

PROJECT MONITORING

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PMG333

Lecture 08

RISK MONITORING TOOLS

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Monte Carlo Simulation & Sensitivity Analysis

ADVANCED

Risk Register Overview

Your Blueprint for Managing the Invisible Threats

- **Story:** In 2014, the Big Dig tunnel project in Boston faced a catastrophic ceiling collapse that killed a worker. Post-analysis revealed that risks were identified but never properly documented in a centralized register. This oversight cost over \$24 billion in delays and repairs. A simple risk register could have prevented this tragedy.
- **Definition:** A Risk Register is a living document that catalogs all identified risks, their characteristics, and planned responses throughout a project lifecycle (PMBOK & ISO 31000).



Core Components

The 10 Essential Building Blocks of a Risk Register

1. **Risk ID** — Unique identifier (R-001, R-002...)
2. **Risk Description** — Clear problem statement
3. **Risk Category** — Technical / Financial / Schedule / Scope / HR
4. **Probability** — Likelihood (Low / Medium / High)
5. **Impact** — Consequence severity (Low / Medium / High)
6. **Risk Score** — Probability × Impact
7. **Response Strategy** — Mitigate / Avoid / Transfer / Accept
8. **Response Plan** — Specific actions and timeline
9. **Risk Owner** — Person responsible for monitoring
10. **Status** — Open / Monitoring / Closed

1. Risk ID	Risk Description	Risk Category	Probability	6. Impact	Strategy	8. Respo.	9. Risk Owner	10. Status

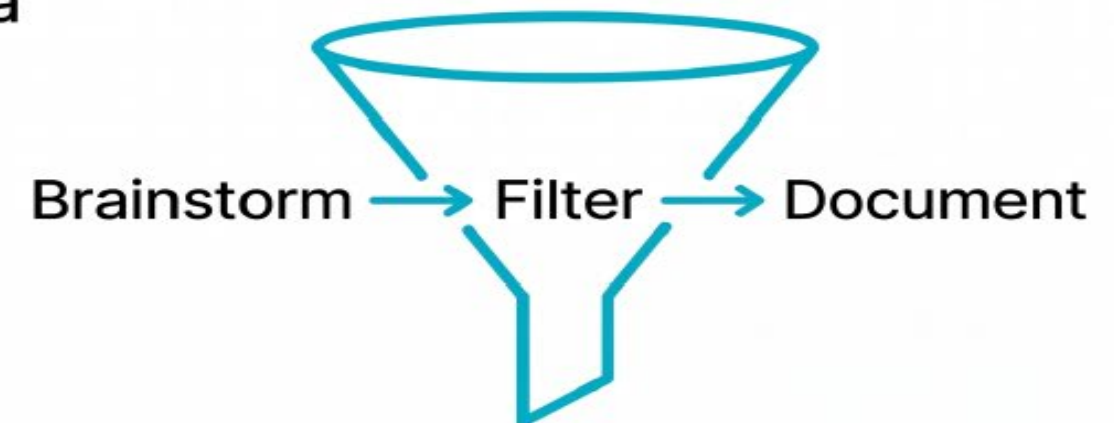
Risk Identification

Surfacing Threats Before They Emerge

- **Story:** Vodafone's GLAN project (2015) identified 42 potential risks in the planning phase through structured brainstorming with cross-functional teams. By documenting these early, they achieved a 96% project success rate and completed 3 months ahead of schedule.

Identification Methods:

- Brainstorming sessions with project team
- Historical project reviews
- SWOT analysis
- Expert interviews
- Stakeholder consultations
- Lessons learned database



