

PROJECT MONITORING

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PMG333

Lecture 02

SCOPE MONITORING TOOLS

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Lecture Contents

Scope Monitoring Tools (Part 1/2)

01 Variance Analysis

Comparing actual project performance against the planned baseline to identify deviations in scope, schedule, or cost.

02 Earned Value Management

A quantitative technique that integrates scope, schedule, and resource measurements to assess project performance and progress.

03 Trend Analysis

Examining project performance over time to determine if performance is improving or deteriorating, allowing for proactive corrective actions.

Lecture Contents

Scope Monitoring Tools (Part 2/2)

04 Requirements Traceability Matrix (RTM)

A grid that links product requirements from their origin to the deliverables that satisfy them, ensuring all requirements are tested and met.

05 Work Breakdown Structure (WBS)

A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish project objectives.

06 WBS Dictionary

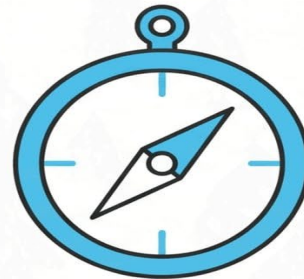
A document that provides detailed deliverable, activity, and scheduling information about each component in the WBS.

07 Change Control System

A set of procedures that describes how modifications to the project deliverables and documentation are managed and controlled.

Variance Analysis: Your Project's Navigation System

Comparing Actual Performance Against Planned Baseline



Variance Analysis is a technique that continuously compares your actual project performance against your planned baseline—much like a GPS system that alerts you when you deviate from the intended route.



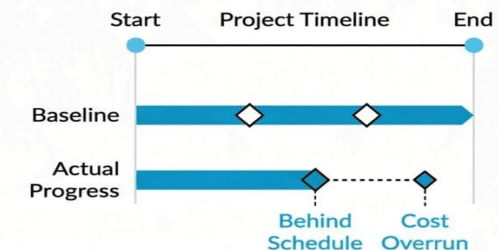
Detects deviations early before they become critical problems



Measures performance gaps in scope, schedule, and cost



Triggers corrective actions when variances exceed thresholds



The Three-Step Process: From Baseline to Action

How Variance Analysis Works

1 Establish the Scope Baseline



- Define planned work from Scope Baseline
- Includes Project Scope Statement, WBS, and WBS Dictionary
- This becomes your reference point

2 Measure Actual Work Performed

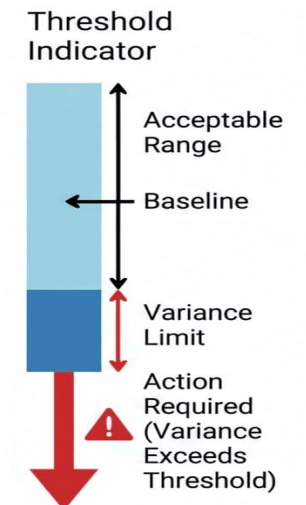


- Collect Work Performance Data from the field
- Document what has actually been completed
- Record any deviations or obstacles

3 Calculate and Analyze the Variance



- $\text{Variance} = \text{Actual Work} - \text{Planned Work}$
- Investigate root causes of variances
- Assess impact on other constraints (schedule, cost, quality)



Action Threshold: When variance exceeds the tolerance level established in the Scope Management Plan, a corrective action or formal change request must be submitted.



Real-World Case Study: Mobile App Development Project

From Planning to Reality: Detecting Scope Creep Through Variance Analysis

A company planned to develop a mobile shopping application with 8 programmed modules over two months, following a detailed Work Breakdown Structure.

Professional variance analysis results

Element	Planned	Actual	Variance	Status
Total Modules	8	6	-2 (-25%)	Negative
User Management	Complete	Complete	None	On Track
Shopping Cart	Complete	Complete	None	On Track
Payment Gateway	Complete	70%	-30%	Negative
Reports Module	Complete	Not Started	-100%	Negative

Root Cause Analysis

Problem 1: Payment Gateway Delay (30% variance)



- An additional third-party payment gateway was added without formal scope change approval—a classic case of scope creep

Problem 2: Reports Module Delay (100% variance)



- Resources were diverted to develop a product comparison feature requested informally by a stakeholder, bypassing formal change control

Key Outcome: By detecting these variances early, the project manager prevented further scope creep, maintained stakeholder expectations, and brought the project back on track.





Variance Analysis: E-Commerce Website Redesign - Part 1

The Variance Table: Detecting Performance Issues

Project Context: A company planned to redesign its e-commerce website with 5 major components (Homepage, Product Catalog, Shopping Cart, Checkout, Admin Dashboard) over 3 months. The project had a detailed WBS and a baseline schedule.

Professional Variance Analysis Results Table

Component	Planned Tasks	Actual Tasks Completed	Variance	Status
Homepage	12	10	-2 (-17%)	On Track
Product Catalog	15	15	0	On Track
Shopping Cart	10	8	-2 (-20%)	Negative
Checkout Process	8	4	-4 (-50%)	CRITICAL
Admin Dashboard	5	2	-3 (-60%)	CRITICAL



🔍 Notice the pattern: While some components are on track, the Checkout Process and Admin Dashboard show significant delays. This is not random—it signals underlying problems that need investigation.

What does this variance table tell us? Two components are in critical condition. But **WHY?** That's what we investigate in **Part 2**.



Part 2: Root Cause Analysis

Variance Analysis: E-Commerce Website Redesign - Part 2

Root Cause Analysis: Why Did Variances Occur?

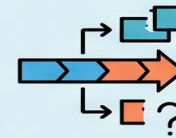


Problem 1: Checkout Process Delay (50% variance)

Cause: Unexpected integration issues with third-party payment gateway API. The vendor's API documentation was incomplete, requiring additional development time.

Impact: Delayed entire checkout component by 4 weeks

Scope Creep Indicator: This was NOT in the original scope



Problem 2: Admin Dashboard Delay (60% variance)

Cause: Stakeholder requested additional reporting features (sales analytics, customer insights) not in original WBS.

Impact: Resources reallocated from other tasks. Project timeline compressed.

Scope Creep Indicator: CLASSIC SCOPE CREEP - Work added without formal change control

Key Outcome

By detecting these variances early through Variance Analysis, the project manager identified that:

1. The Checkout component had a legitimate technical issue (vendor responsibility)
2. The Admin Dashboard had uncontrolled scope expansion (scope creep)

Immediate corrective actions were taken:

- Escalated payment gateway issues to the vendor
- Moved additional reporting features to Phase 2 of the project through formal change control
- Realigned project schedule and resources

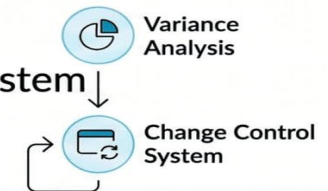


"Variance Analysis revealed that what appeared as 'technical delays' was actually uncontrolled scope expansion."

