Budget

Main Activity

Output
- Recheck Critical Risk
- Set up Project Operation Plan

Q-Gate 5
Project Execution

- Project Team
- Monthly Report
- Track Key Issue & Resolve

Main Activity

Output
- C, S
- QSE

Q-Gate 6
Project Review

- Project Team
- Performance Evaluation
- Lessons Learned Report

Main Activity

Output
- 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
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 2

Risk Assessment

QG2
Risk Analysis

Cost Estimation

Bidding

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

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)

1-6 Environmental Consideration

1. Physical/Site Risk     2. Estimate Accuracy Risk
5. Project Execution Risk
   A: Project Management
   B: Construction Risk
6. Country Risk
Q-gate 2

Main Risk: Wetland Protection

Start Location: 365km 140

End Location: 373km 600

New wetland

#1 Moojechi

#2 Moojechi

#3 Moojechi

#4 Moojechi

New wetland

#1 ~ #4

#1 Incline

#2 Incline

J Mt.

A Fault
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
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)

- Wetlands
- No-wetlands

Gap(cost)
Similar (time)

Time(days)
Cost
Q-gate5 / 6

Project Execution / Review

QG5
Project Execution

- Cost
- Schedule
- Quality
- Safety
- Environment

QG6
Project Review

- Performance Evaluation
- Lessons Learned
- Data-Based

2008
**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**

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**OK! Go**
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)
1st: Rock Classification

2nd: Geophysical Survey

3rd: Geological Structure

4th: Final Ground Class

Start

Shaft #1

Shaft #2

Shaft #3

End location

Q-gate 2

Ground Class

TBM? / NATM? / TBM+NATM?

Highly Weathered

NATM

TBM

ITA-WTC2006 Open Session - Seoul

31
# Main Risk: Excavation Method in Urban Area

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Tunneling Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1</td>
<td>Full face TBM (13.2m Diameter)</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>NATM Tunneling</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>TBM Pilot Tunnel(D=4.5m) with NATM Enlargement</td>
</tr>
</tbody>
</table>
## Q-gate 2

### Qualitative Risk Analysis

#### Level of Risk = Likelihood x Consequence

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>5</td>
<td>Likely to occur repeatedly during construction of the tunnel</td>
</tr>
<tr>
<td>Probable</td>
<td>4</td>
<td>Likely to occur several times during construction of the tunnel</td>
</tr>
<tr>
<td>Occasional</td>
<td>3</td>
<td>Likely to occur at least once during construction of the tunnel</td>
</tr>
<tr>
<td>Remote</td>
<td>2</td>
<td>Unlikely to occur during construction of the tunnel</td>
</tr>
<tr>
<td>Improbable</td>
<td>1</td>
<td>Extremely unlikely to occur during construction of the tunnel</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>(5) Catastrophic</th>
<th>(4) Critical</th>
<th>(3) Serious</th>
<th>(2) Marginal</th>
<th>(1) Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>(5) Frequent</td>
<td>25 (VH)</td>
<td>20 (VH)</td>
<td>15 (VH)</td>
<td>10 (H)</td>
<td>5 (M)</td>
</tr>
<tr>
<td>(4) Probable</td>
<td>20 (VH)</td>
<td>16 (VH)</td>
<td>12 (H)</td>
<td>8 (M)</td>
<td>4 (L)</td>
</tr>
<tr>
<td>(3) Occasional</td>
<td>15 (VH)</td>
<td>12 (H)</td>
<td>9 (M)</td>
<td>6 (M)</td>
<td>3 (L)</td>
</tr>
<tr>
<td>(2) Remote</td>
<td>10 (H)</td>
<td>8 (M)</td>
<td>6 (M)</td>
<td>4 (L)</td>
<td>2 (L)</td>
</tr>
<tr>
<td>(1) Improbable</td>
<td>5 (M)</td>
<td>4 (L)</td>
<td>3 (L)</td>
<td>2 (L)</td>
<td>1 (L)</td>
</tr>
</tbody>
</table>
Hazards Categories (31 elements)

1. Ground Stability (8 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

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)
## Alternative 3: TBM Pilot + Enlargement

<table>
<thead>
<tr>
<th>No</th>
<th>Hazard</th>
<th>Initial Risk Level</th>
<th>Mitigation Measures TBM PILOT</th>
<th>Mitigation Measures ENLARGEMENT</th>
<th>Residual Risk Level</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Likelihood</td>
<td>Consequence</td>
<td>Risk</td>
<td>Smooth outer face of cutterhead</td>
<td>Apply appropriate support pattern</td>
</tr>
<tr>
<td></td>
<td>1) Roof falls and sidewall instability &lt; 5 in highly weathered and jointed rock mass</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>Recessed cutting disks to reduce risk of cutterhead becoming stuck</td>
<td>Probing ahead of face (essentially by pilot drive)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Probing ahead of face</td>
<td>Advance grouting from pilot tunnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pre-injection grouting</td>
<td>Install rock support without delay</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Install rock support (shotcrete + rock bolts) behind cutterhead without delay</td>
<td>Adjust advance length and/or excavation sequence</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Additional rock support and/or advance support (forepoling)</td>
<td>Additional rock support and/or advance support (forepoling)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Adjust blasting scheme</td>
</tr>
</tbody>
</table>
### Risk Assessment of Tunnelling Methods

