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Essential Calculations Handbook

For PMP®, PBA®, and CBAP® Exam

Collector: **Aboozar Kordi**, CBPP®, CPCM®, CBAP®, CBDA®, AAC®, CPOA®, CCA®, PBA®, ACP®, PMP®

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📄 Introduction

Essential Calculations Handbook: For PMP®, PBA®, and CBAP® Exam

In today's fast-paced project environment, mastering theoretical frameworks is not enough. **Success in project management**, whether predictive, adaptive, or hybrid, requires a strong command of **practical calculations and financial reasoning**.

This handbook is designed as a **focused, no-fluff guide** to the essential mathematical and analytical tools you need to **pass the PMP®, PBA®, and CBAP® exams with confidence**, and to apply those skills effectively in real-world project work.

🎯 Why This Book Matters

Many candidates struggle with:

- Memorizing formulas without context
- Applying calculations to exam questions
- Translating math into decision-making

This book tackles those challenges head-on by: ✅ Explaining each formula clearly
✅ Providing real exam-style examples
✅ Showing when and why to use each calculation
✅ Comparing tools like NPV, IRR, Float, Earned Value, and more
✅ Covering both **predictive** and **agile/hybrid** project environments

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👥 Who Should Use This Book?

- Aspiring **PMP®** professionals needing to master Earned Value, Risk Quantification, and Procurement
- **Business analysts (PBA®, CBAP®)** preparing for role-based calculations like opportunity cost, cost-benefit analysis, and decision trees
- Project managers working in **hybrid** setups who need to blend Agile metrics with traditional forecasting
- Anyone seeking a **quick-reference** math toolkit that goes beyond theory

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📊 What You'll Learn

- Project selection metrics: NPV, IRR, ROI
- Decision analysis & weighted scoring
- Agile forecasting using velocity
- Stakeholder communication paths
- Earned Value and critical path analysis
- Procurement calculations like PTA
- Risk evaluation through decision trees
- Hybrid budgeting and forecasting formulas

By the end of this guide, you won't just "know the formula" — you'll understand the **why, when, and how** behind every key calculation that can influence your project's outcome.

Let's get started.

🕮 Chapter 1: Financial Calculations

Chapter 1: Financial Calculations, covering:

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Return on Investment (ROI)
- Payback Period
- Total Cost of Ownership (TCO)

◆ 1. Net Present Value (NPV)

Definition: NPV is the present value of cash inflows minus the present value of cash outflows over a time period.

Formula:

$$NPV = \sum \left(\frac{R_t}{(1+r)^t} \right) - C_0$$

Where:

- R_t = net cash inflow during period t
- r = discount rate (cost of capital)
- t = time period
- C_0 = initial investment

Interpretation:

- **NPV > 0** → Profitable project
- **NPV < 0** → Loss-making project
- **NPV = 0** → Break-even

Example:
Initial investment: $10,000
Cash inflows: $4,000 per year for 3 years
Discount rate: 10%

NPV= $\frac{4000}{1.1} + \frac{4000}{1.1^2} + \frac{4000}{1.1^3}$ **-10000=3,636.36+3,305.79+3,005.26-10,000=-52.59**

◆ 2. Internal Rate of Return (IRR)

Definition: IRR is the discount rate that makes the NPV of a project equal to zero.

Formula:
There's no direct formula – it's typically found via trial and error or a financial calculator.

$$\mathbf{0} = \sum \left(\frac{R_t}{(1 + IRR)^t} \right) - C_0$$

Interpretation:

- Compare IRR to required rate of return
- **IRR > required return** → Accept project
- **IRR < required return** → Reject project

Example Concept:
If an investment of $5,000 returns $1,500 annually for 4 years, solve for IRR where NPV = 0.

◆ 3. Return on Investment (ROI)

Definition: ROI measures the gain or loss relative to the original investment.

Formula:

$$\boldsymbol{ROI = \frac{Net\ Profit - Cost}{Cost} * 100}$$

Example:
Cost: $20,000
Total returns: $26,000

$$\boldsymbol{ROI = \frac{26000 - 20000}{2000} * 100 = 30\%}$$

◆ 4. Payback Period

Definition: The time required to recover the initial investment from the net cash inflows.

Formula (Simple):

$$\boldsymbol{Payback\ Period = \frac{Initial\ Investment}{Annual\ Cash\ inflow}}$$

Example:
Investment: $8,000
Annual savings: $2,000

$$\boldsymbol{Payback\ Period = \frac{8000}{2000} = 4}$$

Note: Doesn't consider the time value of money.

◆ 5. Total Cost of Ownership (TCO)

Definition: The total cost of a system across its lifecycle, including purchase, operations, maintenance, and disposal.

