وما توفيقي إلا بالله

بسم الله الرحمن الرحيم

Cost Management for Engineers

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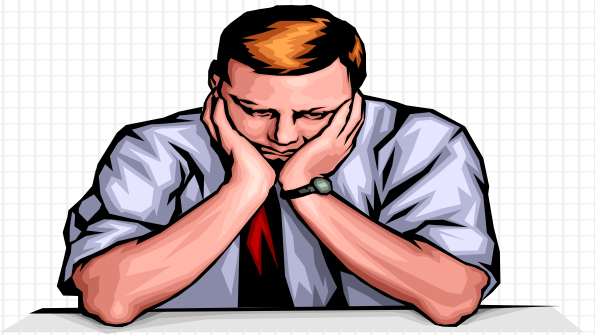
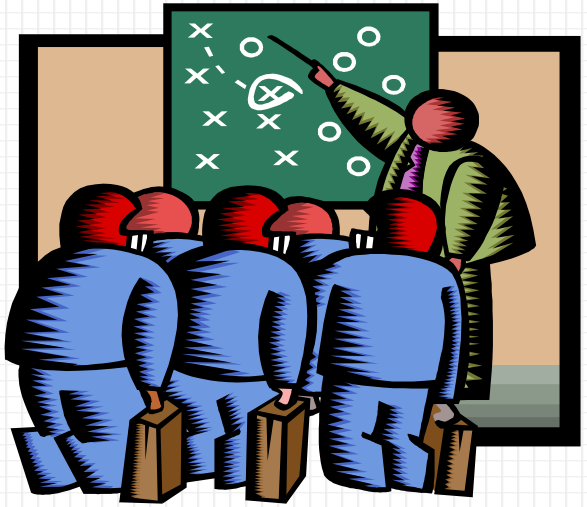
Cost Management for Engineers

Course Contents:

- Cost Management
- Cost Classification
- Cost Estimation
- Cost Analysis
- Depreciation Analysis
- Financial Analysis
- Project Cost Analysis
- Project Cost Control
- Case Studies



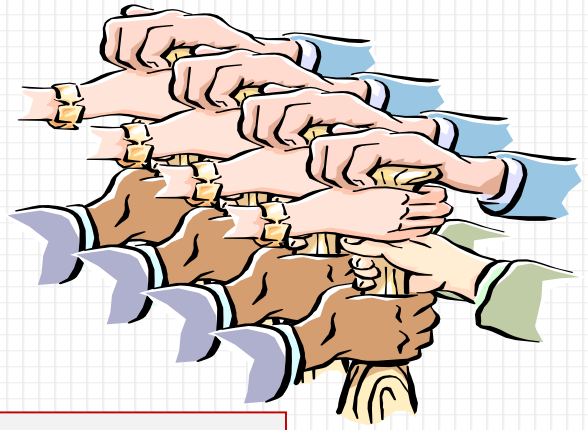
Rules of the Course:



This is an Open Discussion Course:

- Share **Knowledge** – تبادل المعرفة
- Share **Experiences** – تبادل الخبرات
- Share **Best Practices** – تبادل التجارب الجيدة
- Share **Questions** – تبادل الأسئلة

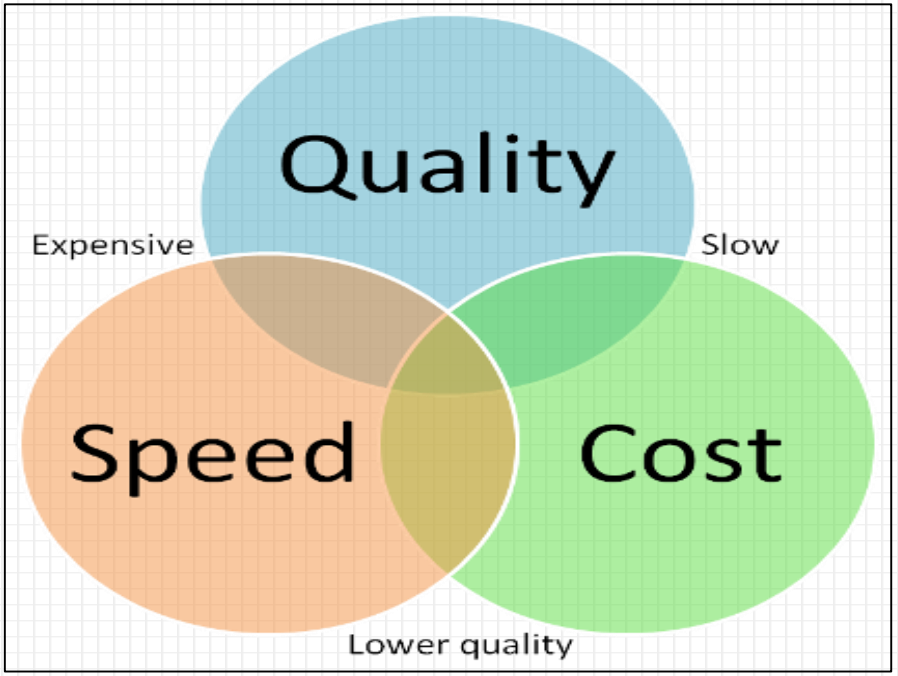
Team Approach



Remember … You can't do it alone!

Let us be a teamwork.

Project Triple Constraints:

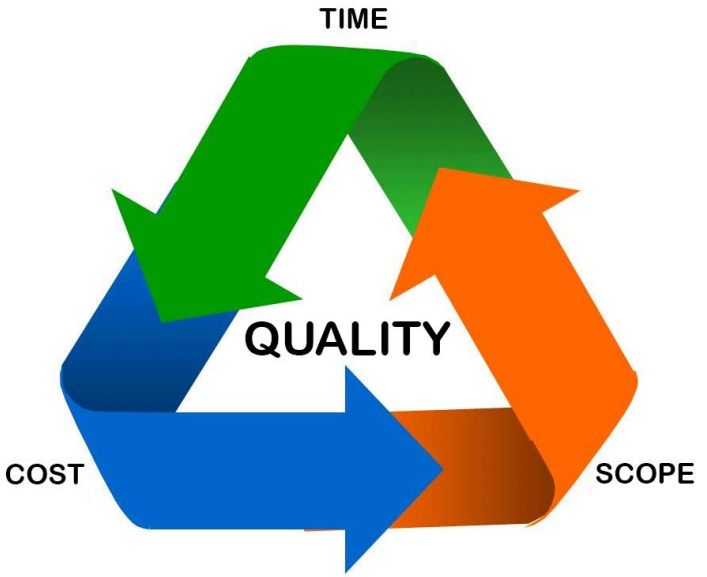


Project Definition:

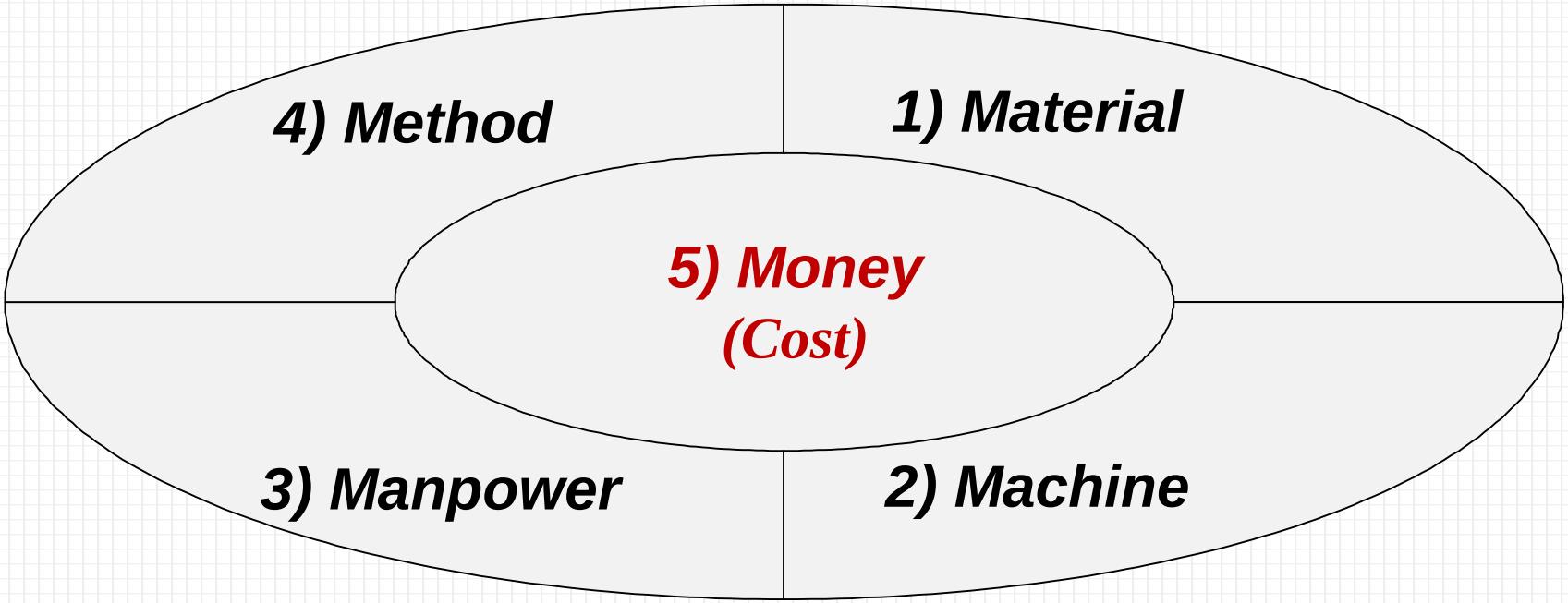
1. Objectives:
2. Scope of Work:
3. Quality Standards:
4. Duration:
5. Cost:
6. Contract:

Project Constraints:

1. Scope of Work (Specs)
2. Quality (Service Quality)
3. Time (Schedule)
4. Cost (Budget)



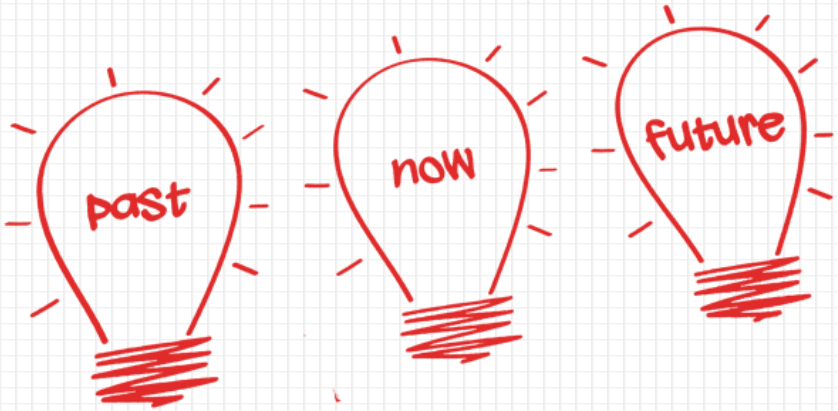
Resources Analysis (5 M's):



Cost Management

Cost Planning

(1) Resource Planning → (2) Cost Estimation → (3) Cost Budgeting → (4) Cost Control → (5) Cost Forecasting