Making Variance Analysis Work for Your Projects

Essential Principles & Best Practices

- ✓ **1. Establish Clear Baselines First** - Your Scope Baseline must be detailed and formally approved
- ✓ **2. Monitor Regularly** - Conduct variance analysis at predetermined intervals to catch issues early
- ✓ **3. Investigate Root Causes** - Find underlying causes, not just symptoms
- ✓ **4. Integrate with Change Control** - Variance analysis feeds into the Change Control System
- ✓ **5. Communicate Transparently** - Share findings with stakeholders regularly



Common Pitfalls to Avoid

- Ignoring small variances that compound over time
- Accepting variances without investigating root causes
- Making unauthorized changes instead of using formal change control
- Failing to update baselines after approved changes

“Variance Analysis is not about blame—it’s about course correction. The goal is to keep your project on track and deliver what was promised.”

Lecture 02

Earned Value Management

Earned Value Management: A Quick Introduction



In medicine, a doctor doesn't simply ask "How are you?" but measures vital **signs**—precise numbers that reveal the true condition. **Earned Value Management** does the same for projects: it measures **three vital signs** to reveal the true health of your project.

Earned Value Management (EVM) is a methodology that measures project performance by comparing:

- What you planned to accomplish
- What you actually accomplished
- What you actually spent

Planned Value (PV)



The value of work you planned to complete

Earned Value (EV)



The value of work you actually completed

Actual Cost (AC)



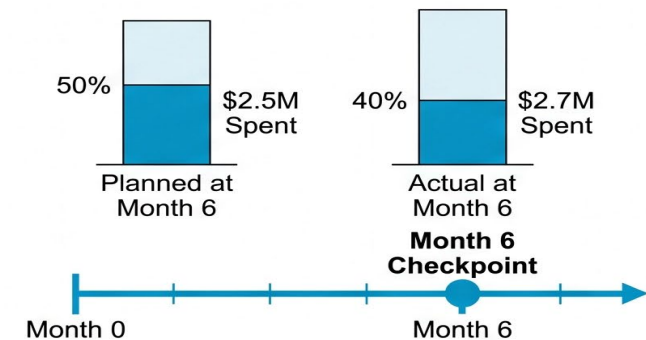
The money you actually spent

Why It Matters for Scope Monitoring

When Earned Value (what you completed) is less than Planned Value (what you planned), it signals a problem. You might be spending money without completing the required work—a clear sign of scope issues.



Simple Example



Imagine you planned to complete 50% of a project by month 6 and spend \$2.5M. But at month 6, you've only completed 40% of the work and spent \$2.7M. The numbers immediately tell you: something is wrong.

EVM reveals what subjective assessments miss. It's your project's vital signs monitor.

We'll dive deeper into detailed calculations and performance indicators in the next session.

"The numbers don't lie. EVM shows you the real story of your project."

Trend Analysis: Predicting Your Project's Future

From Observations to Predictions

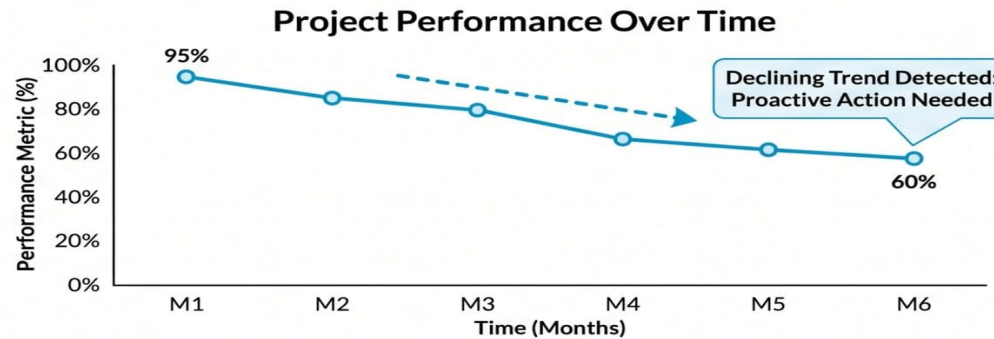
Trend Analysis is not about what happened yesterday—it's about what will happen tomorrow.

The Tire Pressure Analogy



Imagine your car tire slowly losing air over weeks. A single measurement tells you nothing, but if you measure daily and plot the results on a graph, you discover the downward trend before the tire goes completely flat.

This is **Trend Analysis**: discovering slow, gradual patterns invisible in a single moment but clear when viewing data over time.



Definition

(PMBOK Guide, 6th Edition)

Trend Analysis examines project performance over time to identify patterns that may indicate improving or deteriorating performance, enabling proactive decision-making.

Three Key Benefits

- 1. Detects emerging problems before they become crises
- 2. Enables predictive intervention rather than reactive firefighting
- 3. Provides early warning signals to stakeholders

“Trend Analysis transforms project management from reactive to predictive.”

From Data Points to Predictive Insights The Four-Step Trend Analysis Process

1 Collect Data Over Time

- Record performance metrics at regular intervals (weekly, bi-weekly, monthly)
- Metrics include: change request volume, Schedule Performance Index (SPI), Cost Performance Index (CPI)
- Ensure consistent measurement methodology

2 Plot the Data

- Create visual representations (line graphs, trend charts)
- Plot actual values against planned baseline
- Make patterns visible and easy to interpret

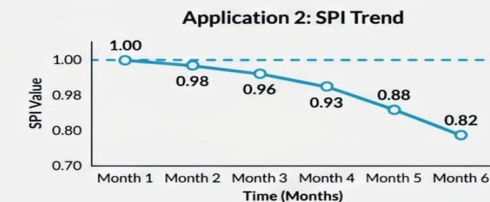


3 Identify Patterns

- Look for upward trends (improving performance)
- Look for downward trends (deteriorating performance)
- Identify acceleration or deceleration in trends

4 Predict Future Performance

- Extrapolate current trends forward
- Calculate where project will be if trends continue
- Assess impact on schedule, cost, and quality



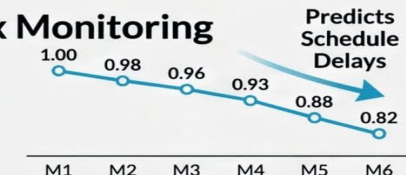
Application 1: Change Request Tracking

If change requests are increasing month-over-month (1, 2, 4, 8, 15, 23), this upward trend indicates scope instability and incomplete initial definition.



Application 2: Performance Index Monitoring

If Schedule Performance Index (SPI) is declining (1.00 → 0.98 → 0.96 → 0.93 → 0.88 → 0.82), this downward trend predicts increasing schedule delays.