Formula (General):

$$\boldsymbol{TCO = Initial\ Cost + Operating\ Costs + Support/Maintenance\ Costs + End\text{-}of\text{-}life\ Costs}$$

Example:

- Purchase: $50,000
- Operating over 5 years: $5,000/year
- Maintenance: $2,000/year
- Disposal: $3,000

$$TCO = 50{,}000 + (5{,}000 + 2{,}000) \times 5 + 3{,}000 = 88{,}000$$

✅ Quick Comparison Table

Concept	Measures	Time Value Considered	Good if...
NPV	Value created	✅ Yes	NPV > 0
IRR	Rate of return	✅ Yes	IRR > required rate
ROI	Profitability	❌ No	ROI is positive and high
Payback Period	Breakeven point	❌ No	Shorter is better
TCO	Lifetime cost	❌ No	Lower is better

📊 Financial Metrics: Comparison Guide

Metric	What It Measures	Better Value Means	Used For	Exam Tip
NPV (Net Present Value)	Value created after accounting for time value of money	Higher NPV = more financially attractive project	Project selection, portfolio analysis	Always choose project with the **highest positive NPV**
IRR (Internal Rate of Return)	Rate at which NPV = 0	Higher IRR = higher rate of return	Investment comparison	Choose project with **IRR > required rate of return**
ROI (Return on Investment)	Profit percentage vs. investment	Higher ROI = more efficient investment	Financial performance summary	ROI is simple and quick, but doesn't consider time
Payback Period	Time to recover initial investment	Lower payback = quicker breakeven	Liquidity and risk consideration	Doesn't consider time value — good for **short-term risk**

Metric	What It Measures	Better Value Means	Used For	Exam Tip
TCO (Total Cost of Ownership)	Full cost over the entire lifecycle	Lower TCO = less total spending	Procurement, system evaluation	TCO is about **long-term cost** — not profitability

🔍 How They Work Together in Exam Scenarios:

- **NPV vs. IRR**:
  - NPV shows actual dollar value gained, while IRR shows efficiency as a rate.
  - If projects are **mutually exclusive**, go with **highest NPV** even if IRR is slightly lower.
- **NPV vs. Payback Period**:
  - A project may have a **quick payback** but a **low NPV**. For long-term value, choose the **higher NPV** project.
- **ROI vs. IRR**:
  - ROI is a simpler version and doesn't account for compounding or time. IRR is more reliable for **multi-year** decisions.
- **TCO vs. ROI**:
  - TCO looks only at **cost**, while ROI balances **cost and benefit**. Use TCO for procurement decisions (e.g., software).

✅ Key Takeaways for the Exam:

- If asked **which project to choose**:
  - **Choose highest NPV** if all other factors are equal
  - **IRR must exceed cost of capital** to be acceptable
  - **Shortest payback** is better if liquidity is a concern
  - **Lowest TCO** is best when evaluating long-term operational solutions

Hurdle rate is a critical concept tied to NPV and IRR — and it's **very test-relevant** for PMP®, PBA®, and CBAP® exams.

Let's break it down clearly and then show how each metric interacts with it:

🚧 What Is a Hurdle Rate?

Hurdle Rate is the **minimum acceptable rate of return** on a project — usually set by the organization. It's often equal to the **cost of capital** or **required rate of return**.

Think of it as:

💬 *"The project must return **at least** this much to be worth doing."*

📌 How Each Metric Relates to the Hurdle Rate:

Metric	Role of Hurdle Rate
NPV	You **discount cash flows using the hurdle rate**. If NPV is **positive**, the project exceeds the hurdle rate.
IRR	IRR must be **greater than the hurdle rate** for the project to be acceptable. If **IRR > hurdle rate**, the investment is worthwhile.
ROI	Less directly related — but ROI should be **higher than the return you'd expect from the hurdle rate** to be attractive.
Payback Period	Doesn't use hurdle rate. But a shorter payback may be needed if the hurdle rate is high (i.e., more risk-averse orgs).
TCO	Doesn't apply directly. TCO is about minimizing cost, not measuring return. However, a solution with lower TCO may support a higher ROI or faster payback.

✅ Example in Context (Exam-style logic):

- **Company Hurdle Rate**: 10%
- **Project A IRR** = 13%
- **Project B IRR** = 8%

Answer: Project A is acceptable (**13% > 10%**), while Project B should be rejected (**8% < 10%**).

For NPV:

- Project A has NPV = $15,000 (calculated using 10% discount rate)
- Project B has NPV = –$2,000

Answer: Accept Project A, reject Project B.

Exam Tip:

When you see “cost of capital,” “required rate,” or “discount rate” in a question, assume **they’re talking about the hurdle rate**.

🕮 Chapter 2: Make or Buy Analysis & Break-Even Point

◆ 1. Make-or-Buy Analysis

Definition: A decision-making process to determine whether it is more cost-effective to produce a product/service in-house (make) or purchase it from an external supplier (buy).