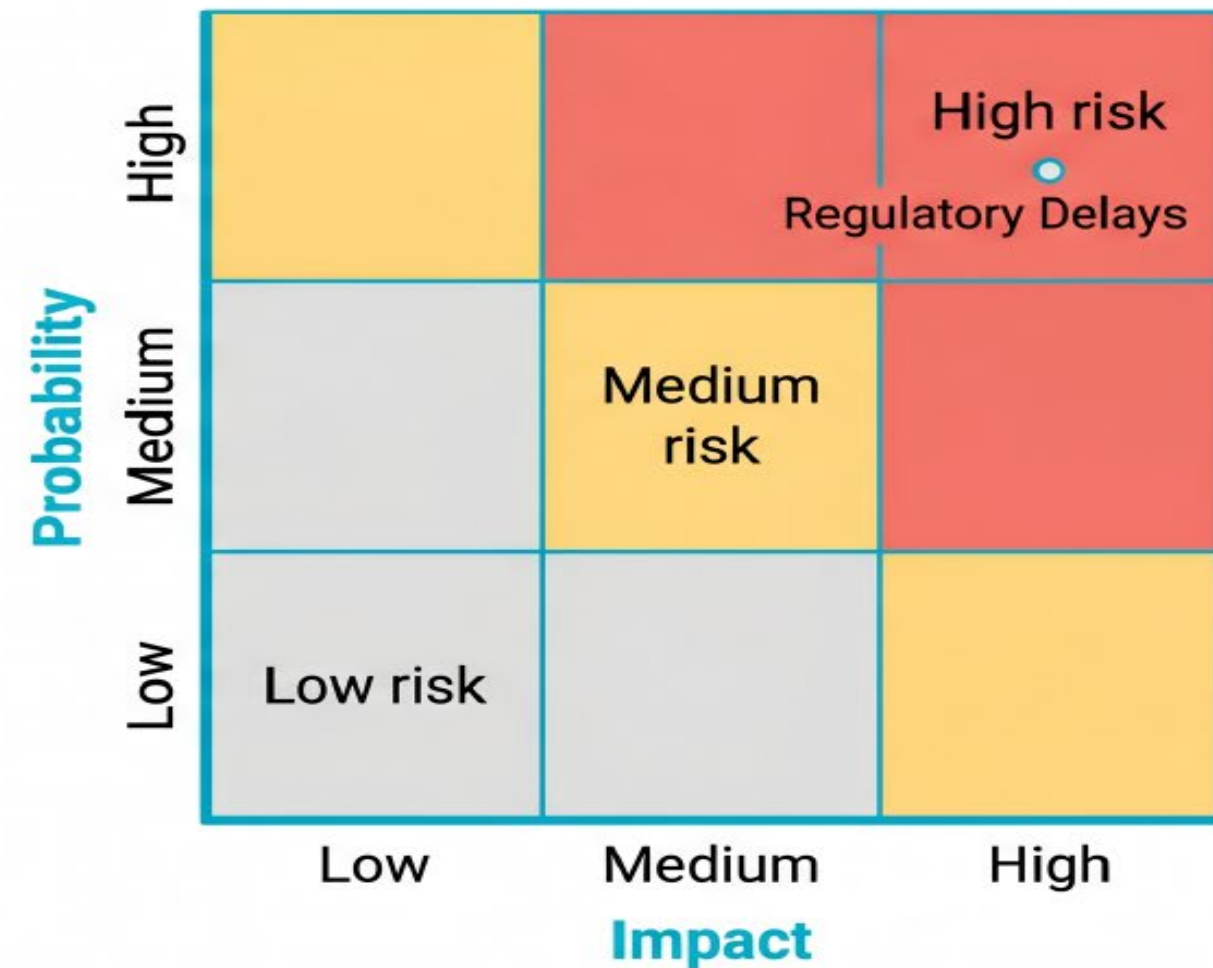
Risk Analysis

Weighing Probability Against Impact

Story: The Fehmarnbelt Tunnel project (Denmark-Germany) analyzed 4 major risks using a probability-impact matrix. “Regulatory delays” scored High probability (80%) × High impact (€500M) = Critical priority. This analysis drove resource allocation and prevented €2B in potential losses.

Analysis Process:

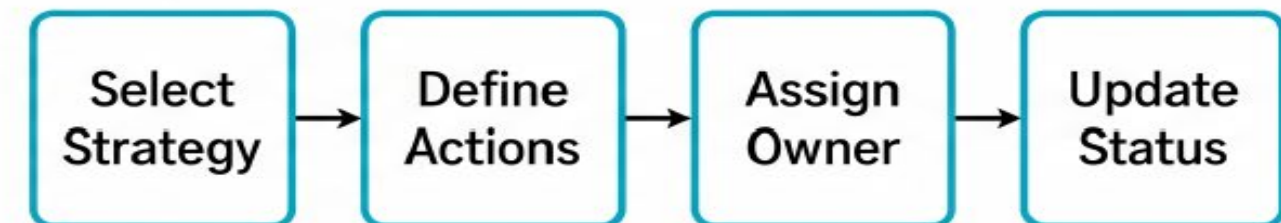
- Assess probability (Low / Medium / High)
- Evaluate impact (Financial, Schedule, Quality)
- Calculate risk score = Probability x Impact
- Prioritize response efforts



Response Planning

Documenting Your Defense Strategy in the Register

- **Story:** Gordie Howe International Bridge project documented response plans for each risk. For “Material price volatility” (High probability), they chose the Transfer strategy and locked supplier contracts 18 advance. This single decision saved \$47M compared to the industry average.
- **Recording Response Plans:**
 - Select strategy: Mitigate / Avoid / Transfer / Accept
 - Define specific actions with clear timelines
 - Assign a responsible Risk Owner
 - Set trigger points for activation
 - Update status regularly (Open → Monitoring → Closed)



Risk ID: R-001	Strategy: Transfer	Owner: PM	Status: Closed
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Best Practices

Maximizing Risk Register Effectiveness



DO (Best Practices)

- ✓ Update register weekly or bi-weekly
- ✓ Share with the entire project team
- ✓ Assign clear ownership for every risk
- ✓ Use simple, precise language
- ✓ Link register to the project schedule
- ✓ Track risk trends over time



AVOID (Common Mistakes)

- ✗ Creating the register but never updating it
- ✗ Hiding risks from stakeholders
- ✗ Ignoring small or low-probability risks
- ✗ Using vague or unclear descriptions
- ✗ Setting unrealistic response plans
- ✗ No clear accountability or ownership

The Catastrophe That Changed Everything

When Risk Assessment Fails, Billions Are Lost

Story: On April 20, 2010, the Deepwater Horizon oil rig exploded in the Gulf of Mexico, killing 11 workers and spilling 5 million barrels of oil.

The investigation revealed:

BP failed to conduct a formal risk assessment of critical operational decisions before the disaster.

The cost: Over \$65 billion in compensation and cleanup — all preventable with a proper risk matrix.

Key Lesson:

- No formal risk assessment was performed
- Critical threats were never visualized or prioritized
- Cost-cutting replaced systematic risk thinking

Without
Risk Matrix



\$65 Billion
Loss

vs

With
Risk Matrix



Risk Identified
& Prevented

Understanding the Risk Matrix

A Visual Tool for Prioritizing Project Threats

Building on probability and impact concepts from Lecture 1, the risk matrix is their practical visual application.

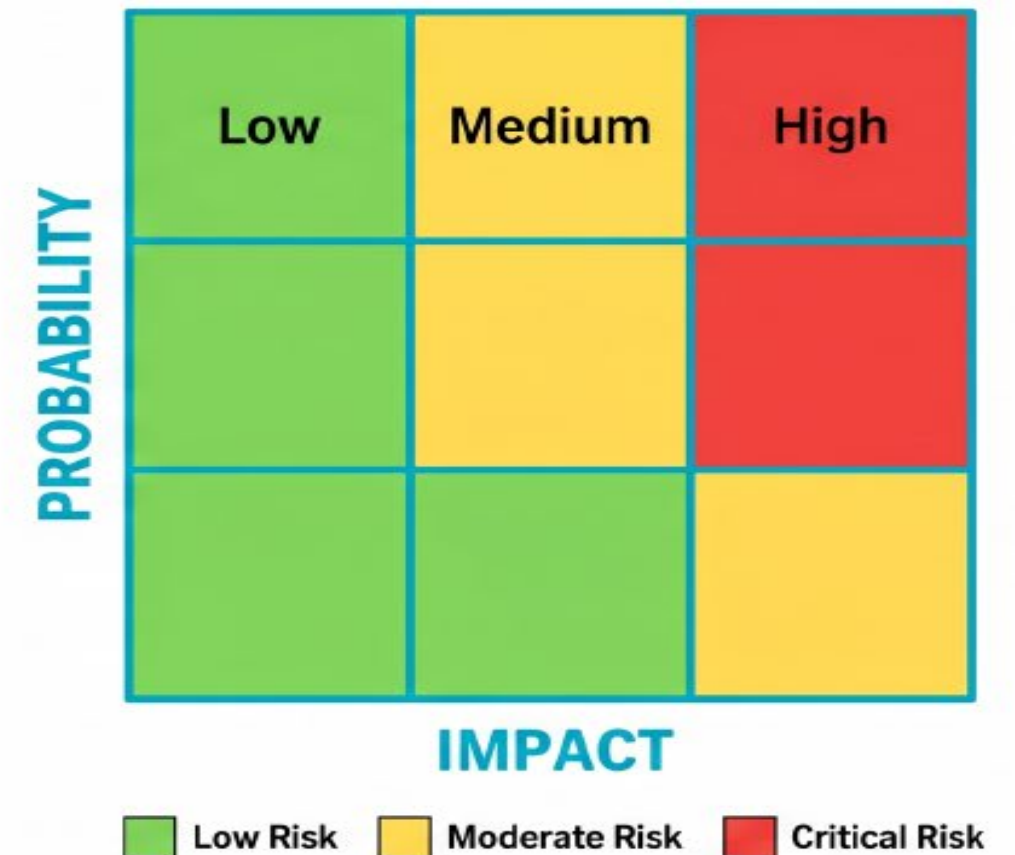
Definition: A visual grid where each risk is positioned based on its likelihood of occurrence and its potential impact on project objectives.