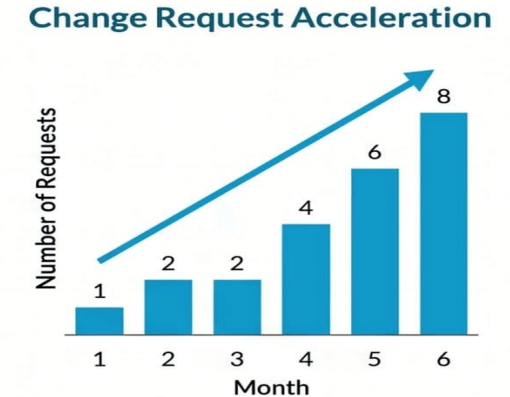
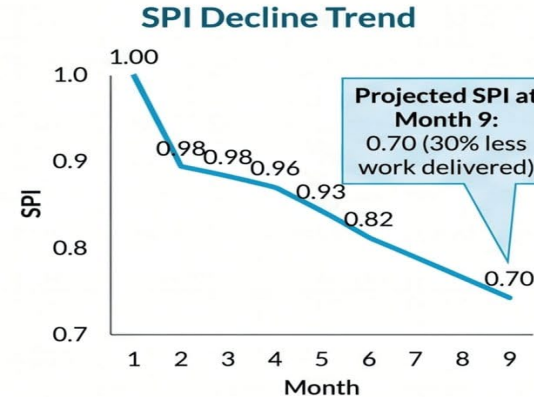


Real-World Case Study: Residential Complex Project

From Trends to Action: A 50-Unit Development

Project Context: Construction of a 50-unit residential complex with a planned 12-month duration. The project manager tracked change requests and Schedule Performance Index (SPI) monthly.

Month	New Requests	Cumulative	SPI	Status
1	1	1	1.00	Perfect
2	2	3	0.98	Minor
3	2	5	0.96	Continued
4	4	9	0.93	Accelerating
5	6	15	0.88	Downward
6	8	23	0.82	Critical



Trend Analysis Findings

Trend 1: Change Request Acceleration (1→2→2→4→6→8)

The accelerating pattern reveals stakeholders are continuously discovering new requirements. Original scope definition was incomplete.

Trend 2: SPI Decline (1.00→0.82)

Mathematical projection: SPI will reach 0.70 by month 9, meaning only 70% of planned work will be delivered if trend continues.

Critical Actions Taken

1. **Scope Freeze:** Emergency meeting with stakeholders to freeze scope
2. **Change Review:** Prioritized all pending change requests
3. **Baseline Update:** Updated baseline with approved changes only
4. **Resource Reallocation:** Redirected resources to critical path items

Detect Trend

Analyze

Act

Recover

Key Outcome: By acting on trend signals in month 6, the project manager prevented a potential 30% schedule overrun.



Scope Expansion Tracking



PROJECT OVERVIEW

E-commerce mobile app project started with 15 core features.

Additional features accumulated gradually:

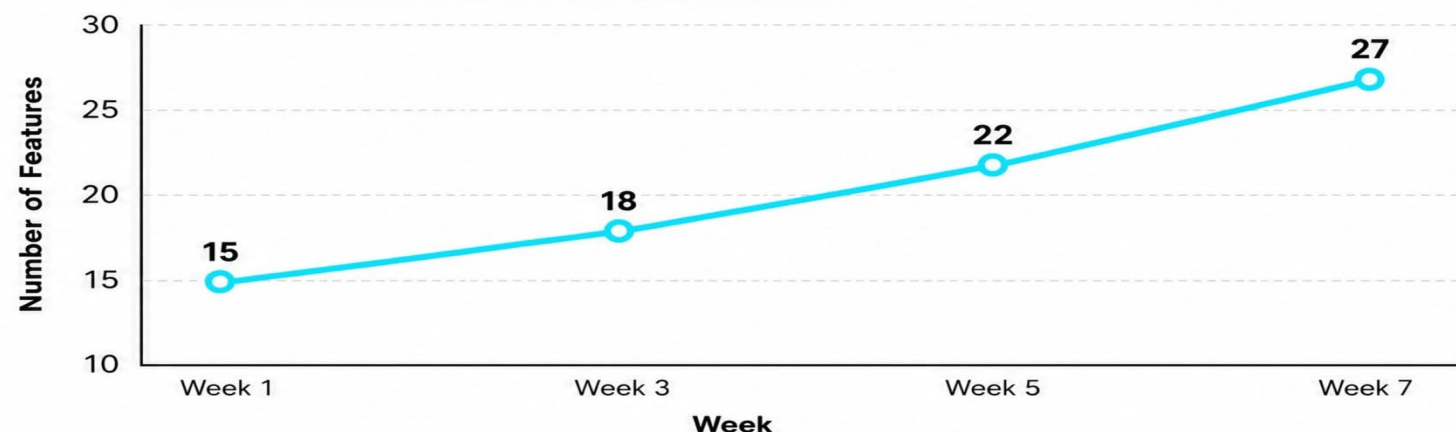
- Advanced payment systems
- Personalized recommendations
- Social media integration



TREND ANALYSIS

Feature addition rate increased by 2–3 new features weekly, showing an accelerating trend.

FEATURE COUNT PROGRESSION OVER TIME



WEEK	FEATURE COUNT	ADDITIONAL FEATURES	INCREASE FROM PREVIOUS
 Week 1	15 (Original Plan)	—	—
 Week 3	18	+3 features	+20%
 Week 5	22	+4 features	+22%
 Week 7	27	+5 features	+23%

Note: Data represents cumulative feature count at the end of each measured week.



KEY TAKEAWAY

The feature count is not just increasing, it is accelerating. The project scope expanded from 15 to 27 features in 7 weeks, with the weekly addition rate growing from 2–3 to 5+ features.

Performance Metrics & Corrective Actions

Trend Analysis Response Strategy

SPI Metrics

Phase 1 (Weeks 1-2):

SPI = 1.0
On Schedule

Phase 2 (Weeks 3-4):

SPI = 0.92
8% Behind Schedule

Phase 3 (Weeks 5-6):

SPI = 0.78
22% Behind Schedule

Corrective Actions

1

Scope Freeze

Stop accepting unplanned new features

2

Priority Assessment

Rank existing features by importance

3

Replanning

Defer additional features to later phases

SPI Improved from 0.78 to 0.95 within Two Weeks

Early trend detection and swift corrective action prevented major project delays and protected profitability

Making Trend Analysis Your Early Warning System

Essential Principles & Best Practices

Five Essential Principles

1. **Establish Regular Measurement Intervals** – Consistency matters more than frequency.
2. **Track Multiple Metrics Simultaneously** – Don't rely on a single metric.
3. **Visualize Data for Clarity** – Line graphs are most effective for trend identification.
4. **Distinguish Between Noise and Signals** – One point is noise; three consecutive points is a signal.
5. **Act on Predictions, Not Just Observations** – The value is in prediction, not documentation.