📐 Make or Buy Formula:

$$\text{Make Cost} = \text{Fixed Cost}_{\text{Make}} + (\text{Unit Cost}_{\text{Make}} \times \text{Quantity})$$

$$\text{Buy Cost} = \text{Unit Cost}_{\text{Buy}} \times \text{Quantity}$$

Decision Rule:

- Choose **"Make"** if Make Cost < Buy Cost
- Choose **"Buy"** if Buy Cost < Make Cost

Example:

- Fixed Cost (Make) = $10,000
- Variable Cost per unit (Make) = $8
- Cost per unit to Buy = $12
- Quantity = 3,000 units

Make Cost = 10,000 + (8 × 3,000) = **$34,000**
Buy Cost = 12 × 3,000 = **$36,000**

✅ **Decision:** Make is cheaper → **Choose to make**

◆ 2. Break-Even Analysis

Definition: A method to determine the number of units or time needed to recover total costs (no profit, no loss).

📐 **Break-Even Point (Units):**

$$\textbf{Break} - \textbf{Even Point} = \frac{\textbf{Fixed Costs}}{\textbf{Unit Price} - \textbf{Variable Cost per Unit}}$$

- Fixed Costs = upfront investments or ongoing fixed charges
- Unit Price = what you sell the product for
- Variable Cost = cost per unit to produce

Example:

- Fixed Costs = $20,000
- Price per Unit = $10
- Variable Cost per Unit = $6

$$\textbf{BEP} = \frac{\textbf{20000}}{\textbf{10} - \textbf{6}} = \textbf{5000 units}$$

◆ Break-Even Time (Alternative)

If measuring over time instead of units:

$$\textbf{Break} - \textbf{Even Time} = \frac{\textbf{Initial Investment}}{\textbf{Annual Net Benefit}}$$

✓ Quick Comparison Table

Metric	Purpose	Key Formula	Better Value Means
Make-or-Buy	Cost-effective sourcing decision	Compare `Make Cost` vs. `Buy Cost`	Lower total cost wins
Break-Even Point	Units needed to cover fixed costs	$\frac{\textbf{Fixed}}{\textbf{Price} - \textbf{Variable}}$	Lower BEP = quicker cost recovery

Metric	Purpose	Key Formula	Better Value Means
Break-Even Time	Time to reach ROI = 0	$\frac{Investment}{Annual\ Benefit}$	Shorter = better

Exam Tips

- **Make-or-buy** often appears in **Procurement Management** questions
- **Break-even** appears in **Cost Management**, **Business Case**, or **Business Analysis Planning**
- Always consider **non-financial factors** (e.g., quality, control, availability) in make-or-buy decisions
- Look for keywords: “outsourcing,” “in-house,” “threshold,” “recover cost,” etc.

🕮 Chapter 3: Decision Analysis Using Weighted Scoring Models

◆ 1. What Is Decision Analysis with Weighting Factors?

It's a **multi-criteria decision-making technique** used to compare multiple options based on **quantitative scoring** and **weighted importance** of evaluation criteria.

It helps avoid subjective bias and supports **justifiable, traceable decisions**.

✅ Use Case Examples:

- Selecting a vendor or contractor
- Choosing between technical solutions
- Prioritizing project alternatives
- Product or feature selection

◆ 2. Steps in Weighted Decision Analysis

Step	What to Do
1. **Define Criteria**	Choose the factors that matter (e.g., cost, quality, speed)
2. **Assign Weights**	Allocate percentage importance to each criterion (must total 100%)
3. **Score Each Option**	Rate each alternative against each criterion (e.g., scale of 1–10)
4. **Calculate Weighted Scores**	Multiply score × weight for each criterion
5. **Sum Weighted Scores**	Add the results to get total score for each option
6. **Choose the Highest Total**	The option with the highest score is usually the best

Example Table

Let’s say you're choosing between 3 vendors (A, B, and C):

Criteria	Weight	Vendor A	Vendor B	Vendor C
Cost	40%	8	6	9
Quality	35%	7	9	6
Delivery Time	25%	6	8	7
Total Score		**7.05**	**7.55**	**7.15**

Vendor B wins with the highest total weighted score: **7.55**

◆ 3. Formula:

$$\textbf{Weighted Score} = \sum(\textbf{Score} * \textbf{Weight})$$

Where:

- **Score** is the value given to an option for each criterion
- **Weight** is the importance of that criterion (as a decimal, e.g., 40% = 0.40)

Tips for the Exam

- Check if **weights add up to 100%** (or 1.0)
- Watch for **"normalized" scores** — convert raw data to scales when needed
- Be careful with **subjective scoring** — some criteria may need expert judgment
- PMP® may ask for **which tool/technique this is** → Answer: **Multi-Criteria Decision Analysis (MCDA)** under **Decision-Making Techniques**

Also Known As:

- Weighted Scoring Model
- Multi-Criteria Decision Matrix
- Prioritization Grid
- Decision Matrix Analysis (DMA)

🕮 Chapter 4: Opportunity Cost, Sunk Cost, and Financial Decision Factors

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◆ 1. Opportunity Cost

Definition:

The **value of the next best alternative** that is **given up** when a decision is made.

📌 Key Idea:
It's not an actual outflow of money — it's what you **could have gained** from choosing another path.