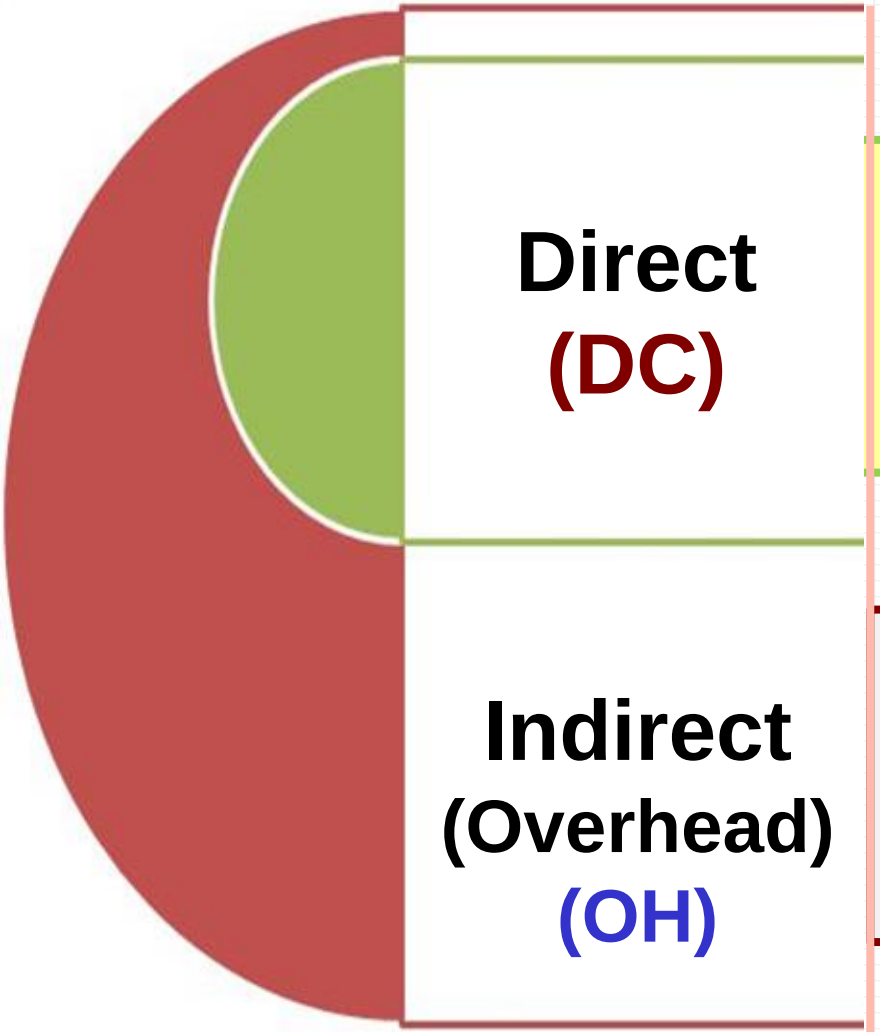
Cost Management

(1) Resource Planning	(2) Cost Estimating
1. Work breakdown structure (WBS) 2. Main activities 3. Resource allocation 4. Resource limits (constraints)	5. Resource requirements 6. Cost rates 7. Cost estimation 8. Cost analysis
(3) Cost Budgeting	**(4) Cost Control**
9. Cost baseline 10. Cash in / cash out 11. Budget plan 12. Budget limits (constraints)	13. Planned performance 14. Actual performance 15. Change requests 16. Performance reports

Source: PMBOK Standard

1) Cost Classification:

$$TC = DC + OH$$



Direct (DC)

Related “Directly” to the product / project.

Indirect (Overhead) (OH)

Overhead used for more than one product / project

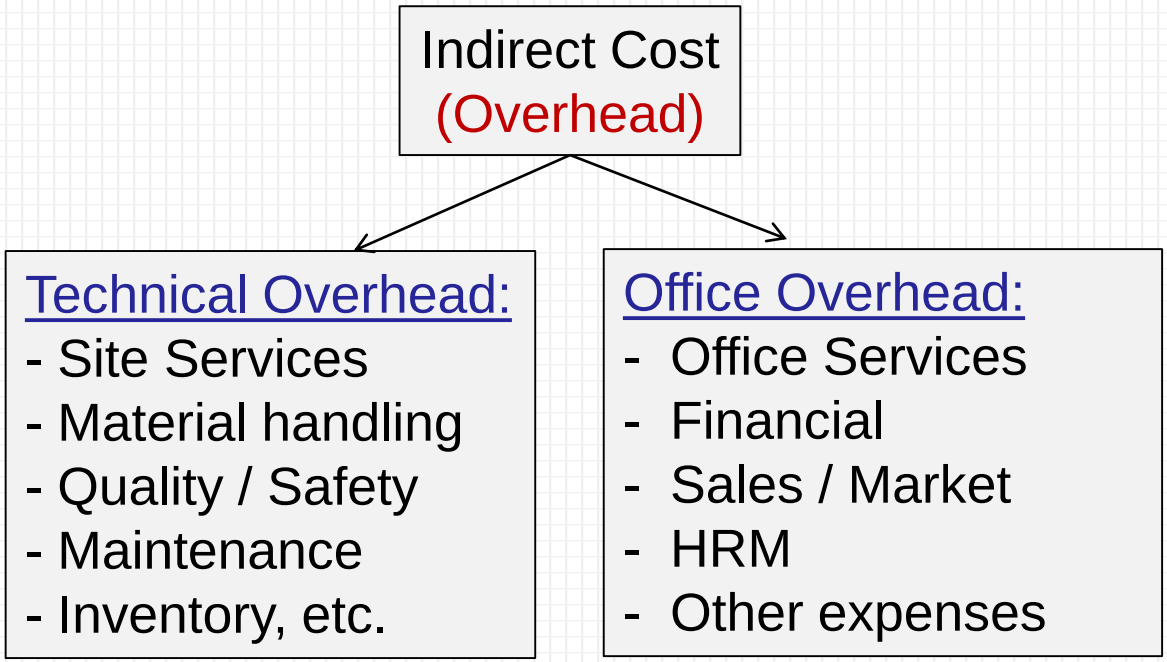
Direct Costs

*Are those costs which **can** be directly identified with a job / product.*

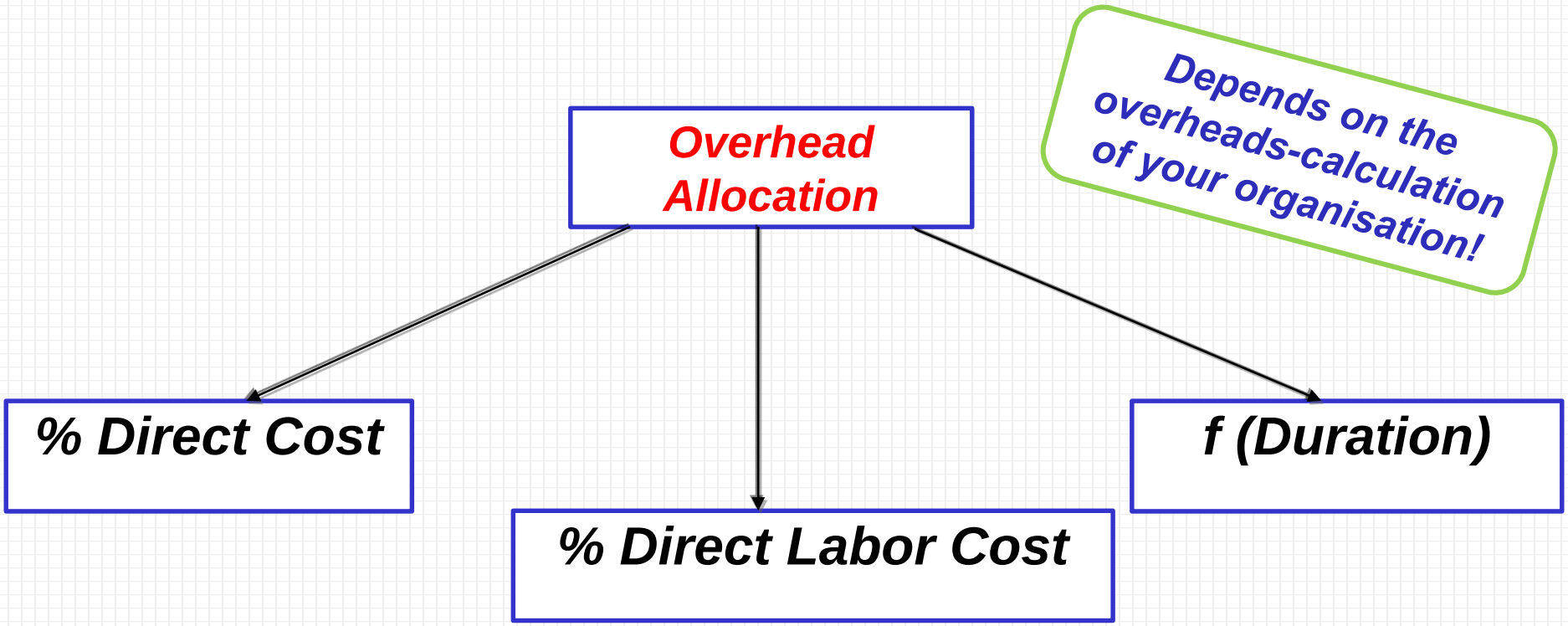
- Direct Material
- Direct Labor
- Direct Equipment
- Sub-contractors

Indirect Costs

*Are those costs which **cannot** be directly identified with a job / product.*



Project Overhead Methods



For Example;

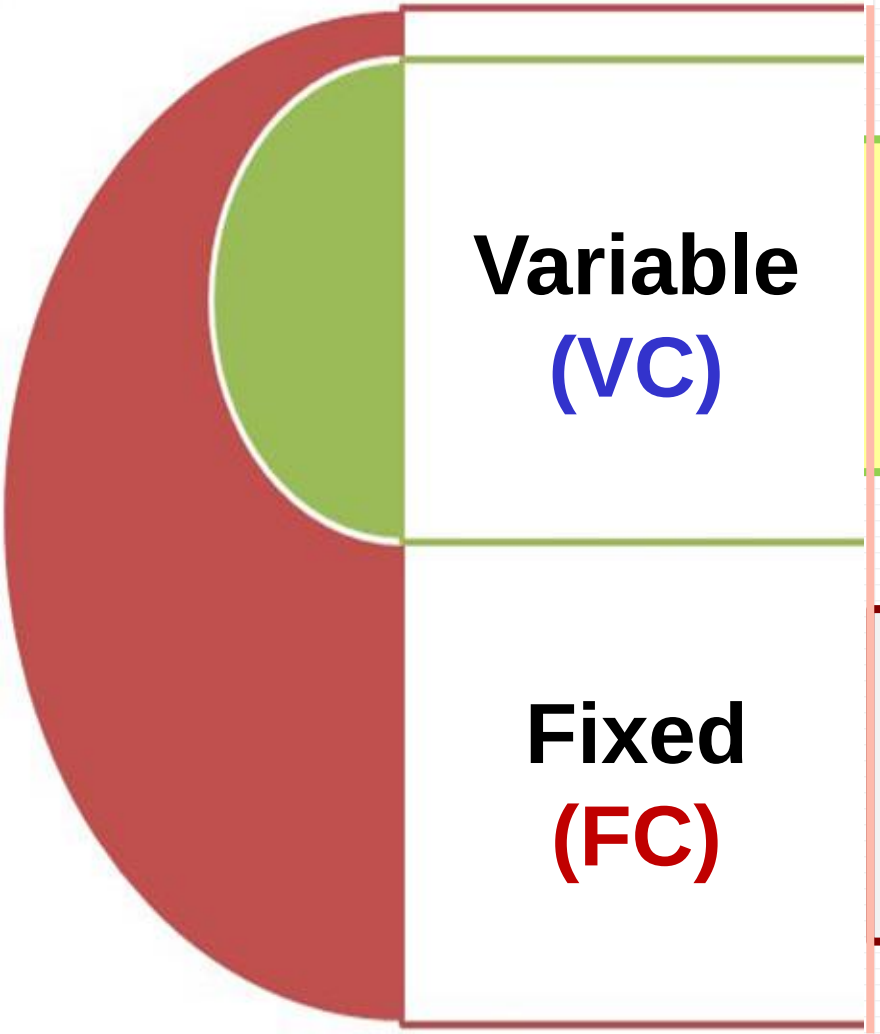
Fabrication Contracts

Service / Lobar Contracts

Construction Contracts

2) Cost Classification:

$$TC = FC + VC$$



Variable costs are costs that change with changes in production levels or sales.

Fixed costs remain roughly the same regardless of production levels or sales.