Positive
Trend

Negative
Trend

Common Pitfalls to Avoid:

- Measuring too infrequently (missing emerging trends)
- Waiting for perfect data before taking action
- Ignoring early warning signals because they seem minor
- Failing to communicate trend implications to stakeholders

When to Escalate Based on Trends:

- Change requests accelerating beyond planned tolerance
- Performance indices declining for three consecutive periods
- Scope compliance falling below 90%
- Resource utilization trending upward while productivity trends downward



“The earlier you detect a negative trend, the more options you have to correct course.”



The Requirements Traceability Matrix: Your Project's Safety Net

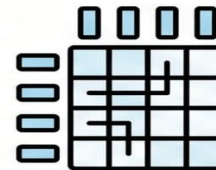
Connecting Every Requirement to Its Deliverable



The Pre-Flight Checklist Analogy

Before every flight, pilots go through a detailed pre-flight checklist. They verify dozens of items—fuel, navigation systems, landing gear—and the plane cannot take off until the entire list is complete.

The Requirements Traceability Matrix is your project's checklist: a document that links every requirement to its source and to the deliverable that fulfills it.



Definition (PMBOK Guide, 6th Edition)

A Requirements Traceability Matrix is a grid that links product requirements from their origin to the deliverables that satisfy them, ensuring that each requirement adds business value and is tracked throughout the project lifecycle.



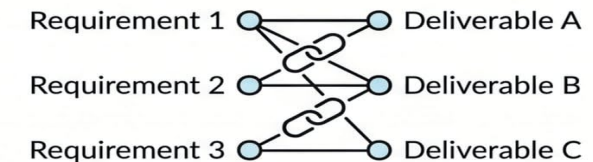
Two Critical Failures RTM Prevents

Gap Detection

Requirements that should have been completed but weren't

Gold Plating Detection

Work that was done but wasn't authorized



Source → Requirement → Deliverable

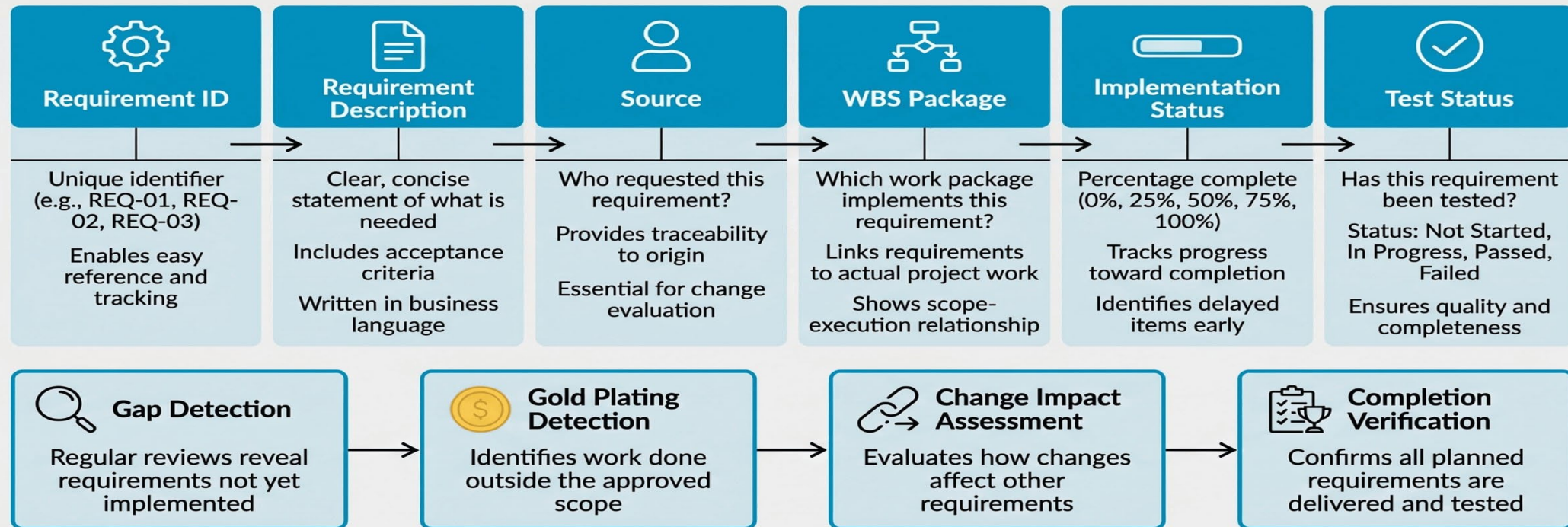
Every requirement has a source. Every requirement has a deliverable.

Every deliverable can be traced back to a requirement.

Nothing is lost. Nothing is extra.

Connecting Requirements to Deliverables: The RTM Structure

Six Key Columns Create Accountability





Detecting Scope Problems: A Hospital Management System Case Study

Real-World Application of RTM in Scope Monitoring

Project Context

Development of an electronic hospital management system with 25 functional requirements. At the end of Phase 2, the project manager reviewed the RTM and discovered critical issues.



RTM Snapshot Table

Req ID	Description	Source	WBS	Status	Test
REQ-01	Patient Registration	Hospital Manager	WP-1.2.1	100%	Passed
REQ-02	Appointment Scheduling	Chief of Doctors	WP-1.2.3	100%	Passed
REQ-03	Medical Records	Health Ministry	WP-1.3.1	60%	Not Tested
REQ-04	Billing System	Finance Director	WP-1.4.1	Not Started	Not Tested
REQ-05	Performance Reports	Quality Manager	WP-1.5.2	100%	Passed
???	SMS Notifications	Unknown	Not in WBS	100%	Passed

Corrective Actions

Actions Taken:

1. **Pause Unauthorized Work** - Halted SMS notification development
2. **Reallocate Resources** - Redirected team to Billing System
3. **Formal Change Request** - Submitted for SMS notifications in later phase
4. **Update RTM** - Reflected actual status and documented change request

Detect → Analyze → Act → Recover

Discovery 1: GAP (REQ-04 Billing System)

The Billing System requirement was planned for Phase 2 but has not started.

This represents a negative variance in scope and requires corrective action.

The team is behind schedule on a critical requirement.

Discovery 2: GOLD PLATING (SMS Notifications)

An SMS notification system was developed and is 100% complete, but it does not appear in the RTM and is not in the WBS. This means the team spent time and resources on unapproved work. This gold plating likely diverted resources from REQ-04.

RTM in Banking Systems

Digital Payment Processing System (DPPS) Case Study

The Challenge

A major financial institution developed a DPPS with 18 core functional requirements, facing strict regulatory mandates (PCI-DSS, GDPR).