🔻 Formula:

$$\text{Opportunity Cost} = \text{Value of Best Alternative} - \text{Value of Chosen Option}$$

But in most exam contexts:

$$\text{Opportunity Cost} = \text{Value of Next Best Option}$$

❓ Example:

- Project A profit = $100,000
- Project B profit = $80,000
- You choose A.
- **Opportunity Cost = $80,000** (what you gave up by not choosing B)

❓ EXAM TIP:

When choosing between two projects, the one **not chosen** represents the **opportunity cost**.

◆ 2. Sunk Cost

Definition:

Costs that have already been spent and **cannot be recovered**, regardless of future decisions.

📌 **Key Idea:**
Do NOT consider sunk cost when making future decisions. Only future costs and benefits matter.

◆ Formula:

There's **no formula** — it's a concept, not a calculation. But you should **identify** and **exclude** sunk costs in decision-making.

Example:

- You've spent $50,000 on a failing software project.
- You now realize it will cost $100,000 more to complete.
- Even if you cancel it, the $50K is a **sunk cost** — it's **irrelevant** to your decision.

✅ What Should Be Considered?

Concept	Included in Decision?	Why?
Sunk Cost	❌ No	Already spent; can't be recovered
Opportunity Cost	✅ Yes	Reflects potential lost value
Future Cost/Benefit	✅ Yes	Affects future value of decision
Committed Cost	✅ Maybe	If it will still be incurred in future

Exam-Ready Insights:

- "We've already spent this much, so we must continue" → **Wrong thinking!**
- "We'd miss out on this if we choose the other" → Opportunity cost applies
- PMP loves testing your ability to **ignore sunk cost** and **factor in opportunity cost**

📌 Quick Comparison Table

Term	Definition	Include in Decision?	Formula?
Opportunity Cost	Benefit of next best alternative forgone	✅ Yes	Often: value of next best
Sunk Cost	Past, unrecoverable cost	❌ No	No formula
Future Cost	Expense not yet incurred	✅ Yes	Varies (based on type)

🔍 Opportunity Cost with Multiple Options

🔹 When There Are More Than 2 Choices:

You're selecting **one or more options** from a list of possible projects, vendors, or solutions.

✅ Opportunity Cost Still Applies — but it focuses on what you gave up by not choosing the next best alternative(s).

🧠 Case 1: Choosing ONLY ONE Option

If you're choosing **just one option** from multiple:

- **Opportunity Cost = Value of the best alternative you didn't choose**

🧮 Example:

Option	Expected Benefit
A	$200,000
B	$180,000
C	$150,000

You choose **A**.
→ **Opportunity Cost = $180,000** (the next best, which is B)

⍰ Case 2: Choosing MULTIPLE Options

Let's say you can fund **2 projects out of 4**.
You will select the **best combination** based on value, cost, or other constraints.

Once you've selected your final set, your **opportunity cost** is the **value of the next best project(s) that you could not choose**.

⍰ *Example:*

Project	Value	Selected?
A	$120,000	✓
B	$100,000	✓
C	$95,000	✗
D	$90,000	✗

You selected A & B.
→ **Opportunity Cost = $95,000** (Project C, next highest unselected)

If the exam asks for **total opportunity cost**, it might be:

$$\text{Total Opportunity Cost} = \text{Sum of all unselected top alternatives}$$

So: **C + D = $185,000**

But usually, **only the "next best alternative"** is used in standard exam questions.

📌 Key Rule:

Opportunity cost is always about the next best alternative(s) you had to give up, whether it's one or more items.

□ PMP® / CBAP® Exam Tip:

- If the question gives several options and says **"Which project should be selected?"**
  → The project not selected with the **highest benefit** is the **opportunity cost**.
- If you're building a portfolio and **can select more than one**, consider the **best remaining project(s)** as the cost of that decision.

🕮 Chapter 5: Stakeholder Communication Channels

◆ 1. What Are Communication Channels?

When you have multiple stakeholders or team members, the number of **potential communication paths** grows rapidly.

This chapter focuses on understanding **how many channels** exist in a project based on the number of participants involved — and why this matters.

⍰ Formula to Calculate Communication Channels:

$$\textbf{Number of Channels} = \frac{n(n-1)}{2}$$

Where:

- **n** = number of people or stakeholders involved
- Result = total possible **two-way communication paths**

📊 Example:

Number of People (n)	Communication Channels
2	1
3	3
4	6
5	10
6	15
10	45

So if a project has 7 stakeholders:

$$\frac{7(7-1)}{2} = \frac{7*6}{2} = 21\ Channels$$

📌 Why It Matters:

- More stakeholders = more communication complexity
- You may need **communication management plans**
- Helps identify when to **centralize** communication or use **communication tools** to reduce overload

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✅ Key Takeaways for Exam:

- **Use the formula** when asked to calculate channels
- **Know that communication gets exponentially more complex** as people are added
- PMP may ask: "What happens to communication channels if two new stakeholders join?"
  → Just **recalculate using n = old + 2**

💡 Bonus Tip:

This is part of **Project Communications Management** — often appears in early planning or stakeholder management questions.

🕮 Chapter 6: Earned Value Analysis (EVA)

◆ 1. What Is Earned Value Analysis (EVA)?