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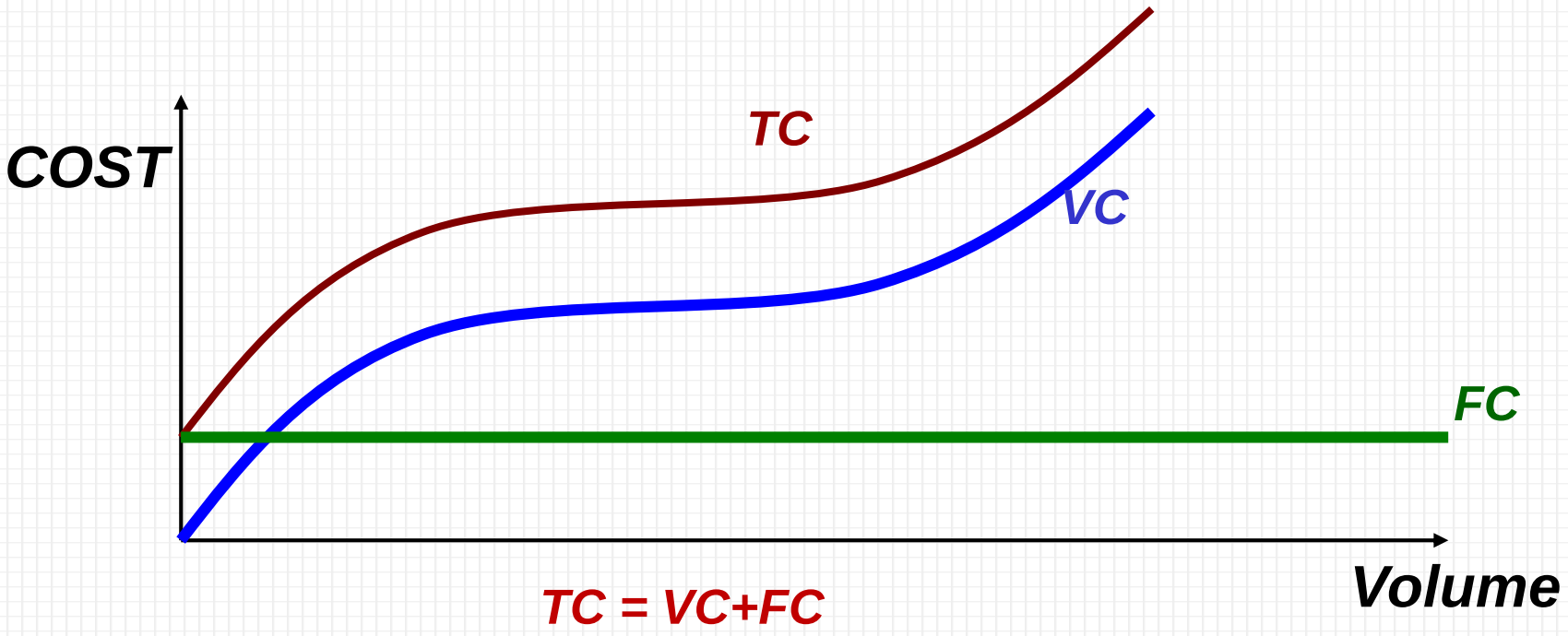
Cost Management & Knowledge Database

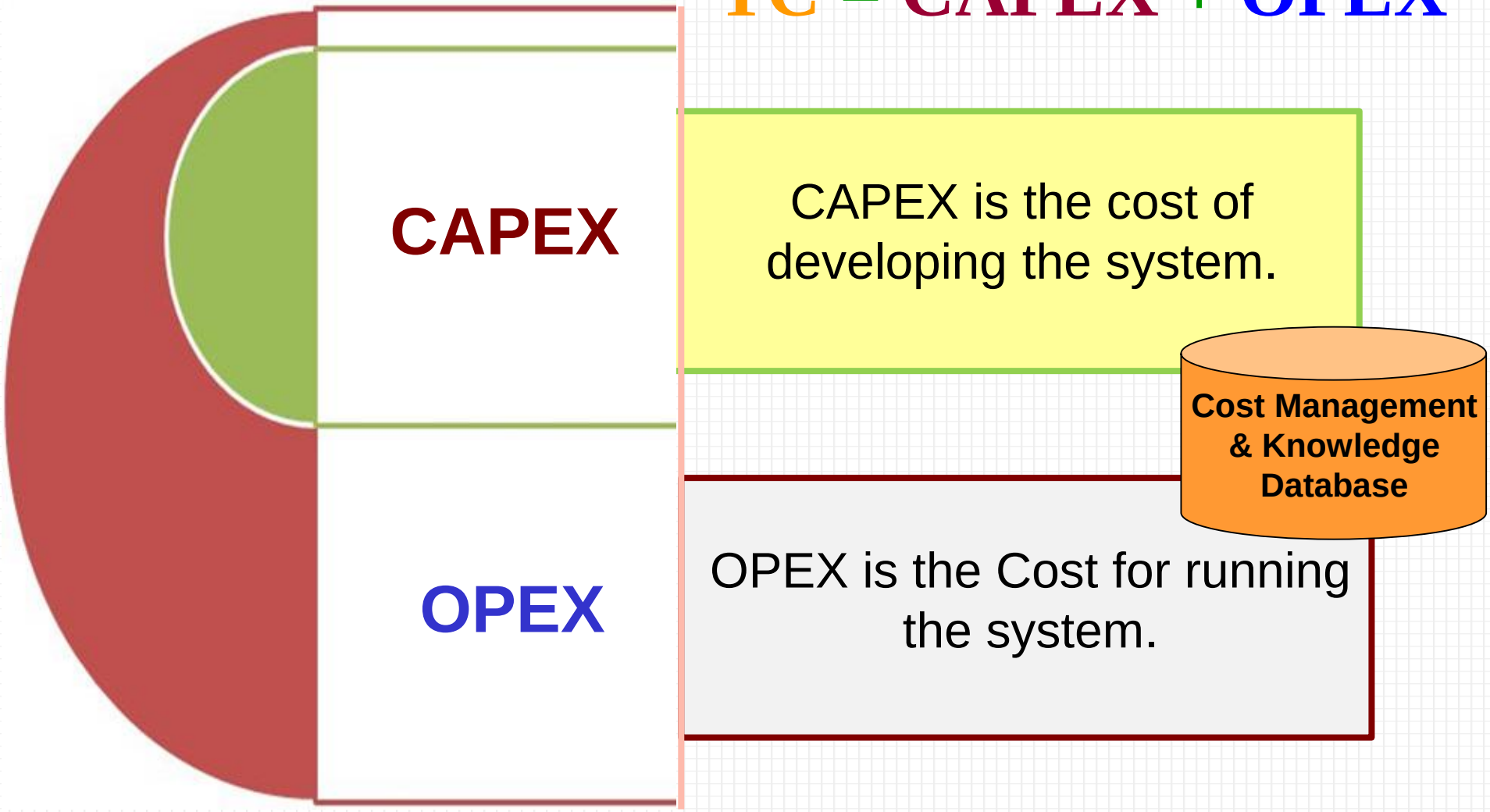
Variable Cost – VC - **Changes with volume**

Fixed Cost – FC- **Stay the same, regardless of volume**



3) Cost Classification:

TC = CAPEX + OPEX



CAPEX / OPEX Analysis

CAPEX

Capital Expenses

(Long term > 1 year)

CAPEX is the cost of developing the system.

CAPEX is investment in the business.

CAPEX tends to cover fixed assets

Fixed assets: buildings, equipment, etc.

OPEX

Operating Expenses

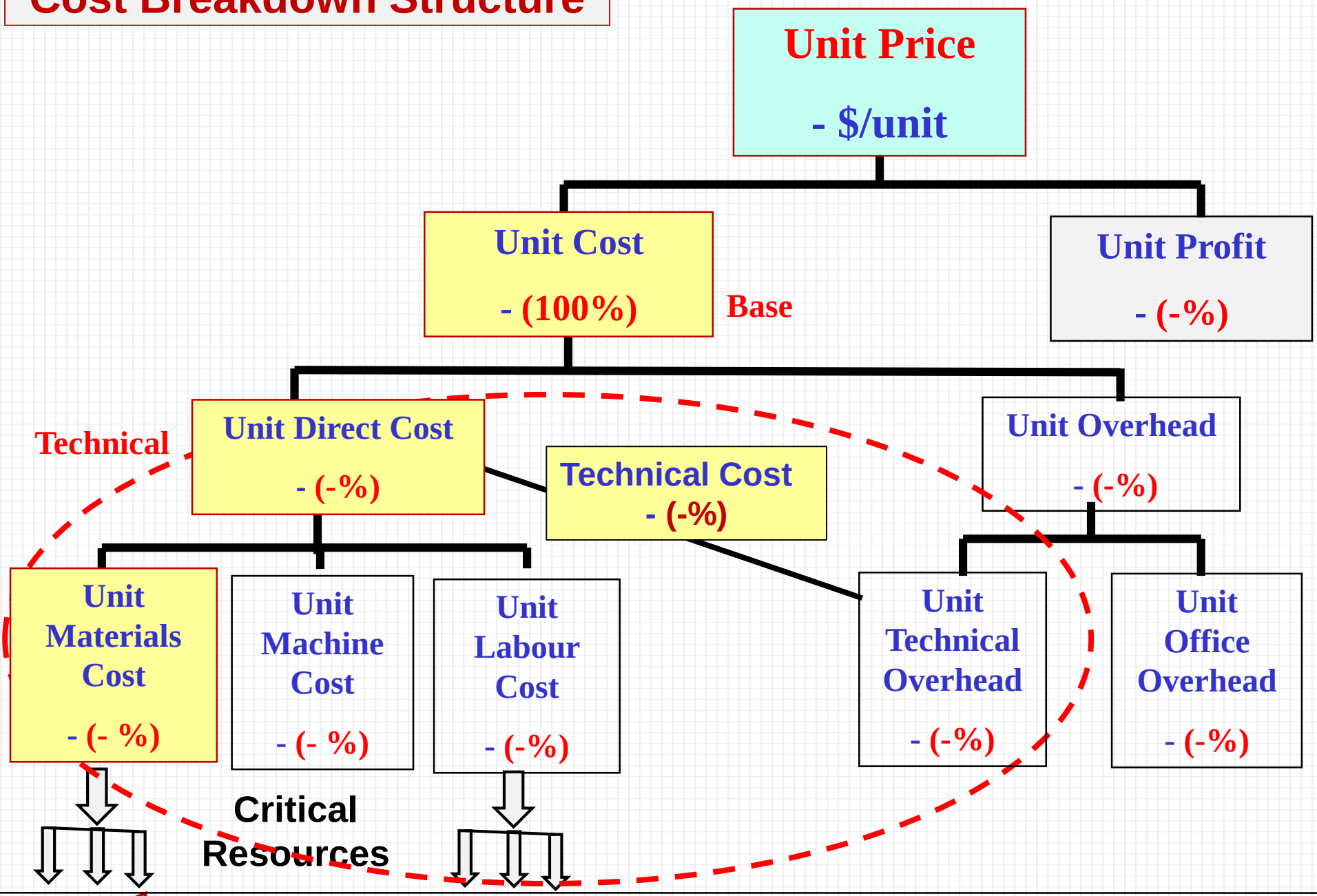
(Short term <=1 year ➔ Running)

OPEX is the Cost for running the system.

wages, utilities, maintenance, and repairs,

Product / Project Cost Analysis

Cost Breakdown Structure



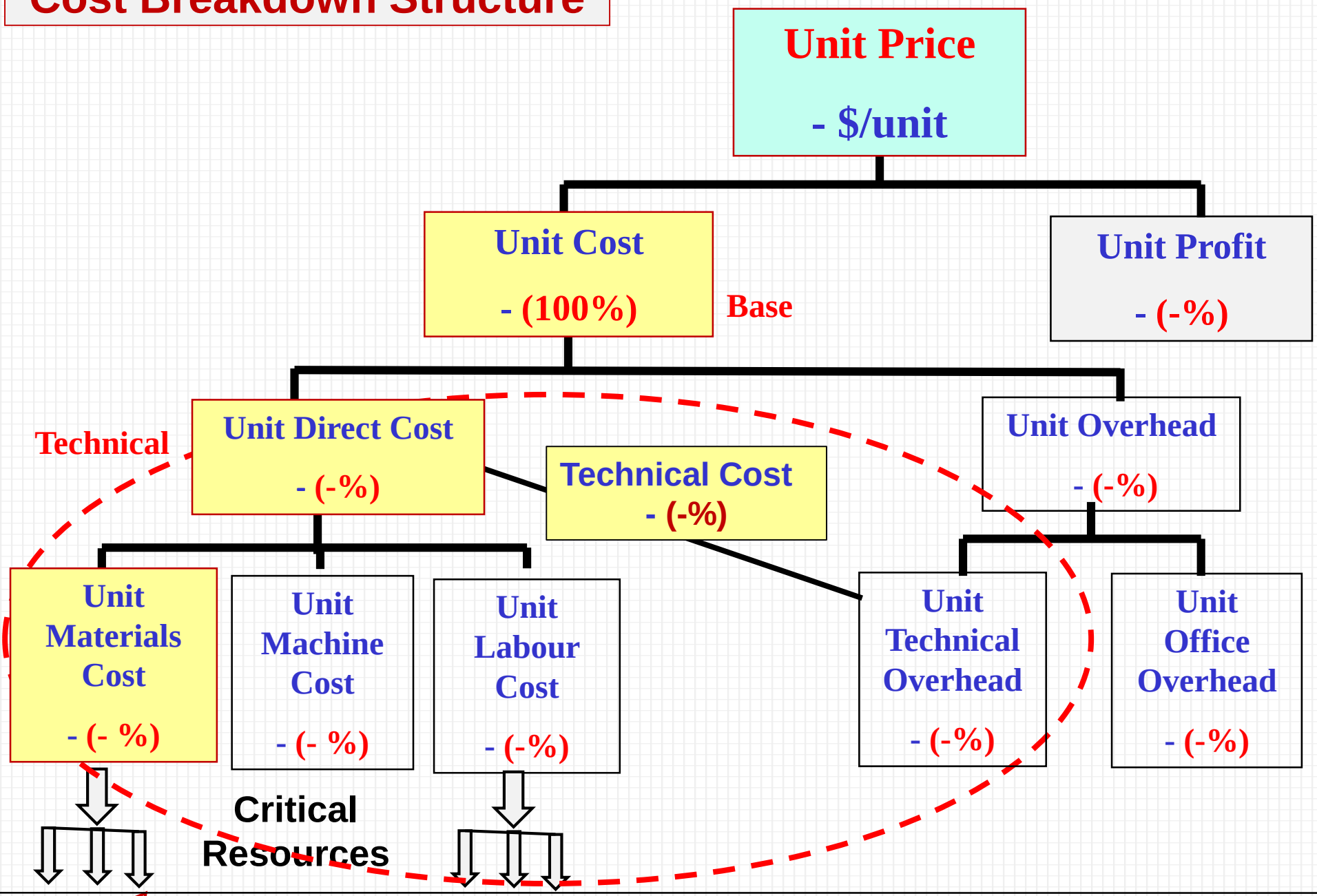
Example:

