

PROJECT MONITORING

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PMG333

Lecture 08

COST& TIME MONITORING 1

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1. Scope Decomposition
2. Assign Responsibilities
3. Schedule Work
4. Develop Time-phased Budget
5. Assign Performance Metrics
6. Establish PMB
7. Authorize & Execute Work
8. Data Collection
9. Performance Analysis

ISO 21508

EARNED VALUE MANAGEMENT IN PROJECT MANAGEMENT

Introduction & Definition

- ▶ ISO 21508:2018 is a key international standard providing guidelines for **Earned Value Management** (EVM) practices.
- ▶ EVM is a project management methodology used to measure project performance and progress **objectively**.
- ▶ It integrates **scope, schedule, and cost** into a single measurement system.
- ▶ EVM links completed work (**Earned Value**) with planned and actual costs, providing deep insights into project health.

Universal Framework for EVM

Universal Framework & Concepts

- › Provides a general framework applicable to any organization, regardless of size or complexity.
- › Establishes unified concepts and principles for **Earned Value Management** (EVM).

Implementation & Forecasting

- › Defines responsibilities and processes necessary for implementing an effective EVM system.
- › Provides performance indicators to help forecast final project outcomes (cost and time).

ISO 21508:2018 Guidelines

- 1 Scope Decomposition:** Use **Work Breakdown Structure (WBS)** to define all required work.
- 2 Assign Responsibilities:** Identify persons or teams for each **Work Package**.
- 3 Schedule Work:** Develop a timeline for executing each part of the work.

- 4 Develop Time-phased Budget:** Distribute the budget across the project schedule.
- 5 Assign Performance Metrics:** Determine how to measure progress (e.g., **% complete, milestones**).
- 6 Establish PMB:** Approve the **Performance Measurement Baseline** integrating scope, time, and cost.

Step 7: Authorize & Execute Work - Begin actual task execution based on the baseline.

Step 8: Data Collection - Record actual costs and work progress.

Step 9: Performance Analysis - Compare Earned Value with Planned Value and Actual Costs.

Step 10: Management Action - Take corrective actions based on discovered variances.

Step 11: Baseline Maintenance - Update the baseline for approved scope or budget changes.

The Cornerstone of Cost and Time Monitoring

- Reference: ISO 21508:2018 - Clause 5.2
- This step is the cornerstone of cost and time monitoring; without a **comprehensive and precise definition** of what must be accomplished, performance cannot be measured.
- According to the standard, this step aims to break down the total work into **smaller, manageable, and measurable elements**.

Work Breakdown Structure & The 100% Rule

- The standard requires breaking down the entire scope of work into logical parts called a **Work Breakdown Structure** (WBS).
- WBS is not just a list of tasks; it is a hierarchical structure focused on deliverables.
- The **100% Rule**: The WBS must include 100% of the work defined in the project scope and capture all deliverables.
- The sum of the work at the lowest levels must exactly equal 100% of the work at the highest level.

ISO 21508 Requirements for Cost & Time Monitoring



Hierarchical

Starts from the project as a whole and **descends** to detailed levels.



Deliverable-Focused

Breakdown is based on what will be delivered (**results, products, services**), not just activities.



Unique Elements

Each WBS element must be **distinct** to **avoid duplication** of work or cost accounting.



Roll-up Capability

The structure must allow **aggregation** of cost and schedule data from lower to upper levels for **comprehensive management reporting**.

The Foundation of Estimation and Measurement

Work Packages (Lowest WBS Level)

- The level where costs are accurately estimated, schedule is defined, and Earned Value (EV) is measured.