EVA is a project performance measurement technique that **integrates scope, cost, and schedule** to assess how well the project is performing.

It allows you to answer:

- Are we **on schedule**?
- Are we **over or under budget**?
- What is the **cost/schedule performance trend**?

◆ 2. Key Terms & Formulas

Term	Meaning	Formula
PV (Planned Value)	Budgeted cost of work scheduled	Given or calculated
EV (Earned Value)	Budgeted cost of work performed	EV = % complete × BAC
AC (Actual Cost)	Actual cost of work performed	Given
BAC (Budget at Completion)	Total budget for the project	Given

◆ 3. Variance Calculations

Metric	Formula	Meaning
CV (Cost Variance)	CV = EV − AC	Negative = over budget
SV (Schedule Variance)	SV = EV − PV	Negative = behind schedule

✓ **Positive = Good**, **Negative = Bad**

◆ 4. Performance Indexes

Metric	Formula	Meaning
CPI (Cost Performance Index)	CPI = EV ÷ AC	>1 = cost efficient
SPI (Schedule Performance Index)	SPI = EV ÷ PV	>1 = ahead of schedule

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◆ 5. Forecasting Formulas

Metric	Formula	Use
EAC (Estimate at Completion)	Various (see below)	Forecasted total cost
ETC (Estimate to Complete)	ETC = EAC − AC	Remaining budget required
VAC (Variance at Completion)	VAC = BAC − EAC	Negative = over budget at end

◆ Most Common EAC Formulas:

When to Use	EAC Formula
If current variances will continue	EAC = BAC ÷ CPI
If original plan no longer valid	EAC = AC + Bottom-Up ETC
If future performance will follow combined CPI & SPI	EAC = AC + [(BAC − EV) ÷ (CPI × SPI)]

📊 Example Question:

- BAC = $100,000
- PV = $60,000
- EV = $50,000
- AC = $55,000

CV = 50,000 − 55,000 = **–$5,000** → Over Budget
SV = 50,000 − 60,000 = **–$10,000** → Behind Schedule
CPI = 50,000 ÷ 55,000 ≈ **0.91**
SPI = 50,000 ÷ 60,000 ≈ **0.83**

✅ **Interpretation**: The project is **over budget** and **behind schedule**.

🧠 Exam Tips:

- Know that **CPI and SPI < 1** means trouble
- **EAC** is very often tested — know which formula fits the scenario
- VAC lets you estimate the final overrun or underrun

🕮 Chapter 7: Risk Quantification and Risk Value Formulas

◆ 1. What Is Risk Quantification?

Risk quantification is the process of assigning **numeric values** to potential risks to understand their **expected impact** on the project. This helps with **prioritization**, **budgeting for contingencies**, and making **data-driven decisions**.

◆ 2. Key Risk Metrics and Formulas

✓1. Expected Monetary Value (EMV)

$$\mathbf{EMV = Probability \times Impact}$$

- **Probability (P):** Likelihood of the risk occurring (as a decimal or %)
- **Impact (I):** Monetary value if the risk happens

📌 Used for **quantifying individual risks** or building **decision trees**

⍰ Example:

- Risk A has a 30% chance of causing a $50,000 loss

$$\mathbf{EMV = 0.3 \times (-50{,}000) = -15{,}000}$$

→ You may need $15,000 contingency reserve

✓2. Contingency Reserve

$$\textbf{Contingency Reserve} = \sum \textbf{EMVs of all known risks}$$

Used for known, **identified risks**.

✓3. Risk Score (Qualitative + Quantitative)

$$\textbf{Risk Score} = \textbf{Probability}\ (1-10) * \textbf{Impact}\ (1-10)$$

- Scaled version (1–10 or High/Med/Low)
- Helps **rank risks** in a risk register
- Used in **qualitative risk analysis**

✓4. PERT for Risk Estimation (Triangular and Beta)

Used when estimating costs or duration with uncertainty:

▪ Triangular (Simple Avg):

$$E = \frac{O + M + P}{3}$$

▪ Beta (PERT Weighted Avg):

$$E = \frac{O + 4M + P}{6}$$

Where:

- **O** = Optimistic estimate
- **M** = Most likely estimate
- **P** = Pessimistic estimate

3. Risk Reserve Types

Type	Covers	How to Calculate
Contingency Reserve	Known risks (identified)	Sum of EMVs
Management Reserve	Unknown unknowns	% of total cost/time (e.g., 5–10%)

📊 Example Table: Risk Register with EMV

Risk Description	Probability	Impact ($)	EMV ($)
Scope creep	40%	–20,000	–8,000
Vendor delay	25%	–10,000	–2,500
Tax refund	10%	+5,000	+500
Total EMV			**–10,000**

→ Use total EMV as part of your **contingency planning**

🧠 PMP® & CBAP® Exam Tips

- EMV is most commonly tested — memorize the formula!
- Watch for **negative impacts = threats**, **positive = opportunities**
- Know when to apply **contingency** vs **management reserves**
- EMV is additive — you can sum across multiple risks

🌳 Sample Decision Tree for Risk Quantification (Using EMV)

📘 Scenario:

You're considering **two project options** to implement a new system. Each comes with different risks and potential outcomes.