The project cost information is as follows:

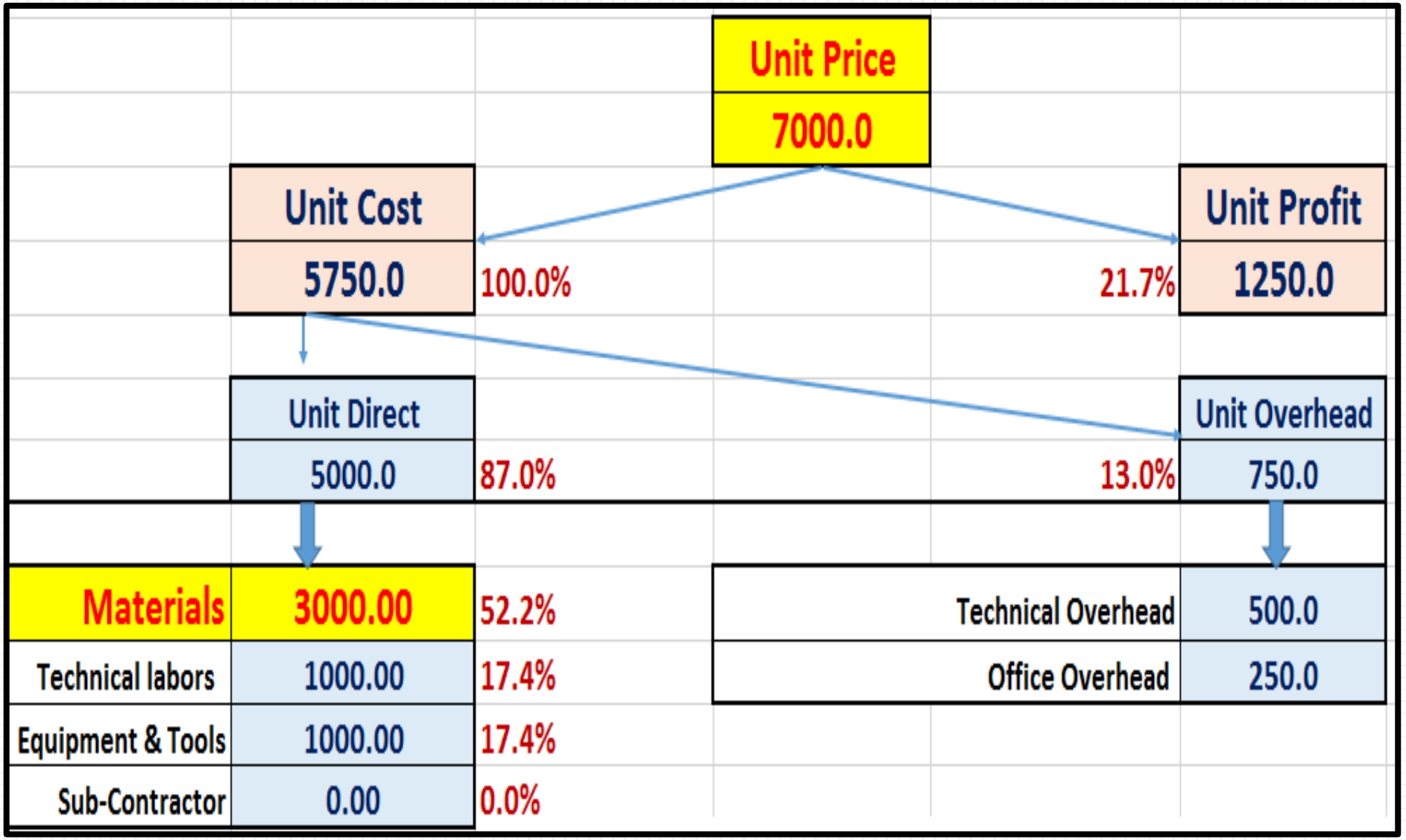
- **Project : Office Building 10 Floors**
- **Bill of Quantity (BOQ): 6000 m2**
- **Direct Material Cost: 18,000,000 LE**
- **Direct Machine Cost: 6,000,000 LE**
- **Direct Labor Cost: 6,000,000 LE**
- **Technical Overhead 3,000,000 LE**
- **Office Overhead: 1,500,000 LE**
- **Unit Price: 7,000 LE/m2**

Based on this information, discuss briefly the Cost Breakdown Structure

Cost Breakdown Structure



Cost Breakdown Structure



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- **Bill of Quantity (BOQ): 6000 m2**
- **Direct Material Cost: 18,000,000 LE**
- **Direct Machine Cost: 6,000,000 LE**
- **Direct Labor Cost: 6,000,000 LE**
- **Technical Overhead 10% Direct Cost**
- **Office Overhead: 5% Direct Cost**
- **Unit Price: 7,000 LE/m2**

Based on this information, discuss briefly the Cost Breakdown Structure

Example:

The project cost information is as follows:

• Item (Main Activity):	Plain Concrete	
• Bill of Quantity (BOQ)	300	m3
• Direct Material Cost	120,000	LE
• Direct Machine Cost	54,000	LE
• Direct Labor Cost	24,000	LE
• Factory Overhead	33,000	LE
• Office Overhead	16,500	LE
• Unit Price	1,100	LE/m3

Based on this information, discuss briefly the Cost Breakdown Structure

Example:

The project cost information is as follows:

• Item (Main Activity):	Concrete
• Bill of Quantity (BOQ)	1000 unit
• Direct Material Cost	10,00,000 LE
• Direct Machine Cost	500,000
• Direct Labor Cost	300,000
• Technical Overhead	10% Direct cost
• Office Overhead	5% Direct cost
• Profit	20% Total cost

Based on this information, discuss briefly the Cost Breakdown Structure

Example:

The project cost information is as follows:

• Item (Main Activity):	Concrete
• Bill of Quantity (BOQ)	1000 unit
• Direct Material Cost	10,00,000 LE
• Direct Machine Cost	500,000
• Direct Labor Cost	300,000
• Technical Overhead	10% Direct cost
• Office Overhead	5% Direct cost
• Unit Price	3000 LE/m3

Based on this information, discuss briefly the Cost Breakdown Structure

Brainstorming:

The project cost information is as follows:

• Item (Main Activity):	Office Building
• Bill of Quantity (BOQ)	1000 m2
• Direct Material Cost	2,000,000
• Direct Machines	200,000
• Direct Labors	200,000
• Tech. Overhead	15% Direct Cost
• Office Overhead	5% Direct Cost
• Profit	20% Total Cost

Based on this information, discuss briefly the Cost Breakdown Structure

Brainstorming:

The project cost information is as follows:

- **Item (Main Activity):** **Power Cable**
- **Bill of Quantity (BOQ)** **1000 m**
- **Direct Material Cost** **1,500,000**
- **Direct Machines** **500,000**
- **Direct Labors** **400,000**
- **Tech. Overhead** **15% Direct Cost**
- **Office Overhead** **5% Direct Cost**
- **Profit** **20% Total Cost**

Based on this information, discuss briefly the Cost Breakdown Structure

Brainstorming:

The project cost information is as follows:

• Item (Main Activity):	Gas Pipe Line
• Bill of Quantity (BOQ)	100 Km
• Direct Material Cost	1,000,000 $
• Direct Sub-Contactor	$ 300,000
• Direct Engineers	$ 100,000
• Tech. Overhead	20% Direct Cost
• Office Overhead	10% Direct Cost
• Profit	20% Total Cost

Based on this information, discuss briefly the Cost Breakdown Structure

Profit Analysis:

Operating Profit

= Total Revenue – Total Cost

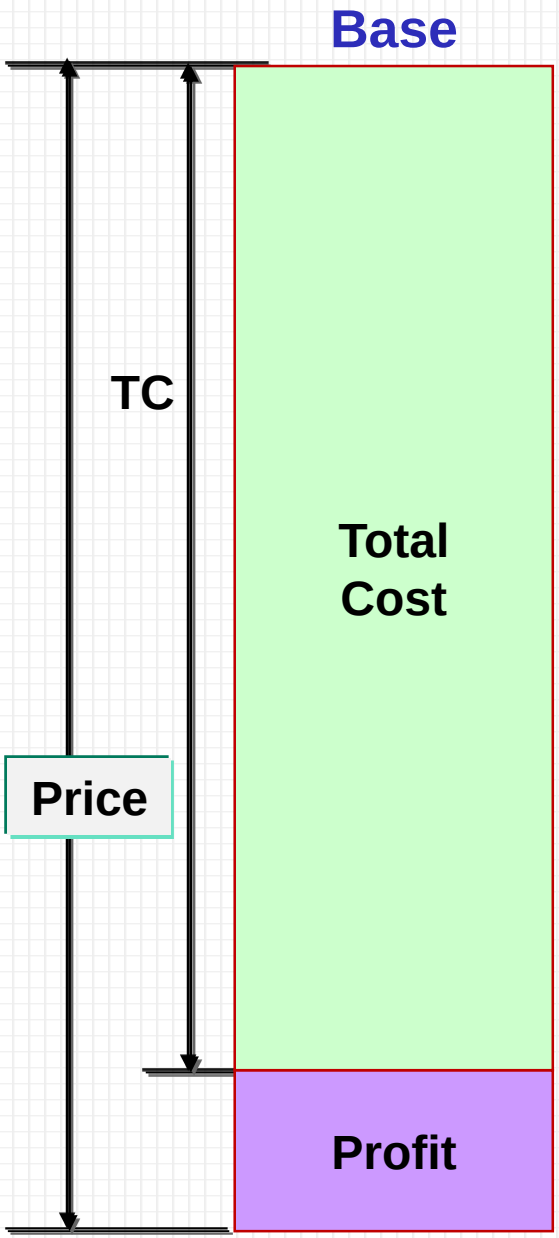
➔ (assume; Zero Stock)

Operating Profit

= Sales Revenue – Cost of Sales

Stock Types:

- Final products
- Work In Process (WIP)
- Raw Materials
- Spare Parts, etc.