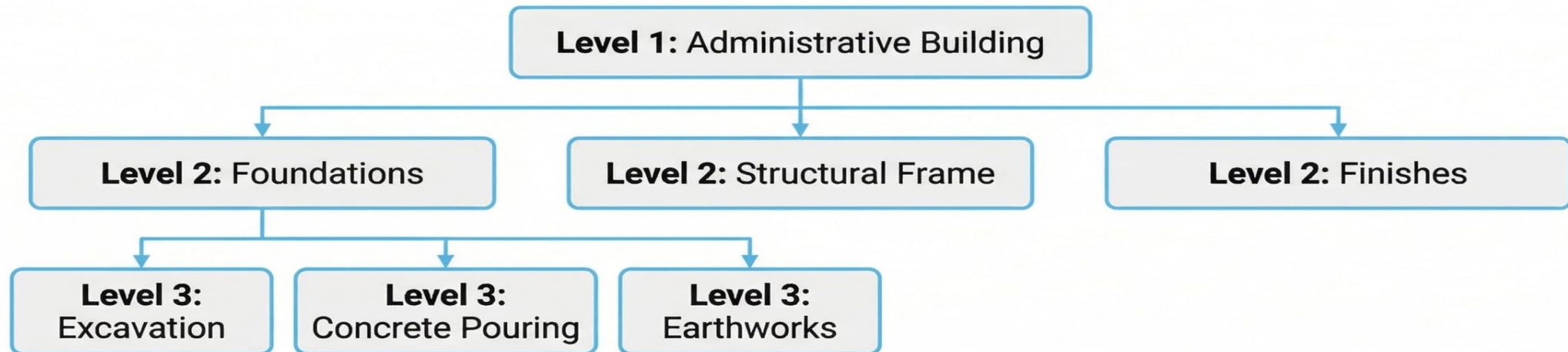
Practical Tip: Duration should ideally be between 1 to 2 reporting cycles (e.g., 2 weeks to a month) to balance monitoring ease and administrative burden.

WBS Dictionary

- A tree diagram is not enough; the standard requires a WBS Dictionary.
- Provides detailed descriptions for each element, including:
 - Description of required work and associated deliverables.
 - Acceptance Criteria.
 - Estimated resources.

Administrative Building (Construction Sector)

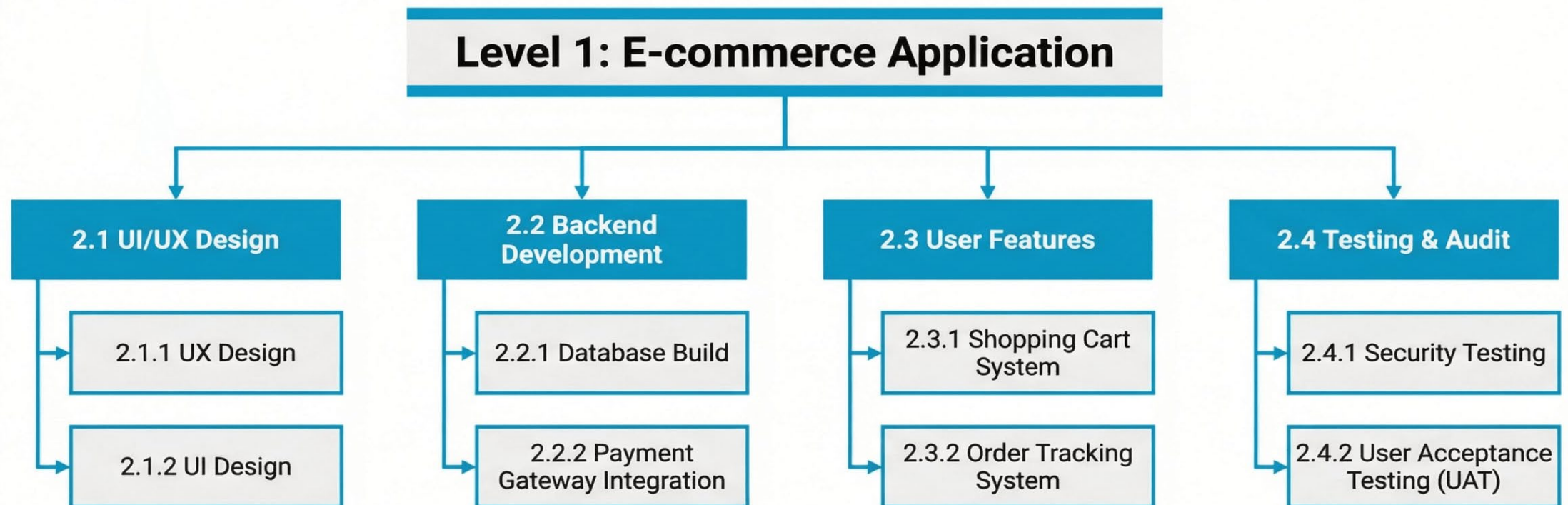
- Decomposing scope based on physical deliverables.