Initial Traceability Gaps:

- Incomplete test coverage (only 65% mapped)
- Unclear regulatory compliance addressing
- Ambiguous change management impact
- Potential for missing critical functionality

The RTM Solution

The team implemented a comprehensive Requirements Traceability Matrix to map each requirement across the project lifecycle.

Mapping Dimensions:

- Design Specifications (DS-XX)
- Test Cases (TC-XX)
- Compliance Standards (COMP-XX)
- Implementation Modules (MOD-XX)

Key Insight

Implementing RTM transformed scattered requirements into a structured, auditable framework, ensuring no critical banking regulation or functional need was overlooked.

RTM Impact & Results

Traceability Matrix Snapshot and Measurable Improvements

RTM Matrix Snapshot

Requirement	Design Spec	Test Cases	Compliance	Module	Status
REQ-01: Auth	DS-01	TC-01, 02	GDPR-1	MOD-01	✓ Complete
REQ-02: Transact	DS-02	TC-03	PCI-DSS-2	MOD-02	✓ Complete
REQ-04: Fraud	DS-04	TC-05, 06, 07	PCI-DSS-4	MOD-04	✓ Complete
REQ-05: Audit	DS-05	TC-08	GDPR-3	MOD-05	✓ Complete
REQ-06: Encrypt	DS-06	TC-09, 10	PCI-DSS-6	MOD-06	✓ Complete

🔧 Corrective Actions

- Created 8 additional test cases for untested requirements
- Established compliance mapping for all regulatory mandates
- Developed design specs for previously unmapped requirements

📈 Measurable Quality Impact

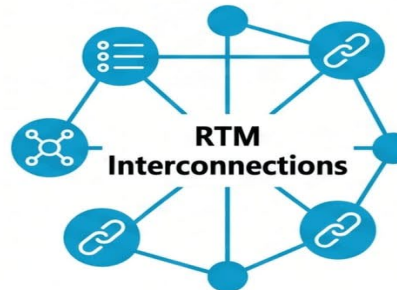
- Test Coverage:** Increased from 65% to 98%
- Compliance:** Audit time reduced by 40% (120h to 72h)
- Risk Mitigation:** Prevented 3 critical security gaps



Making the RTM Your Scope Guardian

Best Practices for Effective Implementation

- 1 **Create the RTM Early** - Develop during requirements gathering and planning phases
- 2 **Keep the RTM Current** - Update whenever requirements change and review at every status meeting
- 3 **Use the RTM for Scope Decisions** - Make it the single source of truth for scope
- 4 **Make the RTM Visible** - Share with stakeholders regularly in status reports
- 5 **Link RTM to Other Tools** - Connect to WBS, test cases, and change control



Common Pitfalls to Avoid:

- Creating an RTM but not using it
- Including too many requirements (becomes unmanageable)
- Vague requirement descriptions that cannot be tested
- Ignoring gold plating and unauthorized work
- Not updating the RTM during changes

When to Escalate:

- Any requirement with 0% implementation after planned completion date
- Any work item not found in the RTM (potential gold plating)
- Multiple requirements from same source showing gaps
- Test failures on requirements marked as complete

"The RTM is not bureaucracy—it's insurance. It ensures every requirement is delivered, nothing is forgotten, and nothing unauthorized is added."



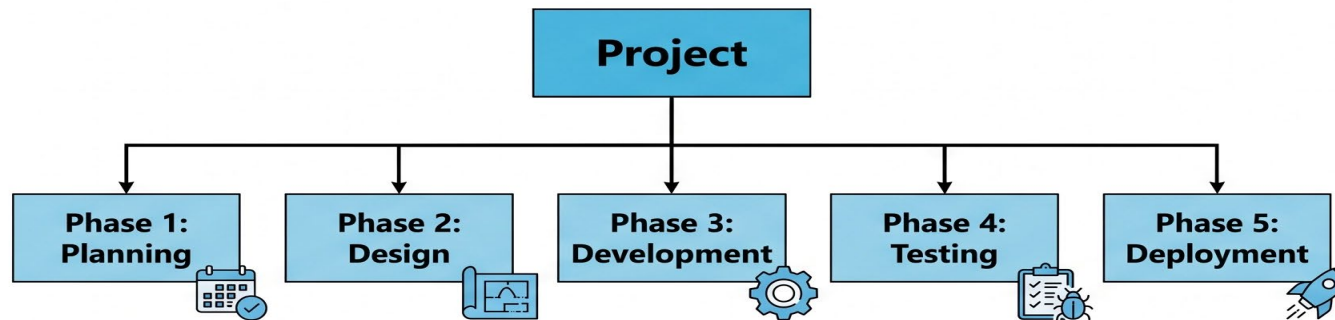
Work Breakdown Structure (WBS)



Imagine building a house. You don't start by building the entire house at once. Instead, you break it down: foundation, walls, roof, electrical, plumbing. Each part is further divided into smaller tasks. This is exactly what WBS does for projects.



Work Breakdown Structure (WBS) is a hierarchical decomposition of the project scope into smaller, manageable components. It breaks down the total project work into deliverables and work packages.



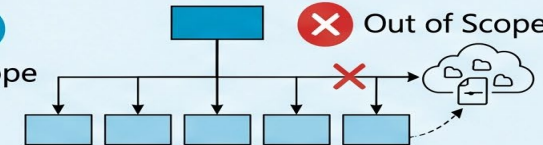
Why It Matters for Scope Monitoring



WBS defines the boundaries of what is included in the project scope. Any work not in the WBS is outside the scope. When monitoring, you compare actual work against the WBS to detect scope creep.



In Scope

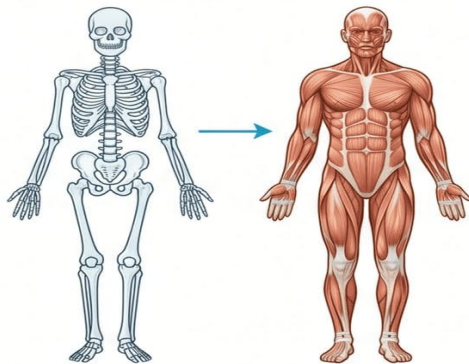


WBS is the foundation of scope monitoring. Without a clear WBS, you cannot effectively monitor whether work is within or outside the agreed scope.

“A well-defined WBS prevents scope creep before it starts.”

The WBS Dictionary: Giving Meaning to Your Project's Structure

From Structure to Clarity



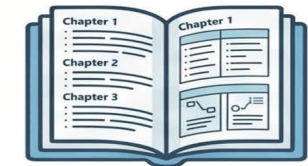
The Skeleton-Tissues-Muscles Analogy

If the WBS is the skeleton of the project that defines its overall shape, then the **WBS Dictionary** is the tissues and muscles that give each bone its meaning and function.