The Three Zones:

- **GREEN** zone — Low risk: Monitor passively, no urgent action required
- **YELLOW** zone — Moderate risk: Active management and mitigation planning needed
- **RED** zone — Critical risk: Immediate intervention and resource allocation required

Core Formula:

Risk Score = Probability × Impact



The 5×5 Risk Matrix: A Detailed View

Scoring Risks from 1 to 25

The 5×5 matrix divides both axes into five levels:

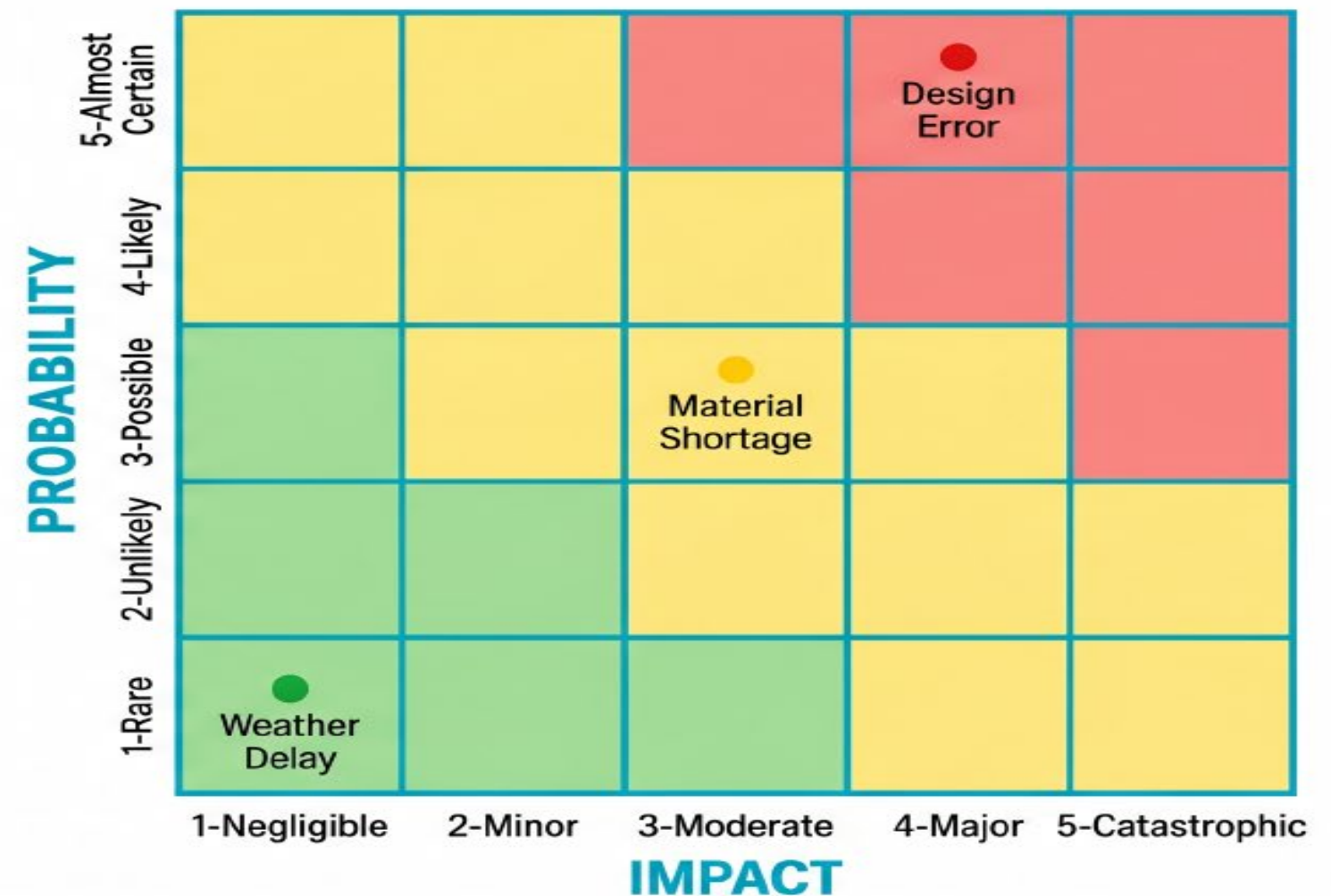
Probability: Rare(1) Unlikely(2) Possible(3) Likely(4) Almost Certain(5)

Impact: Negligible(1) Minor(2) Moderate(3) Major(4) Catastrophic(5)

Risk Score = Probability x Impact (Range: 1 to 25)

Zone Thresholds:

- Score 1-5: GREEN (Accept & Monitor)
- Score 6-14: YELLOW (Manage & Mitigate)
- Score 15-25: RED (Act Immediately)