Monitoring Note:

We can measure 'Earned Value' for each floor separately. This makes it easier to identify if a delay in the 'Structural Frame' will impact the 'Finishes'.

Detailed Work Breakdown Structure (WBS)



🔑 **Decomposition Strategy**

Decomposition based on **product lifecycle phases** or features.

• **Applying the 100% Rule**

If a task like “**Security Testing**” is forgotten, the WBS does not represent 100% of the scope.

🔑 **Consequence of Omissions**

Cost monitoring reports will be **misleading** because funds will be spent on **unplanned** activities.

 Definition:

Assigning clear responsibility for each work package to specific individuals or organizational units.

 Purpose:

Ensures accountability, enables accurate performance tracking, and facilitates corrective actions.

 Connection:

Links 'What needs to be done' (WBS) with 'Who will do it' (OBS).

 ISO 21508:2018 Requirement:

Cornerstone of an effective project performance monitoring system.

 Outcome:

Foundation for Cost & Time Monitoring.

■ KEY GUIDELINES

- **1. Performance Responsibility:**
Assign for each WBS element.
- **2. Project-Wide Responsibility:**
Assign comprehensive responsibility (Project Manager).
- **3. Clarity & Definition:** Ensure responsibilities are clearly defined.
- **4. Organizational Structure Link:**
Link to OBS.
- **5. Control Accounts:**
Intersection points of WBS and OBS.

■ CONTROL ACCOUNT DEFINITION

- Single management point integrating scope, cost, and schedule.
- Assigned to one Control Account Manager (CAM).
- Lowest level intersection of WBS and OBS.

Project - Responsibility Assignment

WBS Structure:

- 1.0 Program Development
 - 1.1 Frontend Design
 - 1.2 Backend Development

OBS Structure:

- Project Manager
 - Frontend Team
 - Backend Team

Control Accounts:

- CA-1: Frontend Design -> Assigned to Frontend Team Lead
- CA-2: Backend Development -> Assigned to Backend Team Lead

RAM Matrix Concept:

- Project Manager is Accountable (A) for overall results, while Team Leads are Responsible (R) for execution.

- **Definition:** Establishing a timeline for all project activities and milestones.
- **Purpose:** Converts abstract plans into time-bound, executable schedules.
- **The Schedule as a Driver:** Distributes budget over time, enabling performance measurement at any point.
- **ISO 21508:2018 Requirement:** Essential component of the EVM system.
- **Foundation for Monitoring:** Enables Cost & Time Monitoring.

Key Guidelines

1. **Activity Definition:** Identify at Work Package level.
2. **Milestone Identification:** Define key checkpoints.
3. **Activity Sequencing:** Arrange in logical order.
4. **Interdependency Definition:** Establish relationships.
5. **Performance Indicators:** Use objective measures.

Core Components

- **Activities:** Smallest units of work.
- **Durations:** Estimated time required.
- **Logical Relationships:** How activities depend on each other.
- **Resources:** People and equipment needed.
- **Calendars:** Work days and holidays.

Activities, Durations & Dependencies:

- A: Excavate foundation (3 days)
- B: Pour concrete foundation (2 days, depends on A)
- C: Install wall reinforcement (4 days, depends on B)
- D: Pour wall concrete (2 days, depends on C)
- E: Backfill and landscaping (3 days, depends on D)

Key Milestones:

- M1: Foundation completion (after B)
- M2: Final wall delivery (after E)

How This Schedule Serves EVM:

- **Planned Value:** Distributes budget over time (e.g., \$1,000/day).
- **Performance Measurement:** Compares actual progress against schedule.
- **Critical Path:** A->B->C->D->E (14 days total).

Definition: Integrating approved budgets with the project schedule to create a time-distributed budget.

• **Purpose:** Establishes the baseline for performance measurement (Planned Value - PV).

The 'When' of Spending: Answers the critical question: 'When will we spend the money?'

• **ISO 21508:2018 Requirement:** Essential for calculating performance metrics.