#### BEFORE MITIGATION

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Number of hazards</th>
<th>Average score</th>
<th>Total Average</th>
<th>Number of hazards</th>
<th>Average score</th>
<th>Total Average</th>
<th>Number of hazards</th>
<th>Average score</th>
<th>Total Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high risk</td>
<td>15 (From) - 25 (To)</td>
<td>10</td>
<td>15.5</td>
<td>5 (From) - 8 (To)</td>
<td>15.2</td>
<td>11.4</td>
<td>8 (From) - 11 (To)</td>
<td>15.4</td>
<td></td>
</tr>
<tr>
<td>High risk</td>
<td>10 (From) - 14 (To)</td>
<td>12</td>
<td>11.5</td>
<td>10 (From) - 11 (To)</td>
<td>11.6</td>
<td>11.4</td>
<td>11 (From) - 11 (To)</td>
<td>11.6</td>
<td></td>
</tr>
<tr>
<td>Medium risk</td>
<td>5 (From) - 9 (To)</td>
<td>6</td>
<td>8.0</td>
<td>5 (From) - 6 (To)</td>
<td>7.2</td>
<td>7.4</td>
<td>6 (From) - 7 (To)</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>Low risk</td>
<td>1 (From) - 4 (To)</td>
<td>1</td>
<td>4.0</td>
<td>0 (From) - 0 (To)</td>
<td>0.0</td>
<td>0.0</td>
<td>0 (From) - 0 (To)</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

#### AFTER MITIGATION

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Number of hazards</th>
<th>Average score</th>
<th>Total Average</th>
<th>Number of hazards</th>
<th>Average score</th>
<th>Total Average</th>
<th>Number of hazards</th>
<th>Average score</th>
<th>Total Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high risk</td>
<td>15 (From) - 25 (To)</td>
<td>0</td>
<td>0</td>
<td>0 (From) - 0 (To)</td>
<td>0.0</td>
<td>0.0</td>
<td>0 (From) - 0 (To)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>High risk</td>
<td>10 (From) - 14 (To)</td>
<td>3</td>
<td>11.3</td>
<td>1 (From) - 2 (To)</td>
<td>10</td>
<td>11.0</td>
<td>2 (From) - 2 (To)</td>
<td>6.3</td>
<td>12.6</td>
</tr>
<tr>
<td>Medium risk</td>
<td>5 (From) - 17 (To)</td>
<td>14</td>
<td>7.4</td>
<td>14 (From) - 6 (To)</td>
<td>6.5</td>
<td>12.0</td>
<td>12 (From) - 12 (To)</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>Low risk</td>
<td>1 (From) - 9 (To)</td>
<td>5</td>
<td>3.8</td>
<td>5 (From) - 3 (To)</td>
<td>3.2</td>
<td>11.0</td>
<td>11 (From) - 3 (To)</td>
<td>3.4</td>
<td></td>
</tr>
</tbody>
</table>

**Score**

**BEFORE MITIGATION**

- Alternative 1: Full-face TBM - 11.9
- Alternative 2: NATM - 11.4
- Alternative 3: TBM Pilot tunnel with NATM Enlargement - 11.7

**AFTER MITIGATION**

- Alternative 1: Full-face TBM - 6.7
- Alternative 2: NATM - 5.9
- Alternative 3: TBM Pilot tunnel with NATM Enlargement - 5.6
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

Response to Market Environment Change
- Stable
- Rapid Growth
- Downside
- Slow Growth
- New Competitors Come In

Business Strategy Set-Up
Set Realistic Goals for Each Biz and Aim to Attain them

Q-Gate

Q-Gate Operation for Performance Target
- Risk Taking
- Aggressive Risk Taking
- Selective
- Rigid
- Selective
3. Integrated Decision Making System

Transparent Procedures & Decision Making

**Procedure for Decision on PJT Bidding or Not**

Before

- Project Review
  - Business Unit
- Decision
  - Director/CEO
- Bidding
  - Business Unit

After

- Issue Finding
  - Project Team
- Project Review TF
  - PJT Support Committee
- Reporting & Decision
  - Business Unit/CEO
- Bidding

**A-team**
- • Strategy Fitness
- • Overall Risk Analysis

**B-Team**
- • Analysis on Expected Profit & Operation Risk

**C-team**
- • Review Legal Risk
- • ………

**Z-team**
- • Review Project Financing, Contract Risk etc
- Related Team if Necessary

**High Risk Probability due to Limited Review**

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