Real-World Application: The High-Rise Project

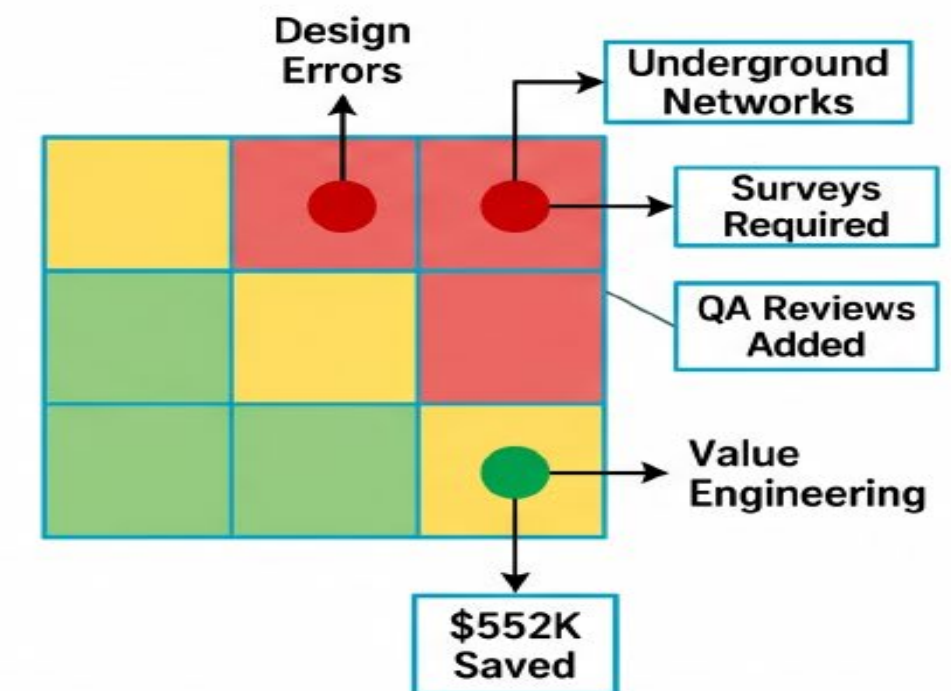
How a Risk Matrix Guided Critical Decisions (Poland, 2023)

Source: Applied Sciences, MDPI (2023)

Project: Complex high-rise office building with 35-meter deep excavations and advanced steel-concrete hybrid structure.

Key Risks Identified:

1. 'Unidentified Underground Networks',
Zone: RED (High Probability x Catastrophic Cost)
Action: Extensive subsurface surveys before excavation
Result: Prevented a potential \$500,000+ disaster;
2. 'Design Documentation Errors',
Zone: RED (High Probability x Major Impact)
Action: Additional quality assurance reviews
Result: Critical design flaws caught before construction;
3. 'Value Engineering Opportunity',
Zone: GREEN (High Probability x High Savings)
Result: Saved over \$552,000 using alternative facade materials.



Strengths and Limitations

Why the Risk Matrix Works — And Where It Falls Short

STRENGTHS

- ✓ **Intuitive Communication**
Stakeholders understand color coding without technical training
- ✓ **Quick Prioritization**
Instantly identifies which risks need immediate attention
- ✓ **Resource Efficiency**
Focuses budget on high-impact threats, avoids waste

LIMITATIONS

- ✗ **Subjectivity**
Assessment relies on human judgment, introducing bias
- ✗ **Risk Compression**
Different risks can receive the same score (e.g., $5 \times 1 = 1 \times 5 = 5$)
- ✗ **Static Snapshot**
Captures risk at one point in time, doesn't track evolution

The Solution: Use the risk matrix as a screening and communication tool, then complement it with quantitative methods (Monte Carlo Simulation) for critical, high-value risks.
(Source: Nature, Humanities and Social Sciences Communications, 2024)

Best Practices for Risk Matrix Implementation

Maximize Effectiveness of Your Risk Assessment

✓ DO

- ✓ Update the matrix regularly (monthly or quarterly)
- ✓ Involve cross-functional teams in risk assessment
- ✓ Link matrix results directly to response planning
- ✓ Use consistent definitions for probability and impact
- ✓ Document the rationale behind each risk's positioning

✗ AVOID

- ✗ Creating the matrix once and never revisiting it
- ✗ Relying solely on the matrix for critical decisions
- ✗ Assigning scores without documented evidence
- ✗ Treating all red-zone risks identically
- ✗ Ignoring low-probability, high-impact 'tail risks'

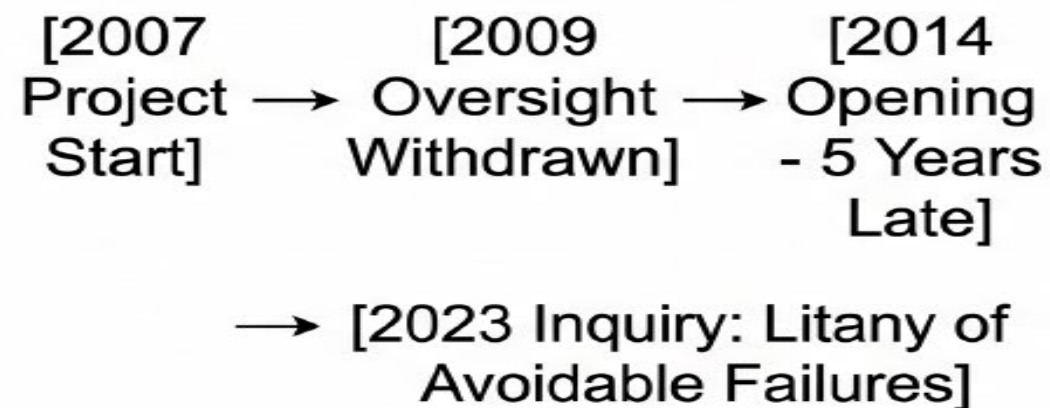
Key Takeaway: The risk matrix is most effective when treated as a living document that evolves with your project, supported by rigorous analysis and professional judgment.

Risk Monitoring Meetings

The Cost of Silence

Edinburgh Trams Project

£835 Million Spent | 5 Years Delayed



Root Cause:
Independent oversight officials removed from Risk Review Meetings



‘When independent voices are removed from the room, catastrophe becomes inevitable.’

Source: BBC News. 2023 | Lord Hardie Inquiry Repo

The Living Pulse of Risk Management

What Are Risk Monitoring Meetings?