• **Foundation for EVM:** Without time-phasing, EVM cannot function effectively.

Budget Distribution by Activity

- A: Excavate (3 days, \$3,000) -> **\$1,000/day**
- B: Pour concrete (2 days, \$2,000) -> **\$1,000/day**
- C: Install reinforcement (4 days, \$4,000) -> **\$1,000/day**
- D: Pour wall concrete (2 days, \$3,000) -> **\$1,500/day**
- E: Backfill (3 days, \$1,500) -> **\$500/day**

Total: 14 days, \$13,500

Cumulative PV Calculation

- Day 1: \$1,000
- Day 5: \$5,000
- Day 14: \$13,500 (S-Curve representation)

- Definition: Establishing objective rules to convert physical work completion into **Earned Value (EV)**.
- Purpose: Enables objective **measurement** of project progress based on **facts**, not subjective estimates.
- Core Principle: "What gets measured gets managed" – metrics provide **accountability** and **consistency**.
- Without Metrics: Progress assessment becomes subjective personal opinion, leading to inaccurate results.
- **ISO 21508:2018 Requirement**: Performance metrics must be defined before work begins and remain consistent throughout.

Key Guidelines

1. Expression of Completion: Expressed in budget or EV.
2. Quantitative Measurement: Use objective metrics.
3. Value Equality: $EV = BAC$ at completion.
4. Pre-Agreement: Agree before work begins.
5. Consistency: Plan and evaluate using the same method.
6. One Metric: One metric per work package.

Common EV Techniques

- 0/100 Rule: Very short activities (< 1 month).
- 50/50 Rule: Short activities (1-2 months).
- Physical % Complete: Measurable units (e.g., m³).
- Weighted Milestones: Long activities (> 3 months).
- Level of Effort (LOE): Support activities.

Practical Example: Assigning Metrics to Retaining Wall

Activity-by-Activity Metric Assignment:

- A: Excavation (\$3,000) → Physical % Complete (Measurable in m³)
- B: Foundation Concrete (\$2,000) → 0/100 Rule (Very short activity)
- C: Wall Reinforcement (\$4,000) → Weighted Milestones (Long activity)
- D: Wall Concrete (\$3,000) → 50/50 Rule (Short activity)
- E: Backfill & Landscaping (\$1,500) → Physical % Complete

Practical Application (End of Week 1):

- Activity A (50% complete):
 $EV = \$3,000 \times 50\% = \$1,500$
- Activity B (Not started):
 $EV = \$0$
- Total EV = \$1,500
- Planned Value (PV) = \$4,000
- Schedule Variance (SV) = EV - PV = -\$2,500 (Behind schedule)

Lecture 08

Step 6: Establish PMB (Performance Management Baselines)

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Creekwood Construction

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ALL	TASK NAME	WBS	PLANNED START ...	PLANNED RESOURCE COST	PLANNED HOURS
1	📁 Contracts	1	1/23/2023	\$945.00	10.5 hours
2	Proposals	1.1	1/23/2023	\$540.00	6 hours
3	Documents Review	1.2	1/24/2023	\$360.00	4 hours
4	Bid Date	1.3	1/26/2023	\$45.00	0.5 hours
5	Award Date	1.4	1/27/2023		
6	📁 Design	2	1/30/2023	\$2,560.00	32 hours
7	Feasibility Study	2.1	1/30/2023	\$640.00	8 hours
8	Apply for Permits	2.2	2/3/2023	\$320.00	4 hours
9	Start Design Work	2.3	2/7/2023	\$960.00	12 hours

JAN, 22 '23

JAN, 29 '23

FEB, 5 '23

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Contracts 90%

Proposals 50% Mike Smith (Sample)

Documents Review 100% Mike Smith (S...