📌 Options:

Option A: Use In-House Team

- Success (70% chance): Profit = **$100,000**
- Delay due to limited resources (30% chance): Loss = **$30,000**

Option B: Hire External Vendor

- Success (80% chance): Profit = **$80,000**
- Risk of contract dispute (20% chance): Loss = **$50,000**

□ Step 1: Calculate EMV for Each Path

🔹 Option A:

- EMV = (0.7 × 100,000) + (0.3 × –30,000)
- EMV = 70,000 – 9,000 = **$61,000**

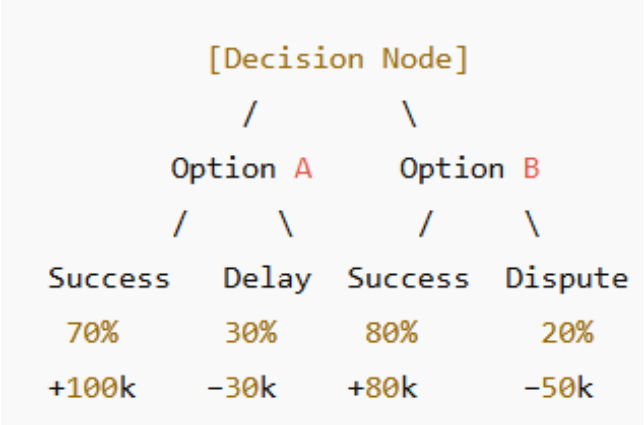
🔹 Option B:

- EMV = (0.8 × 80,000) + (0.2 × –50,000)
- EMV = 64,000 – 10,000 = **$54,000**

✅ Decision:

Choose **Option A**, because it has a higher EMV (**$61,000**) than Option B (**$54,000**)

🌳 Visual: Decision Tree Layout



You can add EV values beside each terminal node and EMV under each option in your diagram.

? Exam Tip:

Decision tree analysis is a **quantitative risk analysis tool** — used in PMP and PBA exam questions when comparing alternatives under uncertainty.

🕮 Chapter 8: Critical Path & Float Analysis

◆ 1. What Is the Critical Path?

The **critical path** is the **longest sequence of dependent activities** in a project that determines the **shortest possible project duration**.

✓ Any delay on the critical path **directly delays the project**.

◆ 2. Key Terms

Term	Meaning
Critical Path	Longest duration path through the network
Float (Slack)	Amount of time an activity can be delayed **without** delaying the project
Total Float	Delay allowed **without affecting the project finish date**
Free Float	Delay allowed **without affecting the next task** only
Early Start (ES)	Earliest time an activity can start
Late Start (LS)	Latest time an activity can start without delaying the project
Early Finish (EF)	ES + Duration
Late Finish (LF)	LS + Duration

◆ Formula Summary

◆ Critical Path Duration:

$$\textbf{Critical Path Duration} = \sum \textbf{Durations on critical path}$$

◆ Total Float:

$$\text{Total Float} = LS - ES \quad \text{or} \quad LF - EF$$

Free Float:

$$\text{Free Float} = \text{ES of next activity} - \text{EF of current activity}$$

Steps to Find the Critical Path:

1. **List all activities and their durations**
2. Identify **dependencies**
3. Create a **network diagram**
4. Perform **Forward Pass** (to find ES & EF)
5. Perform **Backward Pass** (to find LS & LF)
6. Calculate **Float**
7. Identify the path(s) with **zero float** → this is your **critical path**

Example: Simple Activity Network

Activity	Duration	Predecessor
A	3	—
B	4	A
C	2	A
D	3	B, C

Network Paths:

- Path 1: A → B → D = 3 + 4 + 3 = **10**
- Path 2: A → C → D = 3 + 2 + 3 = **8**

→ **Critical Path = A → B → D** (10 days)

Key PMP® & CBAP® Tips:

- Critical path has **zero float**
- Adding resources to critical path activities can **crash** the project
- If asked about "slack" or "float", they're usually referring to **total float**
- Use **network diagrams** (not just Gantt charts) for accurate analysis

🌐 Visual Example: Critical Path and Float (Activity-on-Node Diagram)

📄 Scenario:

You're managing a simple project with 4 tasks:

Activity	Duration	Predecessors
A	3 days	—
B	4 days	A
C	2 days	A
D	3 days	B, C

❓ Step-by-Step Diagram with Forward and Backward Pass

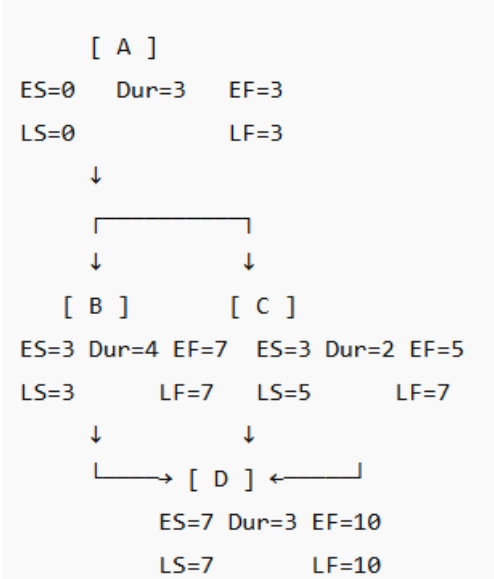
❓ Forward Pass: Calculate ES & EF

$$EF = ES + Duration$$

❓ Backward Pass: Calculate LS & LF

$$LS = LF - Duration$$

🖼️ Network Diagram (AON format):