1. Reassess Existing Risks - Have probabilities or impacts changed? Are response strategies working?

2. Identify Emerging Threats - What new risks have surfaced since the last meeting?

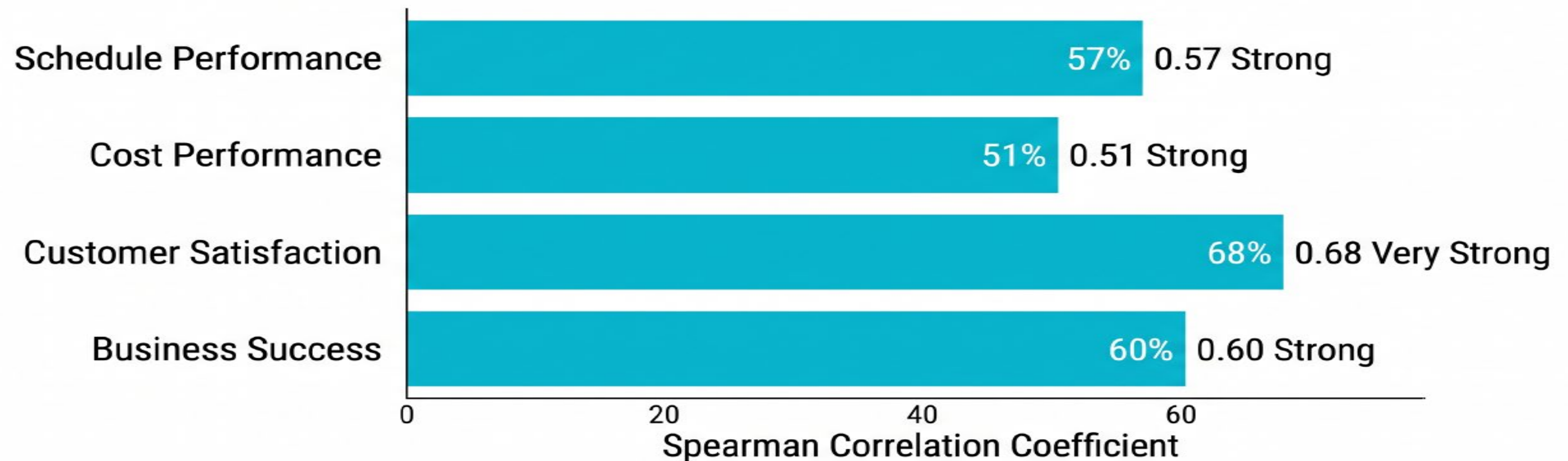
3. Review Response Effectiveness - Are our mitigation actions actually reducing risk?

4. Close Resolved Risks - Remove risks that no longer threaten the project.

PMI: Without regular meetings, even the best risk register becomes a graveyard of forgotten warnings.

'When Meetings Happen, Projects Succeed'

Statistical Evidence from 50 Construction Project Managers (Texas, 2025)



All correlations significant at $p < 0.001$

Source: Obondi. K.C. (2025) IJAMR. Vol. 9(3)

Structure That Prevents Chaos

The Anatomy of an Effective Risk Monitoring Meeting (45 min)



KEY PRINCIPLE: Come with DATA, not guesses. The meeting is for DECISIONS, not information gathering.

Source: PMI BLISS Strategy

Why Meetings Fail — And How to Fix Them

Four Critical Dysfunctions (PMI, 2008)

DYSFUNCTION	CURE
No Clear Agenda — Discussion wanders, time wasted	Send detailed agenda 24 hours before with time allocations
Unprepared Attendees — Guesses replace data	Assign pre-meeting tasks: Update Risk #7 before Thursday
Suppressed Truth — Real risks stay hidden (Edinburgh Trams)	Create psychological safety. Never shoot the messenger.
Forgotten Action Items — Discussion without action	Document immediately: Owner + Deadline. Review in next meeting first 5 min.

Lesson from Edinburgh: When oversight is withdrawn and truth is suppressed, catastrophe becomes inevitable.

When Assumptions Become Problems

RAID Log — Tool 4 in Risk Monitoring



BEFORE: Scattered assumptions across NHS departments



PROBLEM: Hidden dependencies caused project misalignment



AFTER: RAID Log as mandatory living document — single source of truth

R = Risks

A =
Assumptions

I = Issues

D =
Dependencies

The Four Pillars of RAID

Understanding Each Component

R — RISKS

Potential future events that could negatively (or positively) impact the project if they occur.

A — ASSUMPTIONS

Conditions believed to be true for planning purposes, but not yet verified or confirmed.

I — ISSUES

Problems that have already occurred and are currently affecting the project, requiring immediate action.

D — DEPENDENCIES

Tasks that depend on other tasks to start or finish, or critical decisions documented during the project.

Source: Smartsheet (2026), University of Waterloo PMO

RAID Log vs Risk Register

Complementary Tools, Not Competitors

	RISK REGISTER	RAID LOG
Purpose	Deep specialized risk analysis	Quick overview of 4 project elements
Depth	Probability x Impact matrix, mitigation plans	Simplified 3-5 fields per entry
Scope	Risks only	Risks + Assumptions + Issues + Dependencies
Analogy	Mechanic's full inspection report	Car dashboard at a glance

RAID Log discovers → Risk Register analyzes deeply

Source: Smartsheet (2026), Prieto (2016) PM World Journal

RAID Log in Action

Case Study: University HR System Implementation

PROJECT: University-wide HR system upgrade.