Bid Date 100% Mike Smith (Sample)

1/27/2023

Feasibility Study 25%

Apply for Permits

Task Info

hide task info

GENERAL

LINKS

PEOPLE

DEPENDENCIES

+

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Name: Start Design Work

Percentage complete: 100%

Priority: Medium

Planned Start: 2/7/2023

Due: 2/15/2023

Duration: 7 days

Hours: 12 hours

Cost: \$500.00

Actual Start: 2/8/2023

Finish: 2/15/2023

Duration: 6 days

Hours: 13 hours

Cost: \$700.00

Baseline Start:

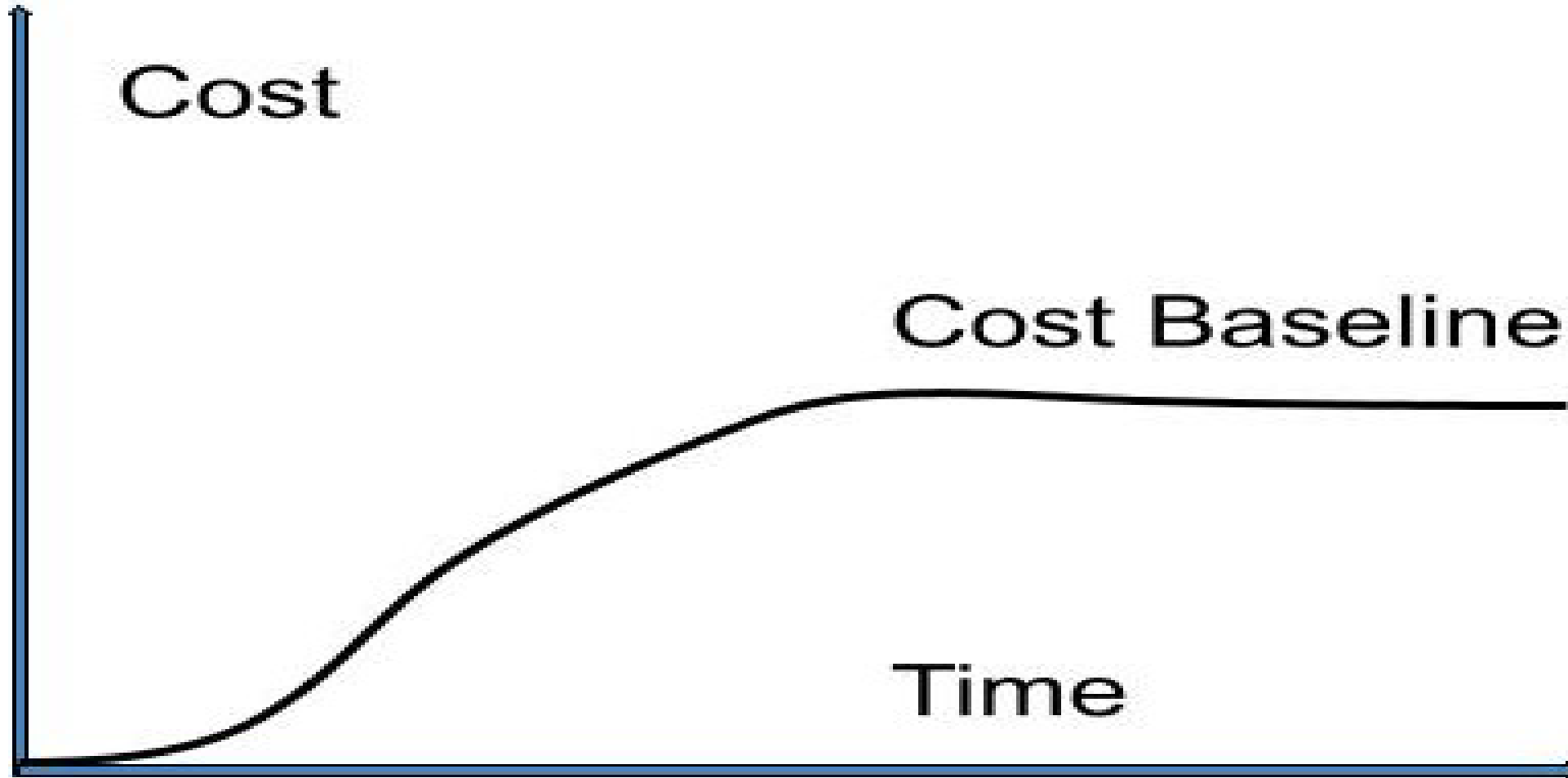
Finish:

Duration:

Hours:

☐ Locked ⓘ

☐ Milestone

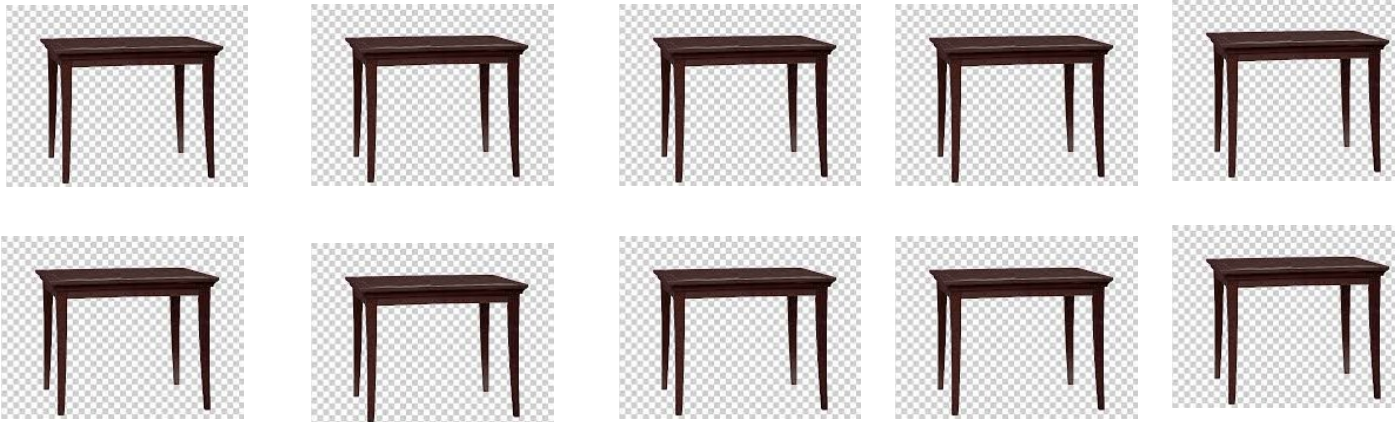


- Begin actual task execution strictly based on the established **Performance Measurement Baseline (PMB)**.
- Ensure all work is **formally authorized** before resources are committed or costs are incurred.
- Maintain strict alignment between the executed work and the approved **Work Breakdown Structure (WBS)**.
- Establish clear communication channels to ensure all team members understand their **authorized tasks**.

- Systematically record **actual costs (AC)** and **physical work progress (EV)** at regular intervals.
- Ensure data collection methods align perfectly with the **predefined performance metrics** (Step 5).
- Maintain **data integrity and accuracy** to enable reliable performance analysis in subsequent steps.
- Integrate cost and schedule data collection to provide a **unified view of project health**.

Mastering Earned Value Management

The requirement is to deliver ten tables in ten days at a cost of one thousand per table



As a result, one table is delivered daily at a unit cost of one thousand

By day four, the planned completion is four tables at a cost of 4,000



However, upon reviewing the actual progress on day four, three tables had been completed at a cost of 5,000

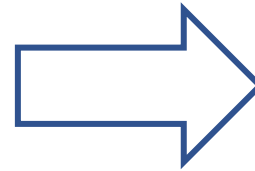


Budget Cost of
Work
Performed
(BCWP)=3000

Budget Cost
of Work
Schedule
(BCWS)=
4000

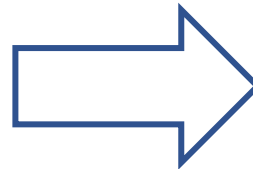
Actual Cost
of Work
Performed
(ACWP)=
5000

