An Integrated Risk Analysis Methodology For Construction Projects
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Stefan Creemers
Filip Deblaere
Erik Demeulemeester
Willy Herroelen
Stijn Van de Vonder
A Taste of Construction Industry Projects

• Construction industry consumes roughly 5% of GDP in the US

• Project diversity: Real-estate, roadwork, tunneling, bridge building, building of power plants, office buildings,…
  – Budget: <1M$ versus multibillion projects
  – Time: less than a month versus several decades
  – Scope: Bid-Build versus DBFOM (Design, Build, Finance, Operate and Maintain; PPP)

• Common divisor: an urgent need for Risk Management
Risk Management 101

• A risk is an event that occurs with a certain probability and that impacts the scope, duration and/or cost of a project.

• The purpose of risk management is to identify risks and to mitigate their impact on project goals (time, budget, scope)

• Risk mitigation includes: risk transfer (e.g. insurance), evaluating execution alternatives, …

• Risk Management methodology may be divided into:
  – Qualitative RM: Risk prioritization, …
  – Quantitative RM: Monte Carlo simulation, …
Industry Status Quo

• Current practice:
  – Experience during duration/cost calculation (not linked to project execution nor project planning)
  – Use of a project buffer
  – Use of Monte Carlo simulation (often adopting a triangular distribution)
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• **Current issues:**
  – Risk management is **activity-level based**
    → **Use of activity groups**
  – Mixing up **cause & effect**
Industry Status Quo: Mixing up Cause & Effect

Current best practice is to use some distribution to assess activity durations (costs)
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In fact, the distribution is the result of risks occurring

⇒ One should assess the cause of the risk, not the effect!

⇒ Assess:
  • The probability of a risk occurring
  • The impact of the risk (allowed to be a distribution)
Industry Status Quo: Mixing up Cause & Effect

Current best practice is to use some distribution to assess activity durations (costs)

Often triangular distributions are used. However, empirical evidence shows that the distribution of activity duration (cost) is bimodal/multimodal

<table>
<thead>
<tr>
<th>Best fit:</th>
<th>Complete fit:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 out of 3 risks are ignored</td>
<td>Severe overestimation of the risk</td>
</tr>
</tbody>
</table>
Industry Status Quo

• Current practice:
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• Current issues:
  – Risk management is activity-level based
    → Use of activity groups
  – Mixing up cause & effect
    → Assess risks, not duration/costs
  – Ignoring risk dependencies
Industry Status Quo: Ignoring Risk Dependencies

- Risk interdependencies:
  - The order of risk impact is often ignored (e.g. the impact of “weather delay” on an activity “masonry” should be assessed after the impact of “faulty estimation of work content” has resolved because weather delay impacts the effective working time)
  - Correlations between risks are seldom taken into account
Industry Status Quo: Ignoring Risk Dependencies

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• Time Dependencies:
  – Weather delay may impact multiple activities at once
  – Weather delay depends on the time of the year
Industry Status Quo: Ignoring Risk Dependencies

• Risk interdependencies:
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• Time Dependencies:
  – Weather delay may impact multiple activities at once
  – Weather delay depends on the time of the year

⇒ Risk analysis and project planning cannot be seen separate
Industry Status Quo

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  – Experience during duration/cost calculation (not linked to project execution nor project planning)
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  – Use of Monte Carlo simulation (often adopting a triangular distribution)

• **Current issues:**
  – Risk management is **activity-level based**
    → **Use of activity groups**
  – Mixing up **cause & effect**
    → **Assess risks, not duration/costs**
  – Ignoring **risk dependencies**
    → **Use of an integrated risk analysis**
ABC is the key:
Example