TOOL USED: RAID Log as mandatory living document (University of Waterloo PMO, 2024)

R – RISKS		Risk	Probability	Impact	Owner
	Row1	Employee resistance to change	High	High	HR Manager
	Row2	Late data delivery from departments	Medium	High	PM
A – ASSUMPTIONS		Assumption	Status		
	Row1	All departments will provide clean data	✗ NOT MET – caused 6-week delay		
	Row2	Vendor support available within 24hrs	✓ VERIFIED		

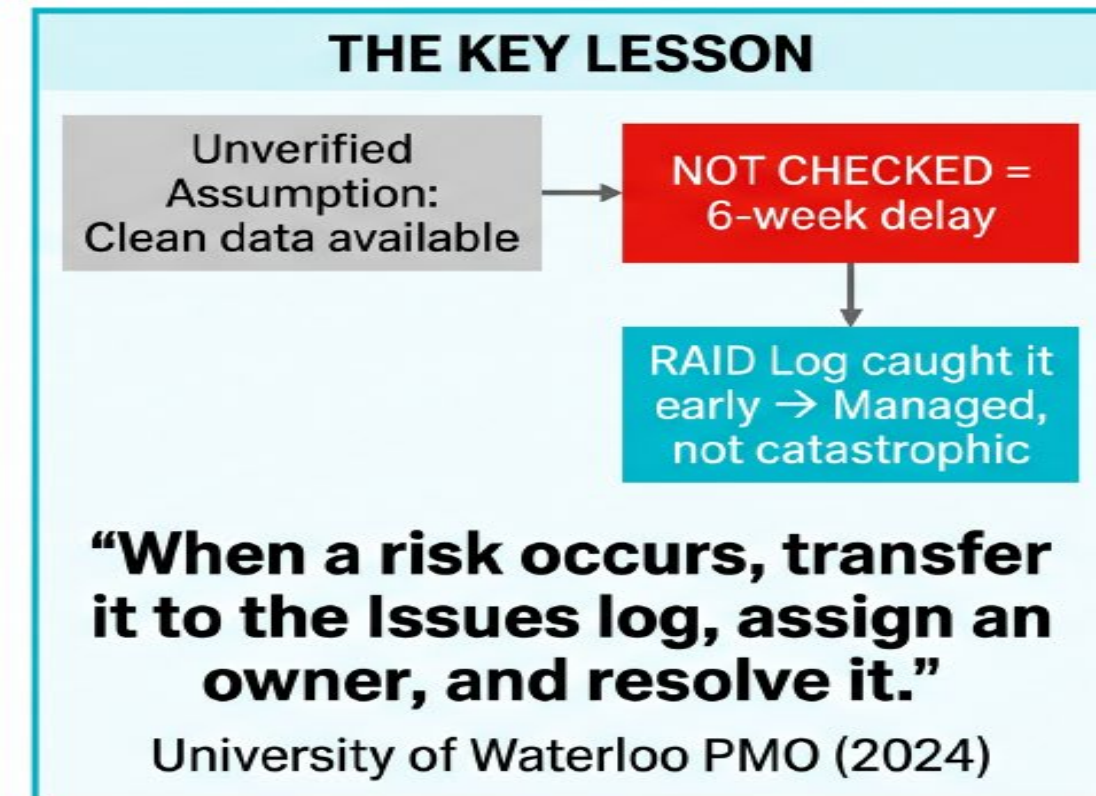
Source: University of Waterloo PMO (2024); Page-Tickell & Sloan (2022)

RAID Log in Action

Issues, Dependencies & The Key Lesson

I – ISSUES	Issue	Discovered=	Owner=IT	Resolution
	Finance dept data incompatible new system'	Week 4	Manager	Resolution='Database restructuring required'

D – DEPENDENCIES	Dependency	If Fails
	Dependency='Training cannot start before data migration is complete'	If Fails='Full system launch delayed'
	Dependency='Legal approval required before processing employee data'	If Fails='Project frozen'



Source: University of Waterloo PMO (2024); Page-Tickell & Sloan (2022)

The Power of Centralized Accountability

Why RAID Log Matters in Complex Projects

**VISIBILITY**

Single source of truth: all stakeholders see the same picture

**ACCOUNTABILITY**

Every risk and issue has a named owner responsible for action

**PROACTIVITY**

Catches problems early before they escalate into crises

**GOVERNANCE**

Ensures nothing falls through the cracks in complex projects

BEFORE

Scattered notes, emails,
verbal assumptions —
no ownership

**AFTER**

One RAID Log —
One Truth —
One Responsibility

‘The Crisis That Changed Everything’

Risk Dashboards — Tool 5 in Risk Monitoring



BEFORE: NHS NPFIT — £10 Billion Disaster

Hundreds of risk reports, no single view, decision-makers blind to threats



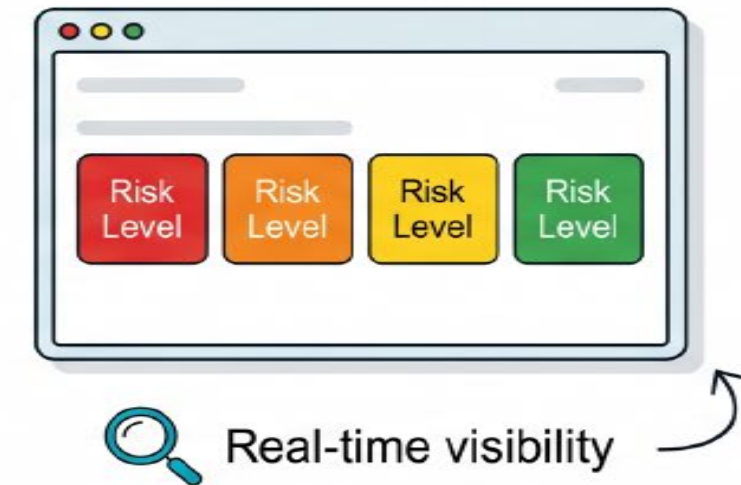
THE PROBLEM: Data Without Visibility = Paralysis