Profit Analysis:

Production Information:

Production Quantity = 1000 Cars

Total Production Cost = 100,000,000 LE

Sales Information:

Sales Quantity = 600 Cars

Total Revenue = 72,000,000 LE

Based on this information, Calculate the profit ratio

Profit Analysis:

Production Information:
Production Quantity = 1000 Cars
Total Production Cost = 100,000,000 LE

Sales Information:
Sales Quantity = 600 Cars
Total Revenue = 72,000,000 LE

Based on this information, Calculate the profit ratio

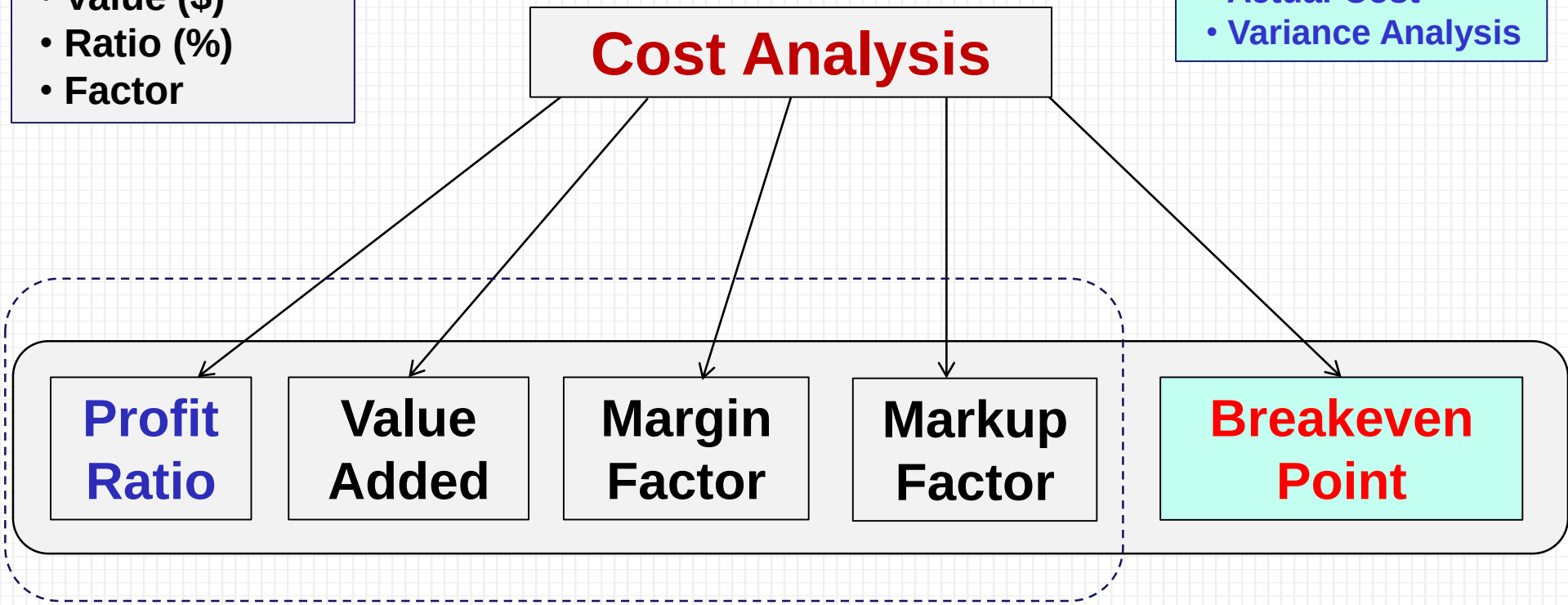
Profit = Revenue – Cost = 72 – 100 = - 28 M-LE
Profit Ratio = Profit / Cost = - 28/100 = - 28%

Unit Profit = Unit Price – Unit Cost = 120 – 100 = +20
Profit Ratio = Unit Profit / Unit Cost = 20/100 = + 20%

Profit = Revenue – Cost of Sales = 72 -60 = 12 M-LE
Profit Ratio = Profit / Cost of Sales = 12/60 = + 20%

Each Indicator:
- Value ($)
- Ratio (%)
- Factor

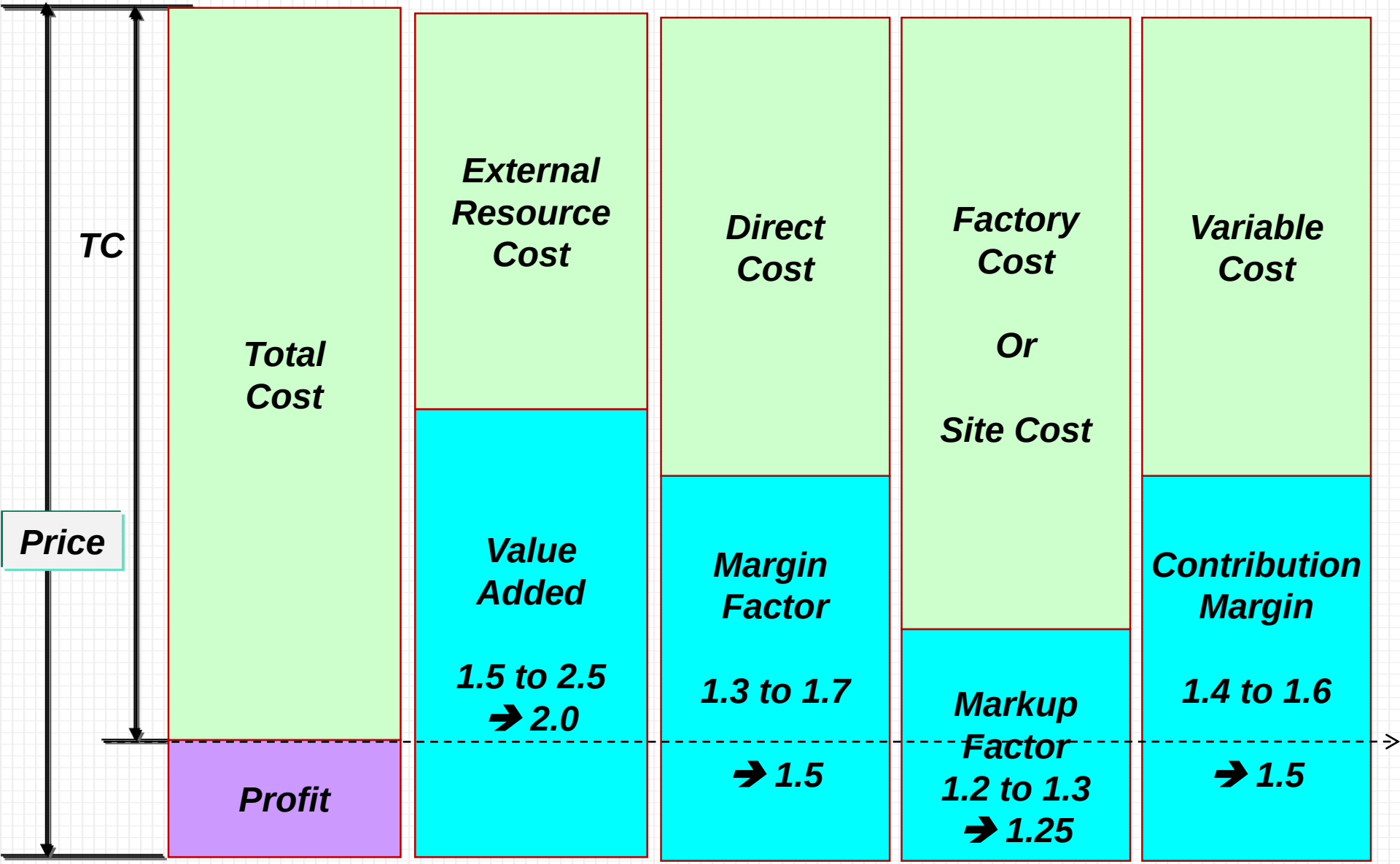
- Planned Cost
- Actual Cost
- Variance Analysis



Main Indicators:

- Profit	= Price - Cost	➔ Total Productivity
- Value Added Factor	= Price / Mat. Cost	➔ Material Productivity
- Margin Factor	= Price / Direct Cost	➔ Direct Resource Productivity
- Markup Factor	= Price / Factory Cost	➔ Factory Productivity
- Breakeven Point	= F / (p-v)	➔ Margin of Safety

Cost Analysis



Price Structure Analysis: (Cost KPIs - Objectives)

Contract Price

Total Cost = Direct Cost + Overhead	Profit

or rough cut estimation by using the value added

For same scope of work

Outsource Cost	Value Added

or rough cut estimation by using the margin factor

For different scope of work

Direct Cost	Margin

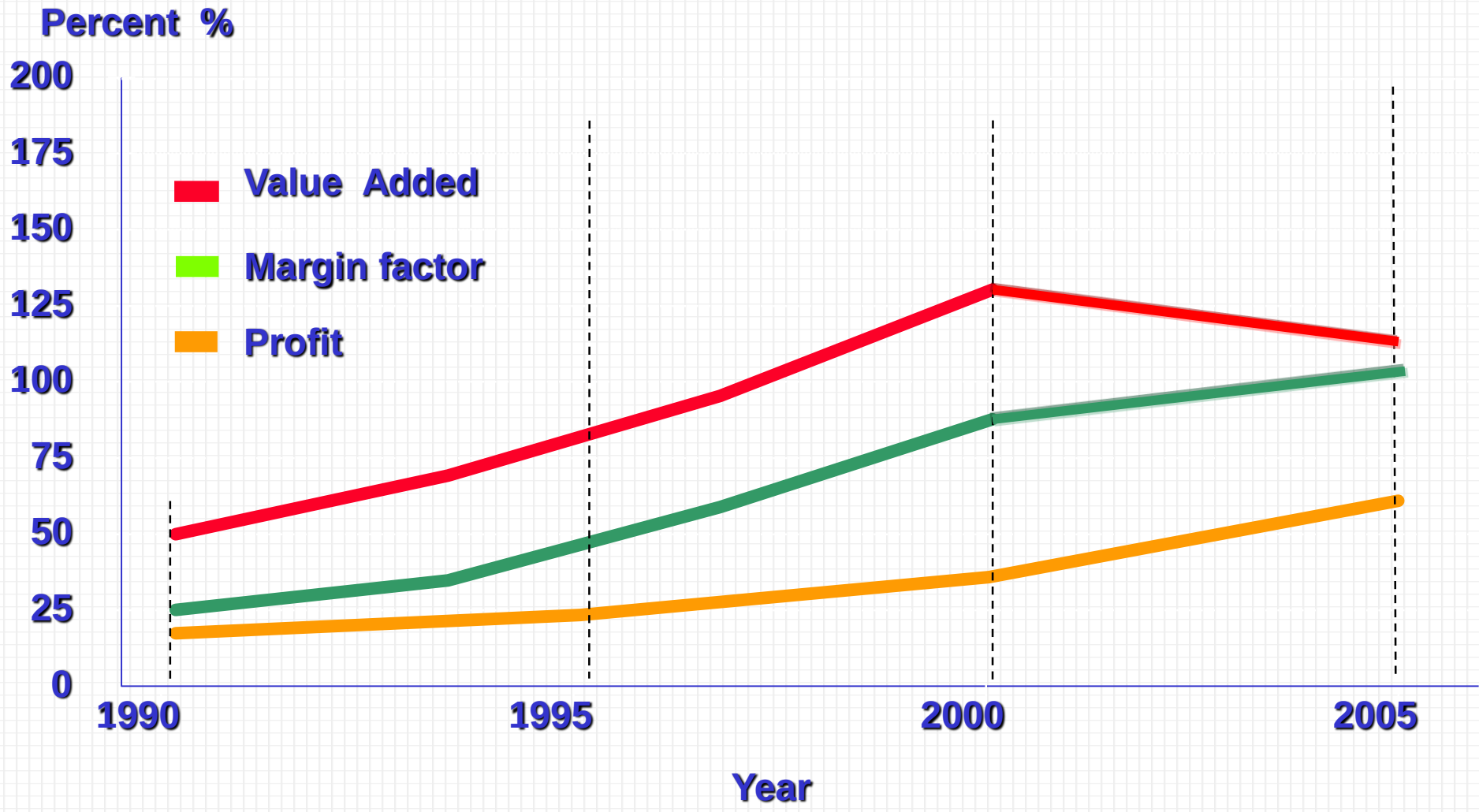
or rough cut estimation by using the markup factor

For Cost Plus Contract

Factory Cost = Direct + Tech. O/h					Markup (Cost Plus)
Mat.	Labor	Equip	Subs	Jobsite OH	

Brainstorming:

Discuss the following figure:



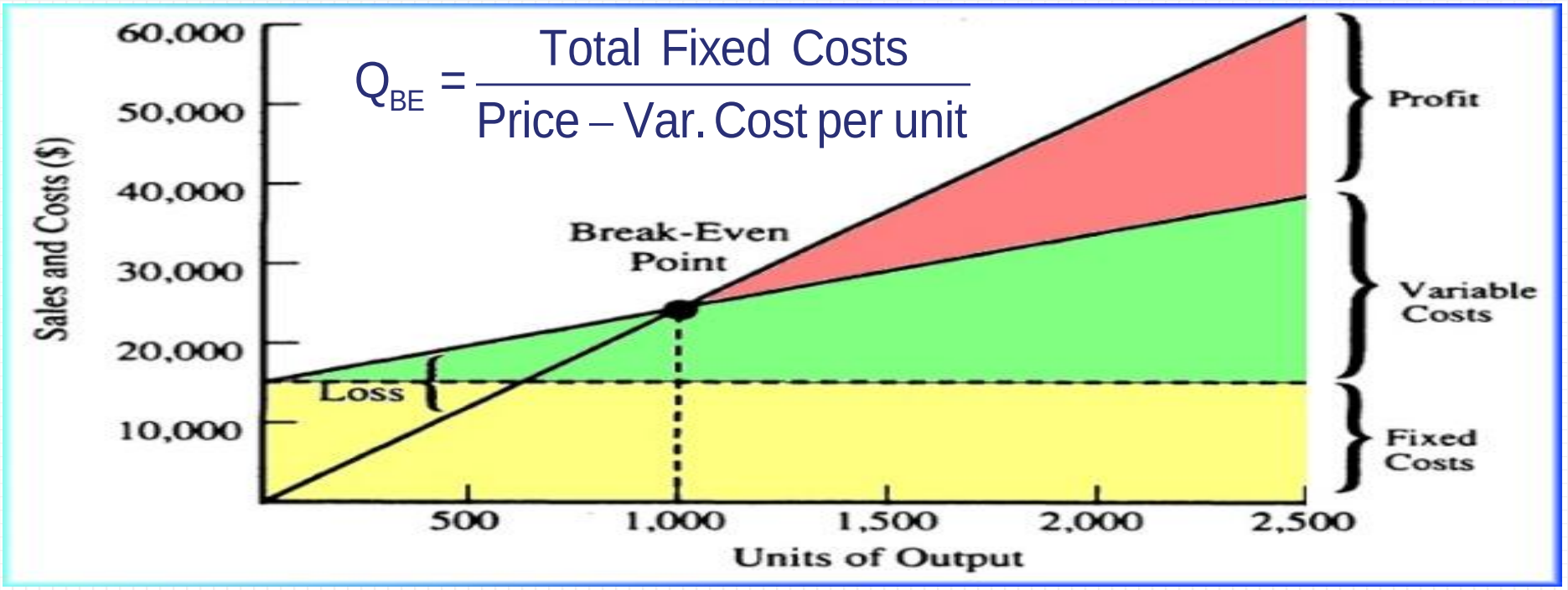
Break-Even Analysis

Breakeven Quantity of Sales:

Total costs = fixed costs + variable costs

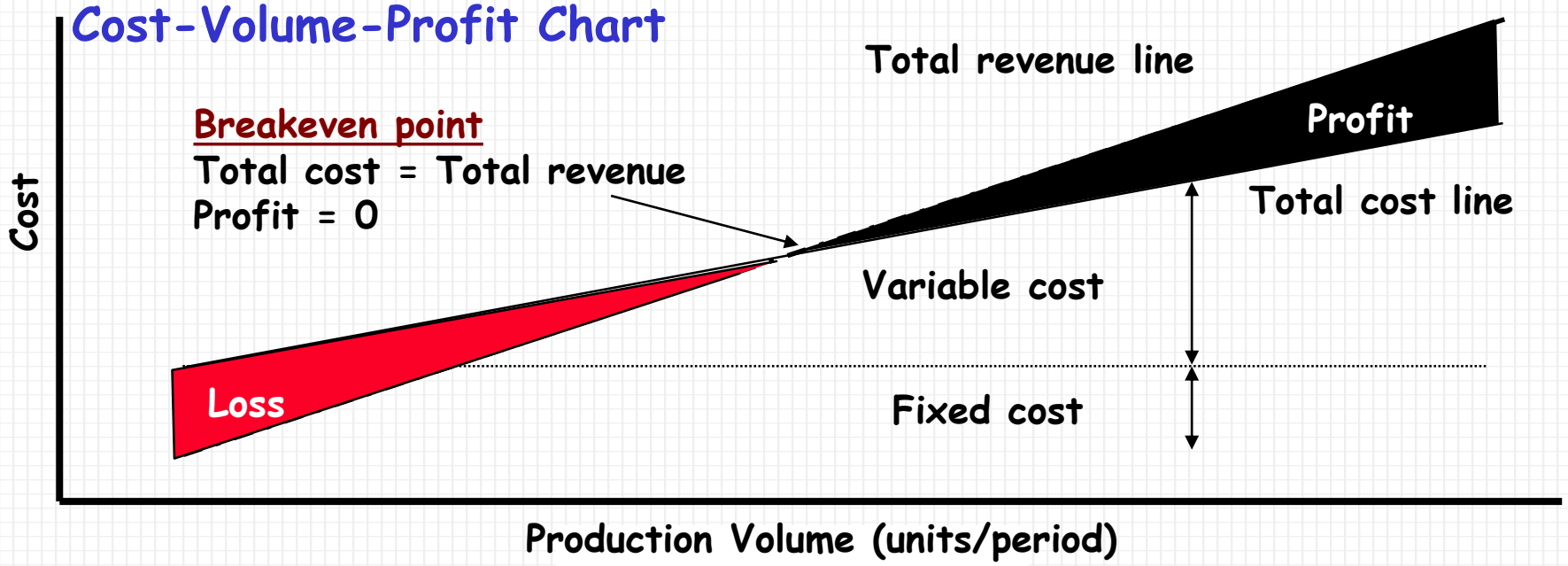
- **Total fixed cost (TFC)** is the cost of fixed inputs, inputs that do not vary with output (e.g., rent)

- **Total variable cost (TVC)** is the cost of all inputs that vary with output (e.g., wages, raw materials)



Break-Even Analysis:

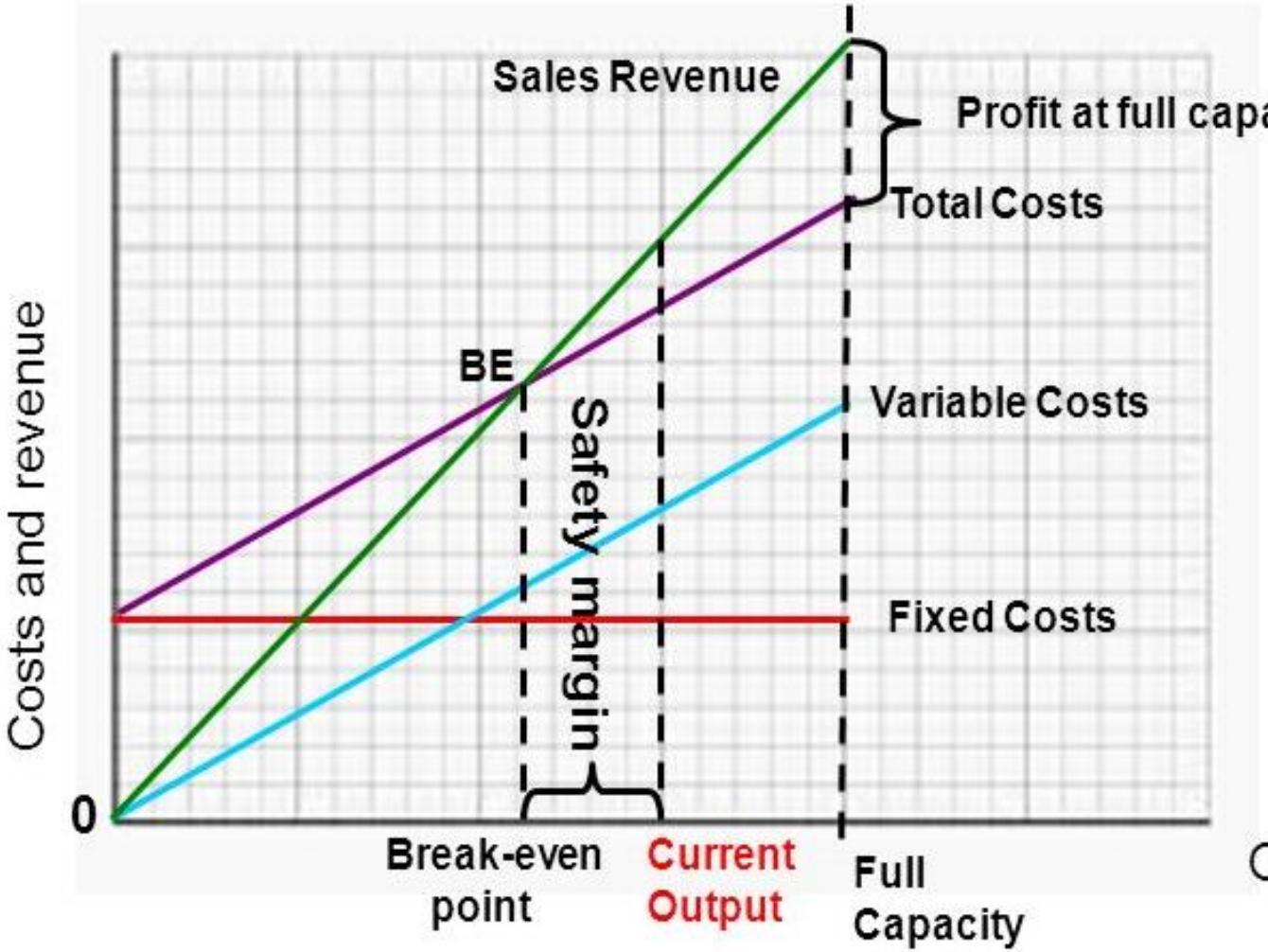
- Determines at what level cost and revenue are in equilibrium
- Break-even point
  - Obtained directly by mathematical calculations
  - Usually presented in graphic form known as break-even chart



Breakeven quantity =

(Total Fixed Cost) / (unit price – unit variable cost)

Breakeven - Margin of Safety



If margin of safety is positive, production is above break even.

If margin of safety is negative, production is below break even.

Margin of safety is the amount by which the sales level exceeds the break-even level. If sales drop below this level, a loss will occur.

Contribution Analysis:

- **Contribution margin** = sales – variable costs
- **Unit Contribution margin** = Unit Price – Unit Variable Cost

- Contribution margin ratio (C/M ratio)
  - Also known as marginal income ratio or Profit-volume ratio
  - Contribution of each dollar towards covering fixed costs and making a profit

Contribution margin ratio = 1 – (Variable costs/Sales)

or

Contribution margin ratio = unit contribution margin/unit sales price

Income Statement:

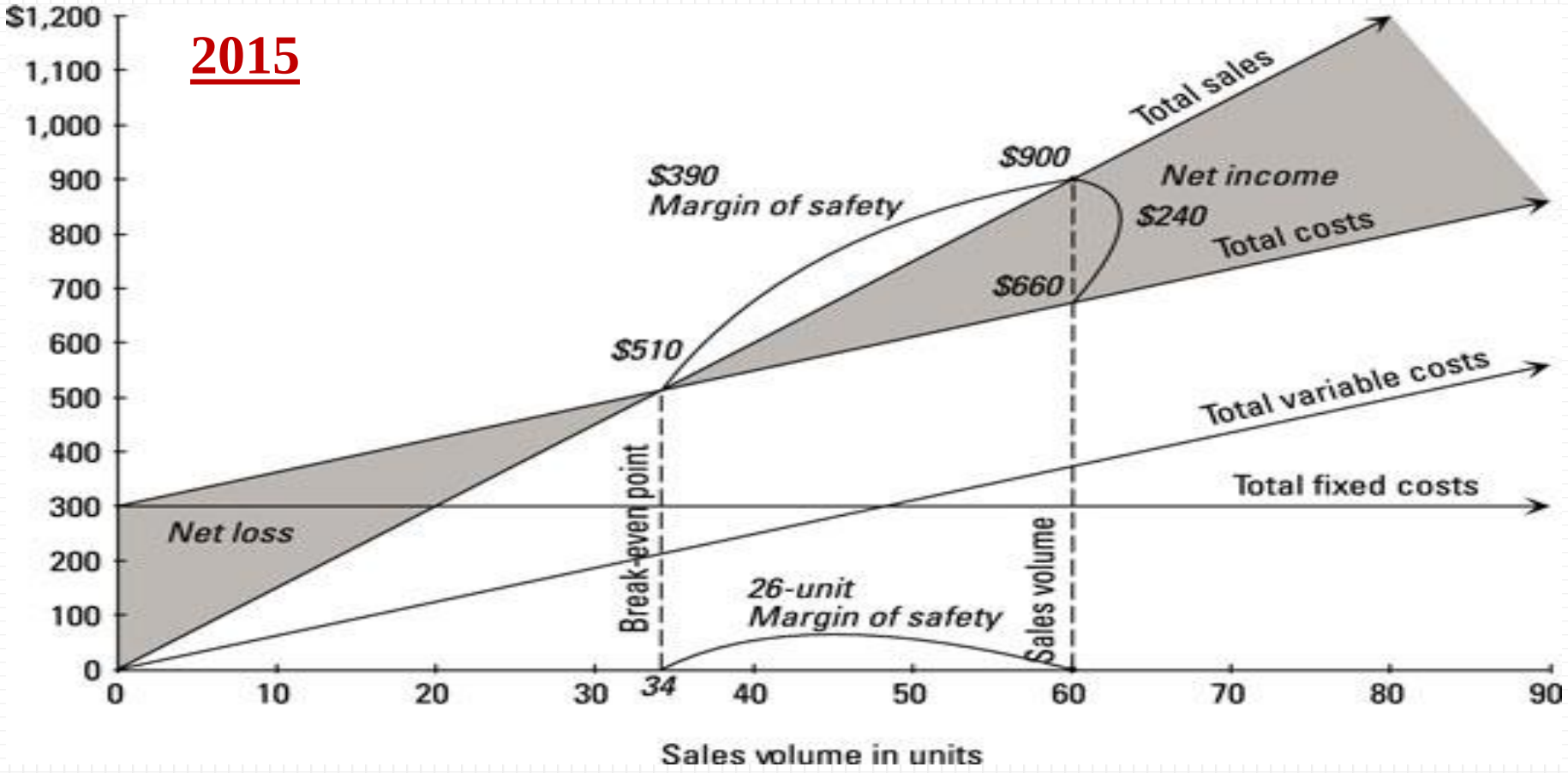
Sales	xxx
Less variable expenses	xxx
Total contribution margin	xxx
Less fixed expenses	xxx
Profit	xxx

$$\text{Break-even sales volume (\$)} = \frac{\text{Fixed costs}}{\text{(Unit Price – Unit Variable)}}$$

$$\text{Break-even sales volume (\$)} = \frac{\text{Fixed costs}}{\text{Contribution margin ratio}}$$

$$\text{Break-even sales volume (\$)} = \frac{\text{Fixed costs}}{\text{1 – (Variable costs/Sales)}}$$