**Task:** Erect wall: 100m²

**Execution:** masonry

**Resources:** 2 masons

**Supplier:** KUL construct

**Schedule**

**Environment**

**Work content:** 100m²

**Yield:** 5 m² / man-hour

**Efficiency:** 2 man-hour / hour

**Unity cost:** 15 $ / man-hour

**Project**

**Work:** 20 man-hours

**Duration:** 10 hours

**Direct costs:** 300 $

**Indirect costs:** 100 $
ABC is the key:
Faulty estimation of the yield

Task: Erect wall: 100m²

Execution: masonry

Resources: 2 masons

Supplier: KUL construct

Schedule

Environment

Project

Work content: 100m²

Yield: 4 m² / man-hour

Efficiency: 2 man-hour / hour

Unity cost: 15 $ / man-hour

Duration: 10 hours

Direct costs: 300 $

Indirect costs: 100 $

Work: 20 man-hours

Efficiency: 2 man-hour / hour

Unity cost: 15 $ / man-hour

Duration: 10 hours

Direct costs: 300 $

Indirect costs: 100 $
ABC is the key:
Faulty estimation of the yield

Task: Erect wall: 100m²

Execution: Masonry

Resources: 2 masons

Supplier: KUL construct

Schedule

Efficiency: 2 man-hour / hour

Unity cost: 15 $ / man-hour

Duration: 12.5 hours

Direct costs: 375 $

Project

Indirect costs: 120$

Work content: 100m²

Work: 25 man-hours

Yield: 4 m² / man-hour
ABC is the key:
Sickness (decreased efficiency)

Task:
Erect wall: 100m²

Execution:
masonry

Resources:
2 masons

Supplier:
KUL construct

Schedule
Environment

Work content:
100m²

Yield:
5 m² / man-hour

Efficiency:
1.5 man-hour/hour

Unity cost:
15 $ / man-hour

Duration:
10 hours

Direct costs:
300 $

Indirect costs:
100 $

Work:
20 man-hours
ABC is the key:
Sickness (decreased efficiency)

**Task:** Erect wall: 100m²

**Execution:** Masonry

**Resources:** 2 masons

**Supplier:** KUL construct

**Schedule**

**Environment**

**Work content:** 100m²

**Yield:** 5 m² / man-hour

**Efficiency:** 1.5 man-hour/hour

**Unity cost:** 15 $ / man-hour

**Duration:** 13.3 hours

**Direct costs:** 400 $

**Indirect costs:** 125 $
ABC is the key:
Increase in price supplies

- **Task:** Erect wall: 100m²
- **Execution:** Masonry
- **Resources:** 2 masons
- **Supplier:** KUL construct
- **Work content:** 100m²
- **Yield:** 5 m²/man-hour
- **Efficiency:** 2 man-hour/hour
- **Unity cost:** 16 $/man-hour
- **Duration:** 10 hours
- **Direct costs:** 300 $
- **Indirect costs:** 100 $
- **Project**
- **Schedule**
- **Environment**
ABC is the key:
Increase in price supplies

Task:
- Erect wall: 100m²

Execution:
- Masonry

Resources:
- 2 masons

Supplier:
- KUL construct

Work content:
- 100m²

Yield:
- 5 m² / man-hour

Efficiency:
- 2 man-hour / hour

Unity cost:
- 16 $ / man-hour

Duration:
- 10 hours

Direct costs:
- 320 $

Schedule:
- Project

Environment

Indirect costs:
- 100 $
## Output of Risk Analysis

<table>
<thead>
<tr>
<th></th>
<th><strong>TIME</strong></th>
<th><strong>DIRECT COSTS</strong></th>
<th><strong>INDIRECT COSTS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROJECT</strong></td>
<td>Probability the project finishes prior to a certain deadline</td>
<td>Probability the project exceeds a given budget</td>
<td>Probability of incurring a penalty and/or additional overhead costs</td>
</tr>
<tr>
<td><strong>RISK</strong></td>
<td>Identification of the most important risks that impact the timely completion of the project</td>
<td>Identification of the most important risks that impact the budget of a project</td>
<td>Identification of the most important risks that impact the indirect costs</td>
</tr>
<tr>
<td><strong>TASK</strong></td>
<td>Identification of those activities that need to be monitored closely in order for the project to finish on time</td>
<td>Identification of the activities that pressure the budget of a project</td>
<td>Identification of the activities that contribute most to the indirect costs</td>
</tr>
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Questions?