Information scattered, no real-time alerts, reactive management



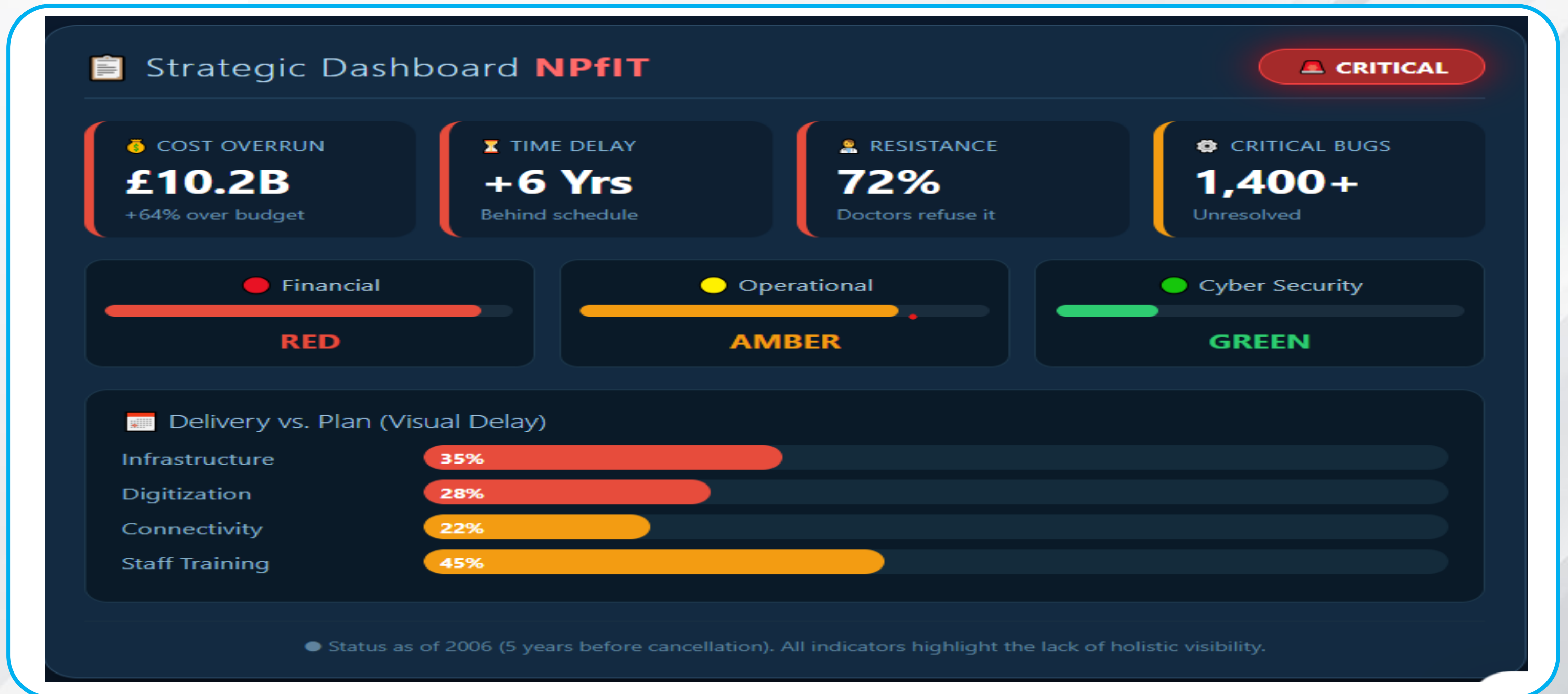
AFTER: Visual Intelligence Transforms Decisions

One-page snapshot, color-coded alerts, proactive management



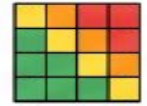
Lecture 08

The Dashboard That Should Have Existed



The Dashboard Blueprint

Four Essential Components of an Effective Risk Dashboard



Risk Exposure

Heat Map showing Red/Yellow/Green zones.
Visualizes probability vs. impact concentration



Response Times

Measures speed from risk detection to action.
Benchmark: 5 days industry standard



Compliance Rates

Percentage adherence to risk protocols.
Example: 95% of risks have assigned owners



Financial Impact

Quantifies potential losses if top risks
materialize. Justifies resource allocation

Dashboard in Action

Case Study: Clinical Trials Management (BMC Medical Research, 2023)

THE CHALLENGE: 15 hospitals, 3 countries,
500+ patients, limited monitoring budget



Monitoring visits reduced by 60%



Issues detected 2 weeks earlier



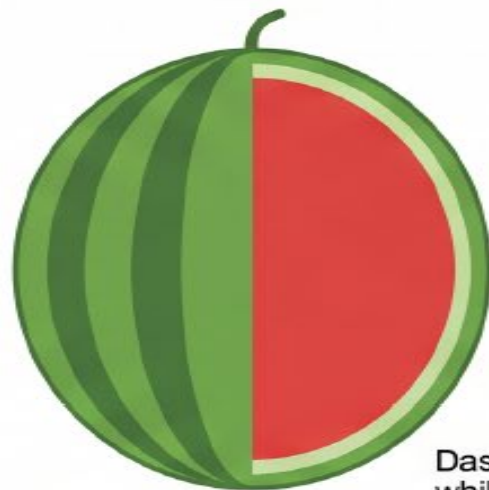
Data quality: 92% → 98%

Key Insight: Dashboard transformed monitoring from reactive to predictive

The Hidden Trap

Watermelon Reporting: Green on the Outside, Red on the Inside

Watermelon Reporting



Dashboard shows GREEN while project is actually RED. Cause: inaccurate manual data entry to please management

1



CLARITY: Max 8-10 KPIs directly tied to project objectives. Avoid information overload

2



INTERACTIVITY: Click red indicator to see root cause. Not just What but Why

3



REAL-TIME AUTOMATION: Live data feeds, no manual entry, automated threshold alerts

A dashboard is only as good as the data feeding it and the culture supporting transparency

Case Study: Barings Bank Collapse (1995)



UK's oldest merchant bank, founded 1762



Nick Leeson: unauthorized trading in Singapore



Total loss: £827 million — bank declared insolvent



Warning signs ignored: abnormal funding requests, concentration of authority



Lesson: KPIs showed high profits; KRIs would have shown escalating hidden risk



What Are KRIs?

Proactive metrics providing early signals of increasing risk exposure.

KPIs (Key Performance Indicators)	KRIs (Key Risk Indicators)
 Focus: Past performance	 Focus: Future risk
 Type: Lagging (backward-looking)	 Type: Leading (forward-looking)
 Example: Q1 Revenue	 Example: Trend in late payments

The Four Categories of KRIs



1. Financial

- Budget variances
- Liquidity ratios
- Revenue concentration



2. Operational

- System downtime
- Audit failures
- Process defect rates



3. People

- Employee turnover
- Absenteeism
- Safety incidents



4. Technology

- Cybersecurity breaches
- Unpatched vulnerabilities
- System failures

Designing Effective KRIs

01



**Map risks to
strategic objectives**

02



**Select measurable,
predictive indicators**

03



Set thresholds
(Green / Amber / Red)



04



**Automate data
collection**

05



**Link KRIs to KPIs for
balanced monitoring**

06



**Review and
update regularly**



Well-designed KRIs provide early warning, enable proactive action,
and strengthen organizational resilience.



Monte Carlo Simulation



DEFINITION & METHODOLOGY



Statistical modeling technique using repeated random sampling.