Schedule Variance (SV)
= BCWP-BCWS
= 3000-4000=-1000<0



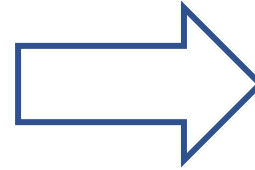
behind schedule

- Cost Variance (CV)
= BCWP-ACWP
= 3000- 5000= -2000<0



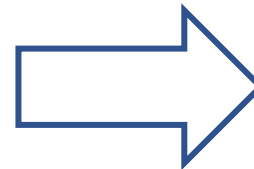
over budget

- Schedule performance Index (SPI)
= $BCWP / BCWS$
= $3000 / 4000 = 0.75 < 1$



behind schedule

- Cost performance Index (CPI)
= $BCWP / ACWP$
= $3000 / 5000 = 0.6 < 1$



over budget

Estimated Final Time (EFT)

$$\text{EFT} = \text{TAC} / \text{SPI}$$

$$\text{EFT} = 10 / 0.75 = 13.33 = 14$$

Estimated Cost At Completion (EAC)

$$EAC = BAC / CPI$$

Estimated)EAC = $10000 / 0.6 = 16667$ •
(at complete

$$EAC = ACWP + \text{Original Remaining Budget}$$

Estimated To Complete (ETC)

(estimated to complete)ETC = EAC – ACWP

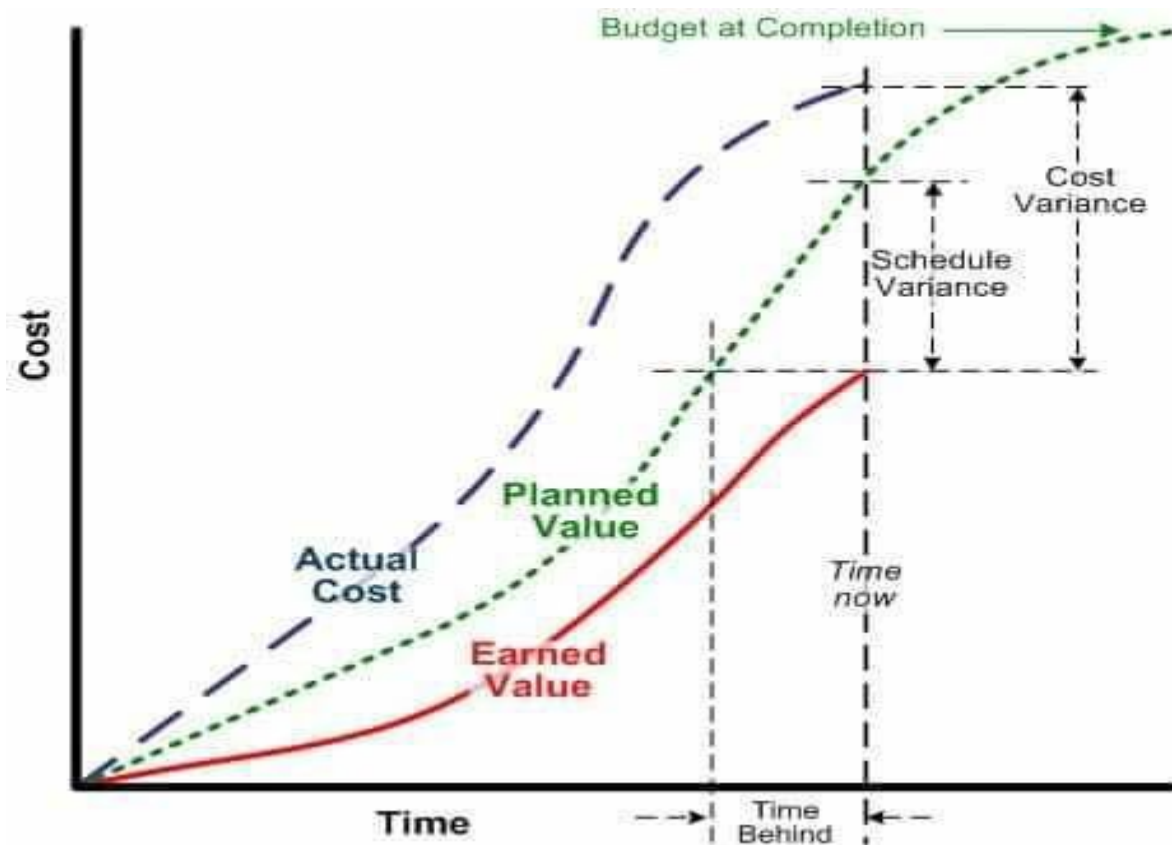
$$\text{ETC} = 16667 - 5000 = 11667$$

Variance At Completion (VAC)