🔍 Critical Path = A → B → D

- Total duration: **10 days**
- Float on critical path: **0**

✅ **Activity C has float = 2 days** (LS – ES = 5 – 3)

💡 Visual Tips:

- Use color: Red = Critical path, Blue = Non-critical
- Float values: Add inside or under each box
- Clearly label **ES, EF, LS, LF** for each activity

🕮 Chapter 9: Procurement Formulas & Contract Types

Understanding procurement calculations is crucial for PMP®, PBA®, and CBAP® exams — especially for evaluating **contract types**, **cost risks**, and calculating **performance-based payments**.

◆ 1. Key Procurement Contract Types

Contract Type	Best For	Buyer Risk	Seller Risk
Fixed Price (FP)	Well-defined scope	Low	High
Cost Reimbursable (CR)	Unclear scope, R&D projects	High	Low
Time & Materials (T&M)	Flexible, short-term or staff aug	Medium	Medium

◆ 2. Common Procurement Formulas

(For Fixed Price Incentive Fee contracts — FPIF)

This tells us when the **seller** assumes all additional costs (cost risk shifts fully to the seller).

$$\textbf{PTA} = \frac{(\textbf{Ceiling Price} - \textbf{Target Price})}{\textbf{Buyer's Share Ratio}} + \textbf{Target Cost}$$

Inputs:

- **Ceiling Price** = Max price buyer will pay
- **Target Price** = Target cost + Target fee
- **Target Cost** = Estimated cost
- **Share Ratio** = Buyer/Seller % split (e.g. 80/20)

Example:

- Target Cost = $100,000
- Target Fee = $10,000
- Ceiling Price = $120,000

- Buyer/Seller Share = 80/20

Target Price = 100,000 + 10,000 = **$110,000**

$$\text{PTA} = \frac{(120{,}000 - 110{,}000)}{0.8} + 100{,}000 = 12{,}500 + 100{,}000 = 112{,}500$$

Beyond $112,500, the **seller absorbs all cost overruns**.

✅ 2. Final Price Under FPIF

Final Price=Target Cost + Seller's Share of (Target Cost – Actual Cost) + Target Fee

Use when actual costs are **below target**, and incentive applies.

◆ 3. Fee Calculations (Cost Plus Contracts)

Type	Formula
Cost Plus Fixed Fee (CPFF)	Fee is fixed regardless of performance
Cost Plus Incentive Fee (CPIF)	Incentive shared based on performance
CPIF Final Fee	

$$\textbf{Final Fee} = \textbf{Target Fee} + (\textbf{Target Cost} - \textbf{Actual Cost}) \times \textbf{Seller's Share}$$

📌 *CPIF Example:*

- Target Cost = $100,000
- Actual Cost = $90,000
- Target Fee = $10,000
- Share Ratio = 70/30 (buyer/seller)

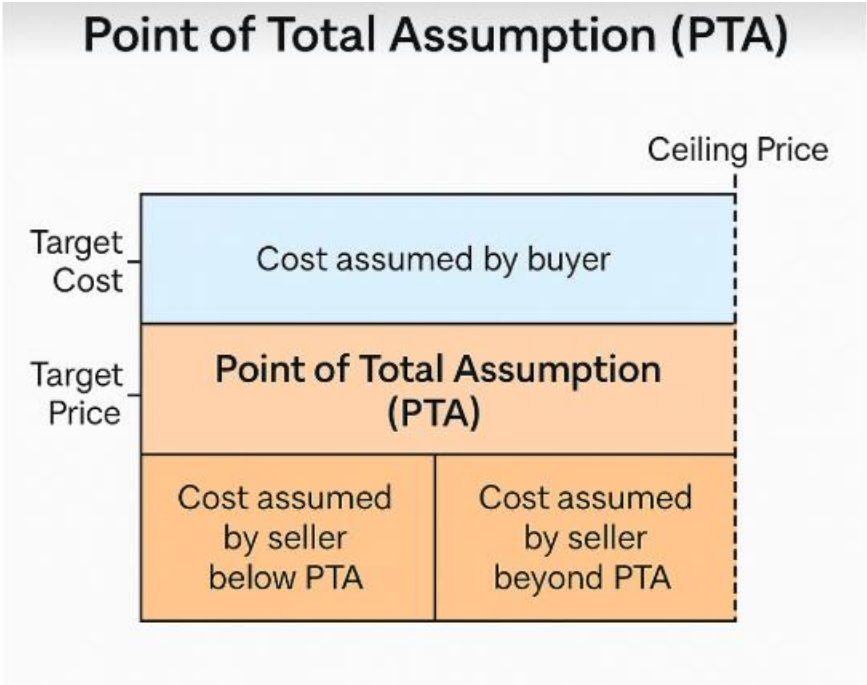
$$\text{Final Fee} = 10{,}000 + (100{,}000 - 90{,}000) \times 0.3 = 10{,}000 + 3{,}000 = 13{,}000$$

🔍 Time & Materials (T&M)

No complex formula — just:

$$\text{Cost} = \text{Time} \times \text{Rate} + \text{Materials}$$

Useful for **short-term**, **consulting**, or **uncertain scope**.