The WBS tells you **WHAT** must be accomplished, but the **WBS Dictionary** tells you **HOW** it must be done and **WHEN** it is considered acceptable. Without the dictionary, the WBS remains just a list of titles—like a book's table of contents without the chapters.

Definition (PMBOK Guide, 6th Edition)

The WBS Dictionary provides detailed **deliverable**, **activity**, and **scheduling** information about each component in the WBS, serving as the definitive reference for what constitutes acceptable completion of each work package.



Why It's Critical



Third Component of Scope Baseline

Completes the scope definition.



Contains Acceptance Criteria

Defines when work is complete and acceptable.



Prevents Ambiguity

Eliminates scope creep through clear descriptions.

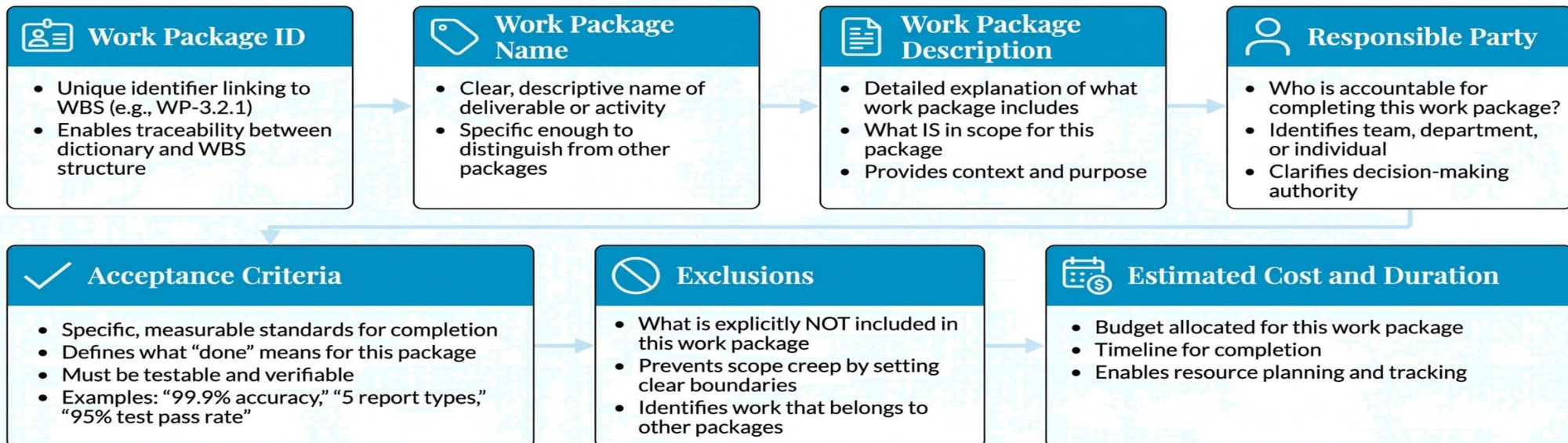
WBS (Structure)

WBS Dictionary (Meaning)

Clear Scope

No guessing. No interpretation. No surprises. Every work package has clear criteria for completion.

The Essential Components of a Work Package Definition Seven Elements That Define Success



Why These Elements Matter

Each element serves a specific purpose in scope monitoring. The description prevents misunderstanding. The acceptance criteria enable verification. The exclusions prevent scope creep. Together, they create an unambiguous definition of what success looks like.

Resolving Scope Disputes: A Real-World ERP Case Study

How the WBS Dictionary Becomes the Source of Truth



Project Context: Implementation of an ERP system for a manufacturing company. During Phase 2, a dispute arose between the development team and the client over whether the Inventory Management module was complete.



The Dispute

CLIENT CLAIM: "The module is incomplete—it doesn't support multi-warehouse management."

DEVELOPMENT TEAM CLAIM: "The module is complete—it meets all requirements."

THE PROBLEM: No clear way to resolve the disagreement.

WBS Dictionary Entry Table	
Element	Details
Work Package ID	WP-3.2.1
Name	Inventory Management Module
Description	Software module for inventory management including: real-time quantity tracking, automatic reorder alerts, and movement reports
Responsible Party	Development Team - Group B
Acceptance Criteria	1. Real-time tracking with 99.9% accuracy 2. Automatic alert at reorder threshold 3. Generate 5 report types 4. Pass 95% of test cases
Exclusions	Does NOT include: multi-warehouse management, barcode integration
Estimated Cost	\$45,000
Estimated Duration	6 weeks



The Resolution

DICTIONARY FINDING: 'Multi-warehouse management' is explicitly listed in the Exclusions section—it is OUTSIDE the scope of this work package.

VERIFICATION: All four acceptance criteria were confirmed as met.

OUTCOME: Module is complete and acceptable. Multi-warehouse management is documented as a separate change request for a future phase with additional cost and schedule.



Dispute



Consult Dictionary



Resolution

Clear criteria in the WBS Dictionary prevents ambiguity and facilitates fact-based resolution.

Bridge Construction: The Challenge

The High Cost of Vague Scope Definitions

The Initial State

In a major infrastructure project for a Lower Structure Steel Bridge, the initial Work Breakdown Structure (WBS) contained high-level deliverables.

One major phase was simply labeled: "**Foundation Work**".

The Problem

"Foundation Work" was interpreted differently by contractors and inspectors.

Unclear boundaries between excavation, concrete pouring, and reinforcement.

Quality standards and acceptance criteria were not explicitly defined.

The Real Impact

Because the scope was vague, the project suffered severe consequences during the foundation phase:

Schedule: 3-month delay in the foundation phase.

Budget: 15% budget overrun on excavation work.

Quality: Rework required on concrete foundations due to unclear specifications.

Communication: Frequent disputes between contractors and quality inspectors.

* Based on academic research: D Nurdiani et al., "Development of work breakdown structure (WBS) dictionary for the construction works of lower structure steel bridge," MATEC Web of Conferences, 2019.

WBS Dictionary Solution in Action

Decomposing "Foundation Work" into Actionable Packages

The Project Manager resolved the ambiguity by creating detailed WBS Dictionary entries for each specific task within the foundation phase.

Component	WP-2.2.1: Excavation for Pier #1	WP-2.2.2: Concrete Foundation Mat
Description	Excavation to 15m depth, site leveling. Total volume: 2,500 cubic meters.	Installation of reinforced concrete mat (20x20x2m). Volume: 800 cubic meters.
Owner	Site Supervisor (Excavation Contractor)	Concrete Foreman (Concrete Contractor)
Quality Standards	Depth tolerance: $\pm 0.5\text{m}$ Soil bearing capacity: $\geq 250\text{ kPa}$	Compressive strength: 30 MPa Rebar placement tolerance: $\pm 25\text{ mm}$
Acceptance Criteria	Surveyor confirms depth/flatness Soil testing report verifies 250 kPa	Cube testing shows $\geq 30\text{ MPa}$ Structural engineer approves foundation
Constraints & Dependencies	Must complete before monsoon season.	Dependent on WP-2.2.1 completion. Concrete poured continuously.