$$\text{VAC} = \text{BAC} - \text{EAC}$$

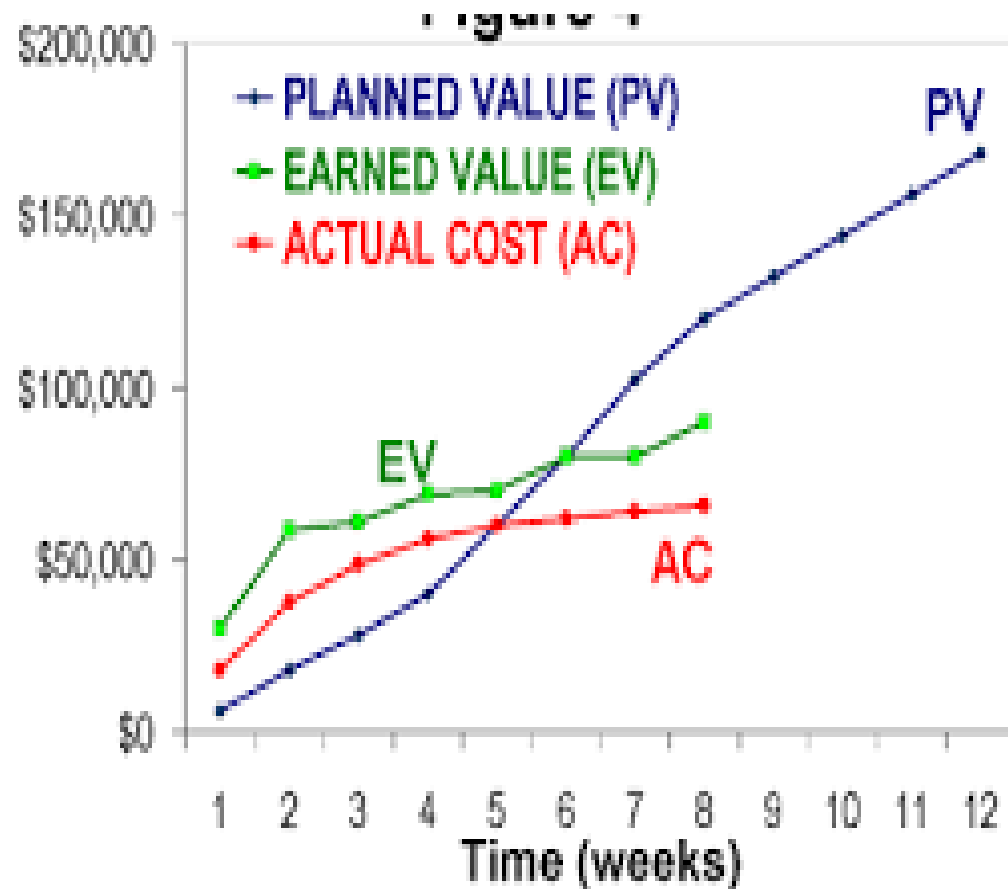
$$\text{VAC} = 10000 - 16667 = -6667$$

Variance At Completion= Budget Cost At Completion - Estimated Cost At Completion



In the adjacent graph, we observe that the curve representing the **Earned Value** (in red) lies below the curve representing the **Planned Value**. Consequently, the **Schedule Variance (SV)** value will be negative, indicating that the project is **behind schedule**."

"Similarly, we observe that the curve representing the **Earned Value** (in red) lies below the curve representing the **Actual Cost**. Consequently, the **Cost Variance (CV)** value will be negative, which means the project is **over budget** based on the current performance



In the adjacent chart, we observe that until **week six**, the curve representing the **Earned Value** was higher than the curve representing the **Planned Value**. Therefore, the schedule variance was positive, and the project was **ahead of schedule**. However, starting from the sixth week, the **Earned Value** curve fell below the **Planned Value**. Consequently, schedule performance declined, the schedule variance became negative, and a delay relative to the planned value will occur."

"Throughout the entire duration of the project, the curve representing the **Earned Value** remained higher than the curve representing the **Actual Cost**. Therefore, the **cost performance is excellent**, and the project will be completed **under the contractual budget**

Thank You