Year	2015	2016	2017
Planned Capacity	60 units	70	80
Annual Fixed Cost	300 M$	325	350
Annual Variable Cost	360 M$	370	380



Year	2015	2016	2017
Planned Capacity	60	70	80
Annual Fixed Cost	300	325	350
Annual Varible Cost	360	370	380
Total cost	660	695	730
Profit	132	139	146
Total price	792	834	876
U. Price	13.2	11.91	10.95
U. Varible	6	5.29	4.75
B.E.P Quantity	41.67	49.03	56.45
BEP %	69.44	70.04	70.56
Margin of safety	30.56	29.96	29.44

Conclusion:

Scenario Analysis

	Worst-Case Scenario	Most-Likely-Case Scenario	Best-Case Scenario
Demand (units)	1,600	2,000	2,400
Unit price ($)	48	50	53
Unit Variable cost ($)	17	15	12
Fixed Cost ($)	11,000	10,000	8,000

Based on this information, discuss the profit & breakeven analysis

Target Net Profit:

- We can use break-even analysis to find the sales required to reach a target level of profit.

- Number of sales units required to earn target profit:

$$= \frac{\text{Fixed Cost + Target net profit}}{\text{Unit contribution margin}}$$

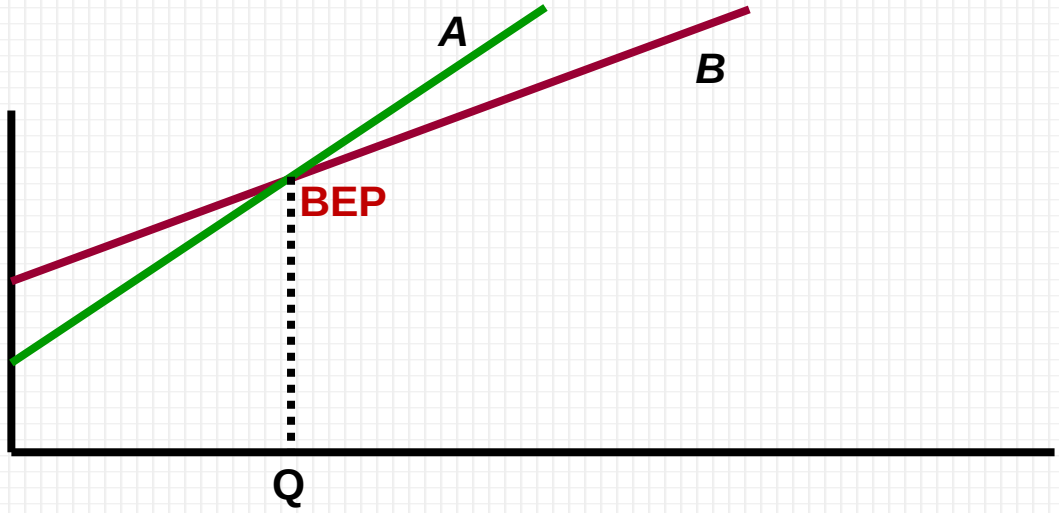
Example:

Calculate the number of units the company needs to sell in order to realize a Profit of $500,000?

Given:

- Fixed costs= $100,000
- Sale price= $10
- Variable cost per unit= $5

Breakeven analysis between two alternatives:



TC = FC + Q.VC

BEP:

TC(A) = TC(B)

$$FC_A + VC_A * Q_{BE} = FC_B + VC_B * Q_{BE}$$

$$Q_{BE} = (FC_A - FC_B) / (VC_B - VC_A)$$

Example:

A manager is trying to decide between two machines (A or B) to produce a certain product:

- **Alt. 1: Machine A:**
  - Fixed Costs:
    - Annual Depreciation: $120,000
    - Annual Maintenance: $20,000
  - Variable costs:
    - Material: $2.25 / unit
    - Labor: $6.25 / unit

- **Alt. 2: Machine B:**
  - Fixed Costs:
    - Annual Depreciation : $165,000
    - Annual Maintenance: $35,000
  - Variable costs:
    - Material: $2.25 / unit
    - Labor: $2.25 / unit

Based on this information, select the best machine.

TC = F + Q.v

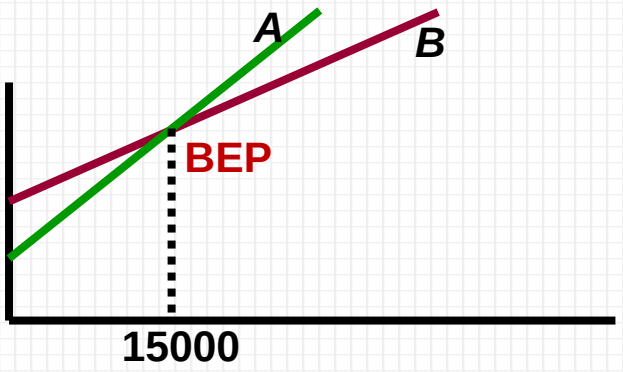
TC(A) = 140,000 + 8.5 Q

TC(B) = 200,000 + 4.5 Q

BEP:
TC(A) = TC(B)
Q = 15,000
TC= 267,500 units

Q= 10,000:
TC(A) = 225,000
TC(B) = 245,000

<15000	15000	>15000
A	A,B	B



Example:

Two alternatives exist for a machining process.

Alternative 1 has an initial cost of $10,000 and a salvage value of $1000 after 5 years. Alternative 1 also has a variable cost of $1/unit of product produced and an annual maintenance of $1000.

Alternative 2 has an initial cost of $15,000 and a salvage value of $2,000 after 7 years. Alternative 2 also has a variable cost of $0.80/unit of product produced and an annual maintenance cost of $1200.

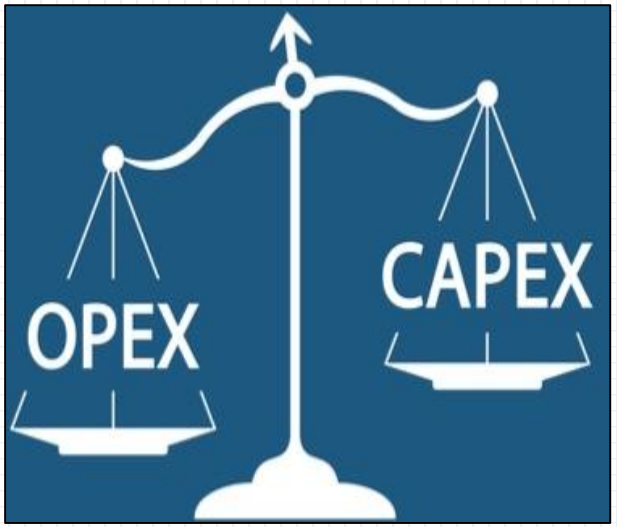
What is the breakeven point in annual production volume?

CAPEX and OPEX Analysis

Total Cost
التكاليف الكلية

Capital Cost
التكليف الإستثمارية

Running Cost
التكاليف التشغيلية



CAPEX Ratio + OPEX Ratio = 100%

Capital Expenses = CAPEX Ratio **(Best CAPEX ≥ 25%)**

= Fixed Asset Depreciation / Annual Total cost

Operating Expenses = OPEX Ratio **(Best OPEX ≤ 75%)**

= 100 – CAPEX

Assets: الأصول:

The economic resources owned by a business that can be used for future operations

Fixed Assets: أصول ثابته

- Land
- Building
- Equipment

Current Assets: أصول متداولة

- Cash
- Accounts Receivable
- Inventories
- Raw Materials
- Supplies

Intellectual Assets:

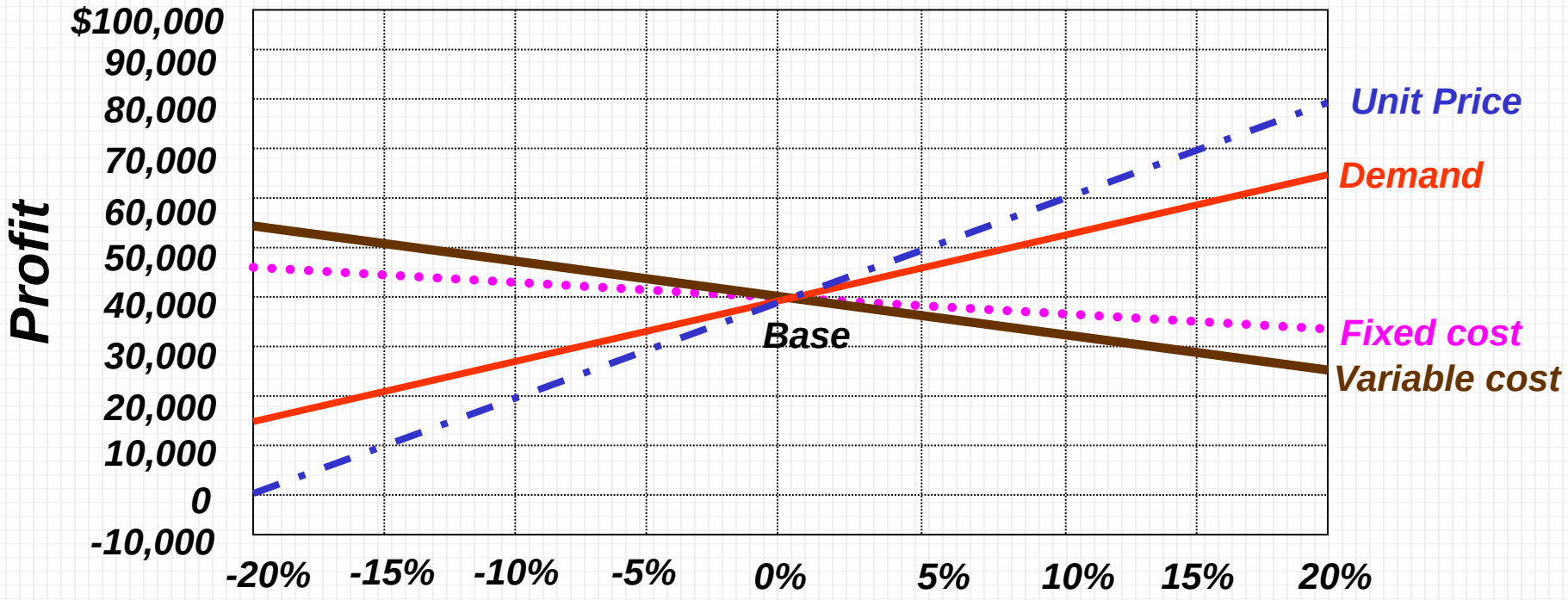
أصول غير ملموسة (فكرية)

- Brand , Know-how

Sensitivity Analysis: Objective: Profit $

Profit Matrix

Deviation	-20%	-15%	-10%	-5%	0% Base	5%	10%	15%	20%
Unit price	$57	$9,999	$20,055	$30,111	$40,169	$50,225	$60,281	$70,337	$80,393
Demand	12,010	19,049	26,088	33,130	40,169	47,208	54,247	61,286	68,325
Variable cost	52,236	49,219	46,202	43,186	40,169	37,152	34,135	31,118	28,101
Fixed cost	44,191	43,185	42,179	41,175	40,169	39,163	38,157	37,151	36,145



Product Cost Analysis: (Information)

The cost classification matrix for a project (First year 2018) is as follows:
Product / Project: xxxxxxx
Unit Price= -- LE/unit **Planned Capacity =** --- units/year

Cost Classification Matrix

Cost Elements		Annual Fixed Cost	Annual Variable Cost
Direct Costs	1) Materials		
	2) Technical labors		
	3) Equipment & Tools		
	4) Sub-Contractor		
Overheads	5) Technical Overhead Costs		
	6) Office Overhead Costs		

Cost Account

Cost Analysis?