PMP® Exam Tips:

- Know **which contract favors which party**
- PTA applies **only to FPIF**
- Know how to use **share ratios**
- T&M = hybrid of **fixed + cost-reimbursable**

🕮 Chapter 10: Agile Velocity & Forecasting

◆ 1. What Is Velocity in Agile?

Velocity is the **average amount of work** a team completes **per iteration/sprint**. It's usually measured in:

- **Story Points**
- **User Stories**
- **Work Items** (customized)

📌 Helps with forecasting, release planning, and setting realistic team capacity.

✓ **Formula: Agile Velocity**

$$Velocity = \frac{Total\ Story\ Points\ Completed}{Number\ of\ Sprints}$$

Example:
Team completed 120 story points in 4 sprints →

$$Velocity = \frac{120}{4} = 30\ Points/Sprint$$

◆ 2. Forecasting Using Velocity

You can use velocity to **predict** how long it will take to complete a product backlog.

✓*Forecast Formula:*

$$Estimated\ Sprint\ Count = \frac{Total\ Backlog\ Size}{Average\ Velocity}$$

Example:
Backlog = 240 points, Velocity = 30 points/sprint

$$Estimated\ Sprint\ Count = \frac{240}{30} = 8\ Sprints$$

◆ 3. Ideal Burnup & Burndown Charts

- **Burndown Chart**: Shows how much work is remaining vs. time.
- **Burnup Chart**: Shows how much work is completed vs. total.

✅ Used in daily standups and sprint reviews to **track progress**.

❓ PMP®/Agile Exam Tips:

- Velocity is **historical** and **team-specific**
- Cannot be used for **individual performance**
- Helps identify if the team is **overcommitting or underperforming**
- Must have **stable team + consistent sprint length** to be reliable

🕮 Chapter 11: Hybrid Project Calculations

Hybrid project management blends **Agile** and **Predictive (Waterfall)** approaches. From a PMP® exam or practical perspective, it means being able to **track, forecast, and control work** across **both adaptive and plan-driven domains**.

◆ Key Concepts in Hybrid Projects

Predictive Components	Adaptive (Agile) Components
Cost Baseline (Planned Value)	Velocity (Story Points per Sprint)
Earned Value Metrics	Burnup/Burndown Tracking
Critical Path & Float	Sprint Goals & Daily Standups
Fixed Scope	Flexible Scope

✅ 1. Blended Forecasting Formula

When part of the project is Agile and the rest is Waterfall:

Total Forecast Duration=Predictive Duration+Agile Forecasted Duration\text{Total Forecast Duration} = \text{Predictive Duration} + \text{Agile Forecasted Duration}Total Forecast Duration=Predictive Duration+Agile Forecasted Duration

Where:

- **Predictive Duration**: Based on WBS & Critical Path
- **Agile Forecasted Duration**:

$$\frac{\textit{Remaining Agile Story Points}}{\textit{Velocity}}$$

✅ 2. Blended Budget Tracking

You might manage Agile parts by tracking **actual effort** and fixed team costs per sprint, while also using **Earned Value Management (EVM)** for waterfall work.

🧮 Sample Blended EAC (Estimate at Completion):

$$\mathbf{EAC_{Hybrid}} = \mathbf{EV - based\ Forecast\ (Waterfall)} + \mathbf{Agile\ Work\ Remaining} \times \mathbf{Cost/Sprint}$$

? Example Scenario

- Waterfall scope: $60,000 budget, $30,000 spent, 50% complete
- Agile work: 200 story points, velocity = 20, cost = $5,000/sprint

➞ Waterfall remaining = $30,000

➞ Agile sprints needed = 200 ÷ 20 = 10

➞ Agile remaining = 10 × $5,000 = $50,000

$$EAC_{Hybrid} = 30{,}000 + 50{,}000 = 80{,}000$$

? PMP® Tips for Hybrid Calculations

- Agile costs are usually **time-boxed** (e.g., cost per sprint)
- Predictive tasks are **scope-based** (WBS-driven)
- Integrate tracking using **deliverables**, not just hours
- Be prepared to use **separate baselines** and **integrated reporting**

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📘 Essential Calculations Handbook: For PMP®, PBA®, and CBAP® Exam

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✓ Fast reference
✓ Real-world examples
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Whether you're studying for the exam or applying calculations on the job — this handbook is your go-to toolkit.