Estimates probability distributions of complex outcomes.



Moves beyond single-point deterministic forecasts.



KEY BENEFITS

01

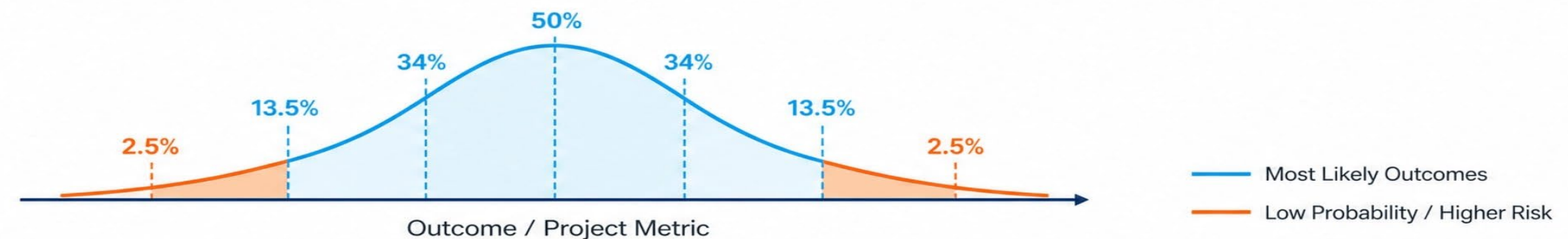
Probabilistic Forecasting:
Provides specific confidence levels (e.g., 85% chance of success).

02

Realistic Contingency Planning:
Data-driven calculation of reserves.

03

Enhanced Stakeholder Communication:
Visualizes risk ranges clearly.



Sensitivity Analysis

Identifying the key variables driving project outcome variance.

KEY TECHNIQUES



Tornado Diagram:
Visual ranking of impact.



Spearman Rank Correlation:
Statistical measure (0 to +1).



What-If Analysis:
Manual scenario testing.

PRACTICAL EXAMPLE



Cost Driver Example



Material A (Base Cost \$1,000):
Correlation = **0.998**
(Primary Driver)



Material B (Base Cost \$10,000):
Correlation = **0.05**
(Low Impact)



Takeaway:
Focus risk mitigation on Material A
despite its lower base cost.

Real-World Application: Luxury Villa Construction



Academic Case Study: Luxury Villa Construction Project (Medium-sized construction company)

Source: Journal of Engineering and Engineering Management

Traditional CPM Method



Optimistic Estimate:

186
working days

- Single-point forecast
- Assumes perfect conditions

Schedule Forecast



VS.

Monte Carlo Simulation



205
working days
50% Probability

- **50% Probability:** 205 working days
- **50% Risk:** Delays beyond 205 days
- **Variance:** 19 days (10% difference)



KEY INSIGHTS



Financial Impact:

At \$5,000/day, the 19-day variance = **\$95,000** additional contingency needed



Risk Visibility:

Monte Carlo exposed **10%** schedule underestimation



Sensitivity Analysis Application:

Identifies which construction phases (foundation, framing, finishing) and resource constraints drive schedule variance

Small & Medium Projects: Essential Tools



Small Projects

- ✓ Risk Register
- ✓ Risk Matrix
- ✓ Monthly Meetings



Foundation tools for
basic risk management



Medium Projects

- ✓ Essential Tools (from Small Projects)
- ✓ RAID Log
- ✓ Risk Dashboards

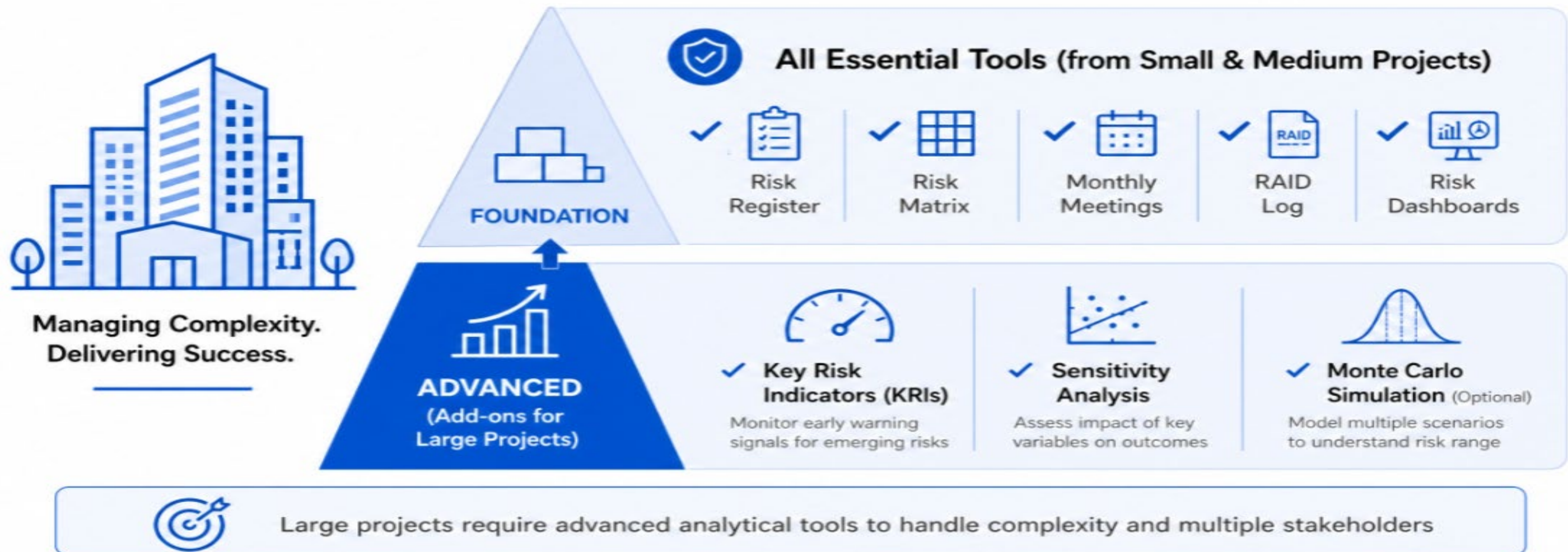


Enhanced tools for
better coordination



Adapt tools based on your project's complexity and team size

Large Projects: Advanced Tools



Thank You