Results and Key Lessons

The Strategic Value of Detailed Scope Definition

Measurable Results

Metric	Before WBS Dictionary	After Implementation
Schedule	3-month delay	On schedule
Budget	+15% overrun	2% under budget
Rework Rate	8% of work	0% (Zero rework)
Quality Disputes	12 disputes	2 disputes (83% drop)
Change Orders	18 change orders	3 change orders

Key Lessons Learned

1. Clarity Prevents Disputes

Explicit definitions for depth, concrete specifications, and quality standards eliminated ambiguity between the contractor and the inspector.

2. Quality is Built-In

By setting objective acceptance criteria (e.g., 30 MPa compressive strength verified by cube testing), quality was assured from the start, preventing costly rework.

3. Strict Dependency Management

The dictionary clearly linked work packages (Concrete Foundation strictly depends on Excavation completion), preventing premature starts and out-of-sequence work.



Creating and Using the WBS Dictionary Effectively

Best Practices for Scope Clarity

- **1. Create the Dictionary During Planning -** ✓
Develop concurrently with WBS, not after
- **2. Make Acceptance Criteria Specific and Measurable -** ✓
Use quantifiable metrics, not vague language
- **3. Clearly Define Exclusions -** ✓
Set boundaries to prevent scope creep
- **4. Link Dictionary to Verification Methods -** ✓
Know how each criterion will be tested
- **5. Update Dictionary During Changes -** ✓
Keep it current as project evolves



Common Pitfalls to Avoid:

- Creating a dictionary but not using it
- Vague acceptance criteria like “complete” or “finished”
- Ignoring exclusions and inviting scope creep
- Not involving stakeholders in defining criteria
- Treating dictionary as static instead of evolving

When to Escalate:

- Acceptance criteria cannot be objectively verified
- Stakeholders disagree on what constitutes “done”
- Work packages have overlapping descriptions
- Exclusions are unclear or disputed
- Team members interpret criteria differently

“A well-crafted WBS Dictionary prevents disputes, enables objective verification, and protects both the project team and the client.”

The Change Control System: Your Project's Court of Justice

Formal Process, Informed Decisions



The Court Analogy: In courts, no judge can issue a ruling based solely on a verbal claim. There must be a written case file, documented evidence, formal arguments, and a reasoned decision. Why? Because important decisions require an organized process that ensures justice, transparency, and accountability. The **Change Control System** is the project's court: no scope change is permitted without going through a formal process of documentation, analysis, review, and approval.



Definition (PMBOK Guide, 6th Edition): A Change Control System is a set of formal, documented procedures that define how project deliverables and documentation are controlled, changed, and approved. It includes change request forms, approval processes, and authorization levels.



- **Prevents Scope Creep** - Stops informal, undocumented changes
- **Ensures Accountability** - Every change is recorded and justified
- **Enables Informed Decisions** - Impact analysis before approval
- **Protects the Project** - Prevents budget and schedule overruns

The Process Ensures

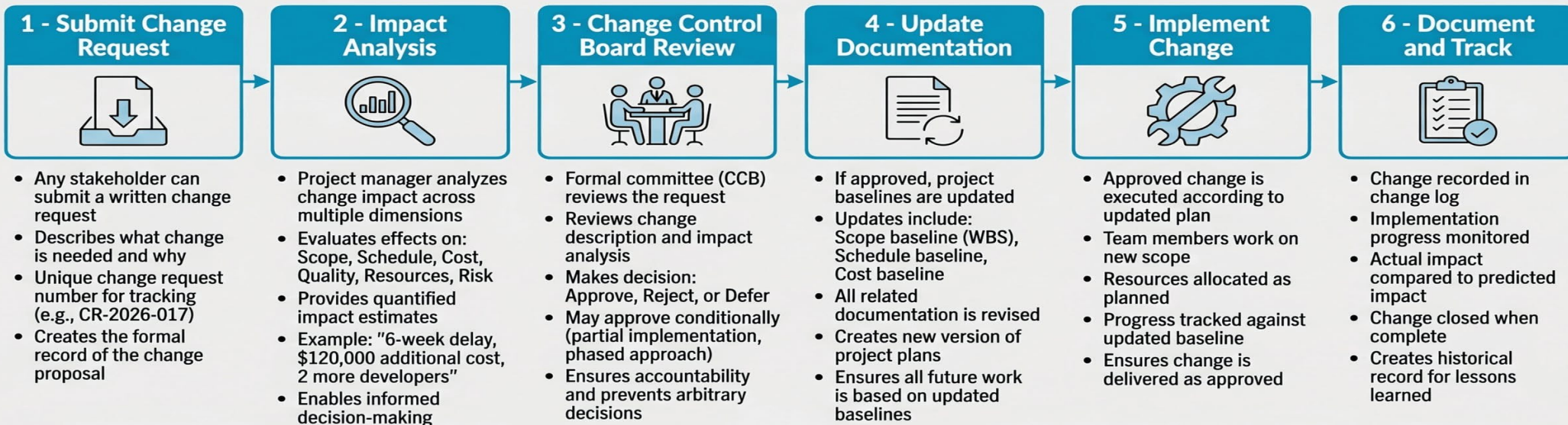
Documentation • Analysis • Review • Approval • Tracking

No informal changes. No hidden scope additions. No surprises.
Every change is documented, analyzed, approved, and tracked.



From Request to Implementation: The Six-Step Change Control Process

Each Step Protects the Project



Why This Structure Matters

Each step filters out unnecessary changes and ensures necessary ones are properly managed.

A change that seems small in Step 1 might reveal major impacts in Step 2, leading to deferral or rejection. A change that passes analysis might be rejected by the CCB due to strategic concerns. This multi-layer approach prevents poor decisions.

Managing Scope Changes: An ERP Implementation Case Study

From Request to Implementation: A Real-World Example



Project Context: Development of an ERP system for a food manufacturing company. In month 4, the Commercial Director requested adding a CRM (Customer Relationship Management) module to the system.



Step 1: Change Request Submission	
Element	Details
Change Request Number	CR-2026-017
Submitted By	Commercial Director
Date	April 15, 2026
Change Description	Add CRM module: customer data management, sales tracking, business performance reports
Business Justification	Company losing customers due to lack of organized follow-up system



Step 2: Impact Analysis	
Dimension	Expected Impact
Scope	Add 8 new work packages to WBS
Schedule	Extend project by 6 weeks
Cost	Increase budget by \$120,000
Resources	Need 2 additional developers
Quality	No negative impact expected
Risk	Potential delay in other modules if resources diverted



Step 3: Change Control Board Decision
After reviewing the analysis, the CCB made a CONDITIONAL APPROVAL :
- Implement simplified CRM module (customer data management and basic reports only) - Cost: \$75,000 (instead of \$120,000) - Schedule extension: 4 weeks (instead of 6 weeks) - Advanced features deferred to Phase 2



Step 4: Documentation Update

WBS updated with 5 new work packages • Schedule extended by 4 weeks • Budget increased by \$75,000

WITHOUT the Change Control System:

- Informal addition to scope
- Unplanned resource allocation
- Schedule and budget overruns
- Team conflicts and unclear priorities

WITH the Change Control System:

- Properly analyzed and approved
- Integrated into project plans
- Tracked and monitored
- Documented for future reference

Commercial Building: The Challenge

The High Cost of Uncontrolled Changes in Construction

Project Context

A multi-story commercial office building project in Taiwan faced severe issues due to a lack of formal change management.

The Core Problems

Informal Communication: Changes were requested verbally or via informal emails.

Information Silos: Architects made design changes without notifying subcontractors.

No Single Source of Truth: Suppliers ordered materials based on outdated specifications.

Real-World Impacts

The lack of a Change Control System led to:

Schedule Delays: A structural change was approved but not communicated to the excavation team, resulting in 2 weeks of rework.

Cost Overruns: Electrical subs ordered materials on old specs, requiring emergency reordering at a 20% premium cost.

Quality Disputes: Finishing teams used original materials instead of architect's undocumented updates.

* Based on academic research: Chen, C. S., et al. "Application of project-based change management in construction: a case study." *Journal of Civil Engineering and Management*, 2013.

Change Control Process: 5 Steps

The Web Project-Based Change Management (WPCM) Workflow

1**Change Request Submission**

Any participant submits a formal request via the portal detailing the change, reason, and estimated impacts.

**2****Impact Analysis**

The team analyzes the change's full impact on Scope, Schedule, Cost, Quality, Safety, and Risk.

**3****Change Control Board (CCB) Review**

The CCB (PM, Architect, Owner) reviews the analysis and decides to Approve, Reject, or Modify.

4**Communication & Implementation**

Formal Change Order is issued. Real-time notifications alert all affected parties to update plans and specs.

**5****Monitoring & Documentation**

Track actual vs. estimated impacts. All documents are stored in the system for future reference.

Real Example: Electrical Wiring Upgrade

Change Request: CHG-2024-047

1. The Request

Description: Upgrade wiring from standard (2.5mm²) to premium (4mm²) to meet international standards.

Requester: Electrical Subcontractor

2. Impact Analysis

Cost Impact: +NT\$530,000 (Material & Labor)

Schedule Impact: +10 days (Procurement & Installation)

Risk: Potential delay to structural work. Mitigation: Coordinate schedules.

3. CCB Decision

Status: **APPROVED (with conditions)**

Conditions: Supplier delivery must be confirmed by March 25.
No further cost overruns permitted.

4. Implementation

Action: Formal Change Order (CO-2024-047) issued.

Communication: Real-time WPCM portal notification sent to Electrical and Structural subs.

Tracking: Actual cost was NT\$497,000 (under budget).
Documented in system.

Results and Key Lessons

The Impact of Implementing a Change Control System

Measurable Results

70%

Faster Approval Time

84%

Reduction in Uncontrolled Changes

29%

Reduction in Cost Overruns

60%

Reduction in Schedule Delays

Key Lessons Learned



Centralization is Critical

A single source of truth eliminates silos and prevents miscommunication among stakeholders.



Standardization Reduces Delays

A clear 5-step process provides clarity and significantly speeds up decision-making.



Impact Analysis Prevents Surprises

Evaluating scope, schedule, and cost before approval prevents unexpected consequences.



Real-Time Communication

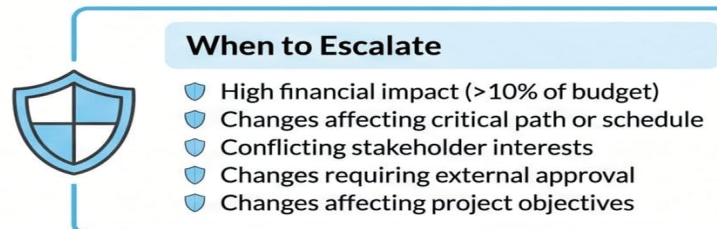
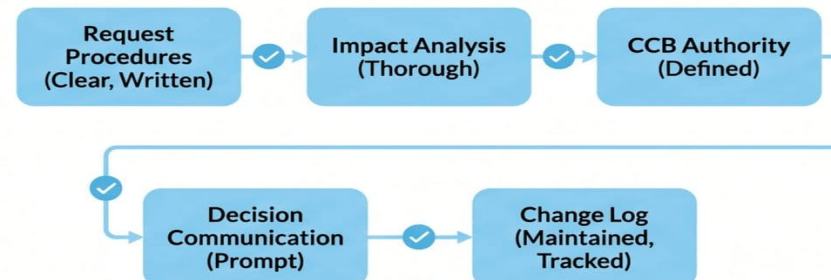
Automated notifications ensure all affected parties can coordinate their work effectively.



Making the Change Control System Work Effectively

Best Practices for Scope Protection

1. **Establish Clear Change Request Procedures** - Define who can submit, create standard forms, ensure written documentation
2. **Define Change Control Board Authority** - Identify CCB members, clarify decision-making authority, establish escalation paths
3. **Perform Thorough Impact Analysis** - Analyze across all dimensions: scope, schedule, cost, quality, risk, resources
4. **Communicate Decisions Promptly** - Inform stakeholders immediately, explain reasoning, update plans without delay
5. **Maintain a Change Log** - Record all requests, track status, document rationale, enable trend analysis



⚠ Common Pitfalls to Avoid

- ✗ Bypassing the system with informal changes
- ✗ Vague impact analysis without specific data
- ✗ Slow decision-making that frustrates stakeholders
- ✗ Changes approved but not communicated
- ✗ Inconsistent application of the system
- ✗ No tracking of actual vs. predicted impact

Red Flags for Scope Creep ⚠

- ✗ Increasing number of change requests over time
- ✗ Changes consistently approved without rejection
- ✗ Actual schedule/budget diverging from baseline
- ✗ Team working on undocumented scope
- ✗ Stakeholders requesting 'quick additions' outside the system

"The Change Control System is not bureaucracy—it's protection. It protects the project, the team, and the stakeholders."

“

"Flexibility in projects is **required,
but flexibility without discipline
is a guaranteed recipe for **chaos**."**

”

THE VALUE OF SCOPE MONITORING



Thank You