Case Study:

Company:	ABC		
Product:	Office Building	Period:	Year 2017
Unit Price:	7,000	Capacity:	6,000 m2

Product / Project Cost Matrix

Cost Elements		Total
Direct Costs (Technical)	1) Raw Materials	18,000,000
	2) Technical labors	6,000,000
	3) Equipment & Tools	6,000,000
	4) Sub-Contractor	
Overheads (Indirect)	5) Technical Overhead	3,000,000
	6) Office Overhead	1,500,000

Case Study:

Company:	ABC		
Product:	Office Building	Period:	Year 2017
Unit Price:	7,000	Capacity:	6,000 m2

Product / Project Cost Matrix

Cost Elements		Total Fixed	Total Variable
Direct Costs (Technical)	1) Raw Materials		18,000,000
	2) Technical labors	2,000,000	4,000,000
	3) Equipment & Tools	2,000,000	4,000,000
	4) Sub-Contractor		
Overheads (Indirect)	5) Technical Overhead	3,000,000	
	6) Office Overhead	1,500,000	

Case Study:

Company:	ABC		
Product:	Office Building	Period:	Year 2017
Unit Price:	7,000	Capacity:	6,000 m2

Product / Project Cost Matrix

Cost Elements		Total CAPEX	Total OPEX
Direct Costs (Technical)	1) Raw Materials		18,000,000
	2) Technical labors	1,000,000	5,000,000
	3) Equipment & Tools	2,000,000	4,000,000
	4) Sub-Contractor		
Overheads (Indirect)	5) Technical Overhead	1,000,000	2,000,000
	6) Office Overhead	500,000	500,000

Case Study:

Product:	Electric Fan		Period:	Year 2015	
Unit Price:	150		Planned Capacity:	100,000	Requirements:

Cost Elements		Annual Fixed Cost	Annual Variable Cost	
Direct Costs	Materials		7,000,000	1) Total Cost Analysis
	Technical labors	2,000,000	1,000,000	2) Unit Cost Analysis
	Equipment & Tools	500,000	500,000	3) Cost Breakdown Structure
	Sub-Contractor			4) Breakeven Analysis
Overheads	Technical Overhead	200,000	100,000	5) CAPEX / OPEX Analysis
	Office Overhead	100,000		6) Sensitivity Analysis (±10%)

Case Study:

Product:	Petrochemical Industry		Period:	Year 2015	
Unit Price:	1500	Planned Capacity:		100,000	Requirements:

Cost Elements		Annual Fixed Cost	Annual Variable Cost
Direct Costs	Materials		65,000,000
	Technical labors	7,000,000	2,000,000
	Equipment & Tools	30,000,000	5,000,000
	Sub-Contractor	3,000,000	2,000,000
Overheads	Technical Overhead	4,000,000	1,000,000
	Office Overhead	2,000,000	1,000,000

1) Total Cost Analysis
2) Unit Cost Analysis
3) Cost Breakdown Structure
4) Breakeven Analysis
5) CAPEX / OPEX Analysis
6) Sensitivity Analysis (±10%)

1) Total Cost Analysis:

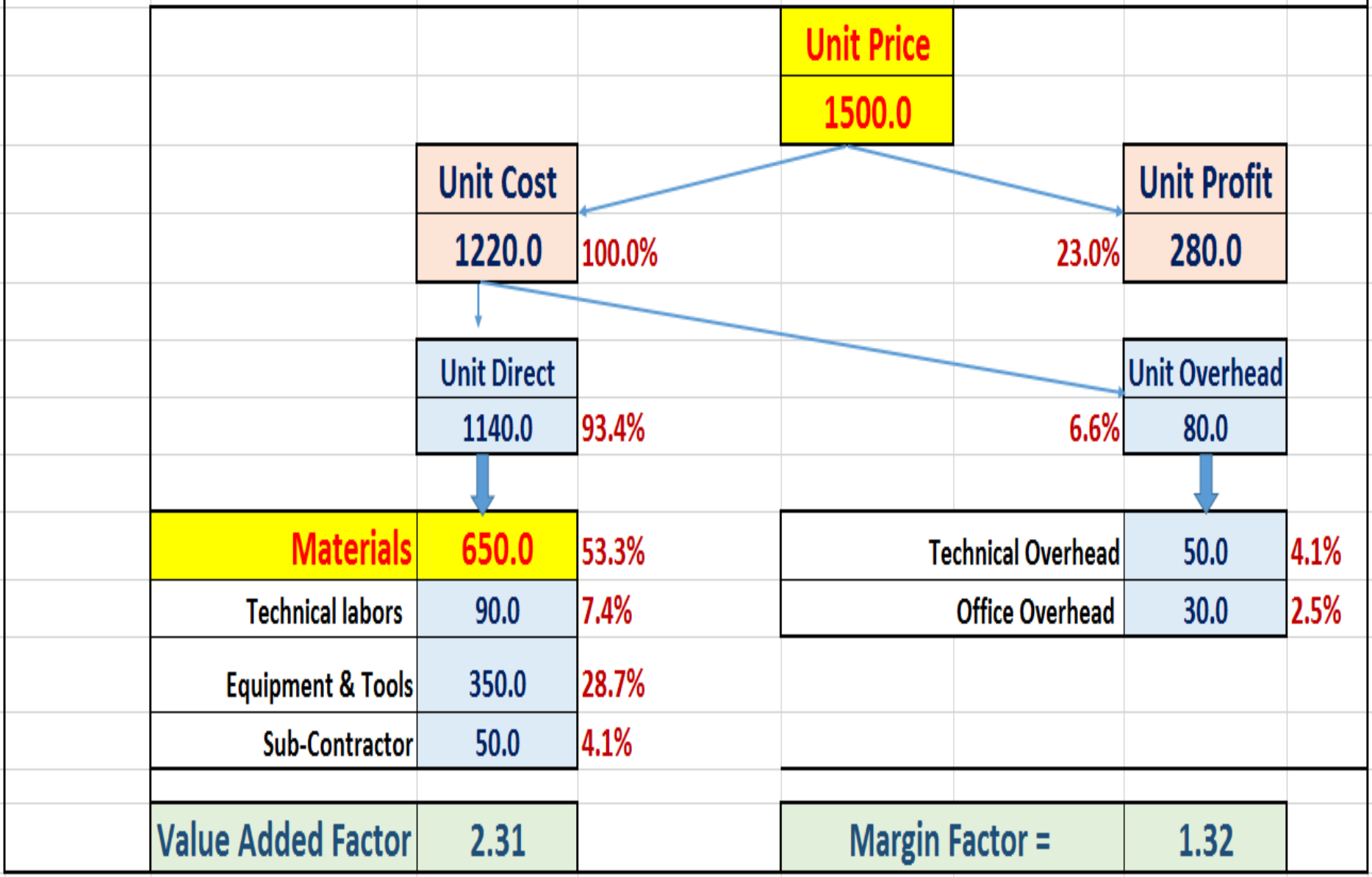
Cost Elements		Annual Fixed Cost	Annual Variable Cost	Total	
Direct Costs	Materials	0	65000000	65,000,000	
	Technical labors	7000000	2000000	9,000,000	
	Equipment & Tools	30000000	5000000	35,000,000	
	Sub-Contractor	3000000	2000000	5,000,000	114,000,000
Overheads	Technical Overhead	4000000	1000000	5,000,000	
	Office Overhead	2000000	1000000	3,000,000	8,000,000
	Total Cost	46,000,000	76,000,000	122,000,000	

Cost Elements		Annual Fixed Cost	Annual Variable Cost	Total	
Direct Costs	Materials	0.0%	53.3%	53.3%	
	Technical labors	5.7%	1.6%	7.4%	
	Equipment & Tools	24.6%	4.1%	28.7%	
	Sub-Contractor	2.5%	1.6%	4.1%	93.44%
Overheads	Technical Overhead	3.3%	0.8%	4.1%	
	Office Overhead	1.6%	0.8%	2.5%	6.56%
	Total Cost	37.7%	62.3%	100.0%	

2) Unit Cost Analysis:

Cost Elements		Unitl Fixed Cost	Unit Variable Cost	Unit Cost	
Unit Direct Costs	Materials	0.0	650.0	650.0	
	Technical labors	70.0	20.0	90.0	
	Equipment & Tools	300.0	50.0	350.0	
	Sub-Contractor	30.0	20.0	50.0	1140.0
Unit Overheads	Technical Overhead	40.0	10.0	50.0	
	Office Overhead	20.0	10.0	30.0	80.0
	Unit Cost	460.0	760.0	1220.0	

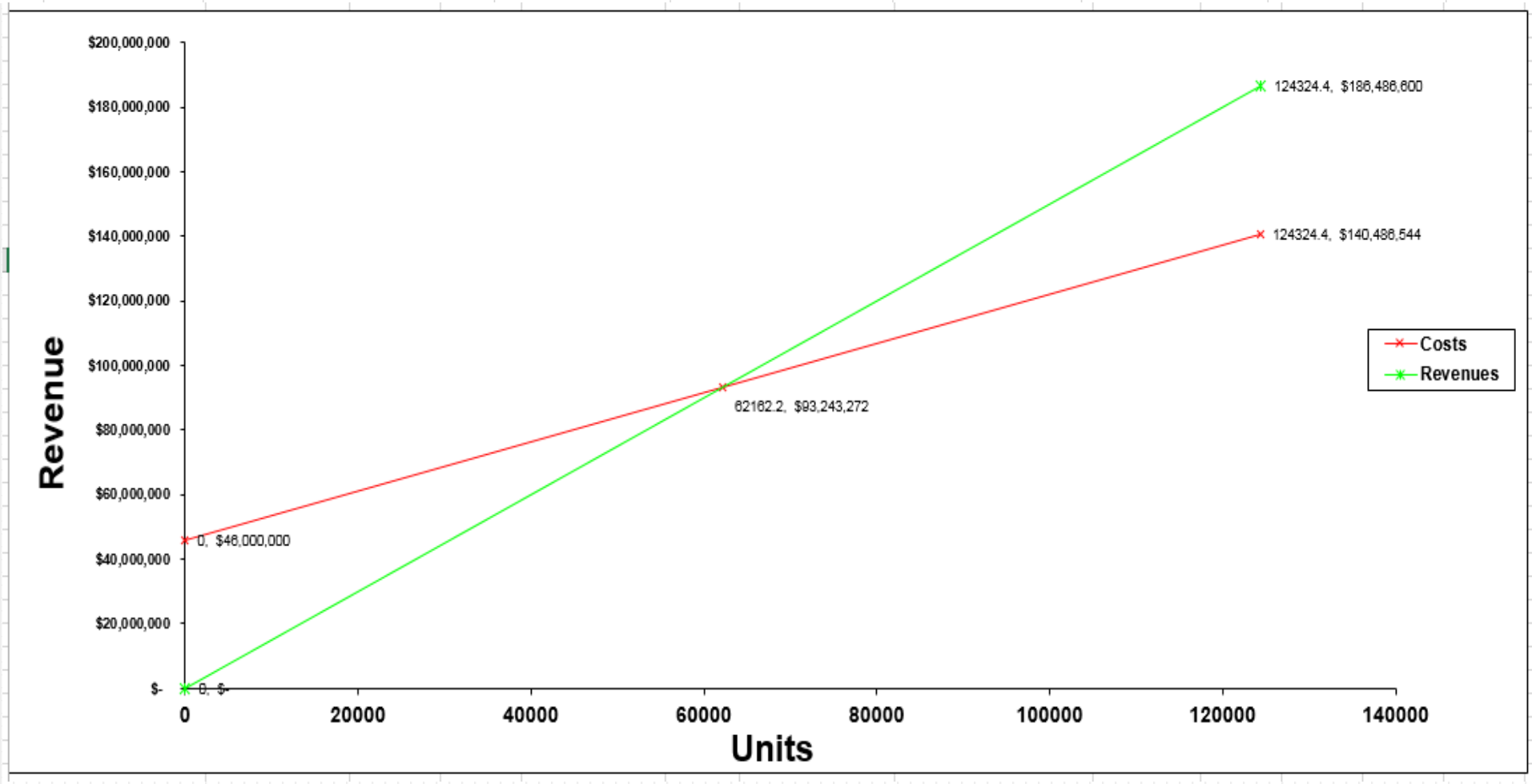
3) Cost Breakdown Structure:



4) Breakeven Analysis:

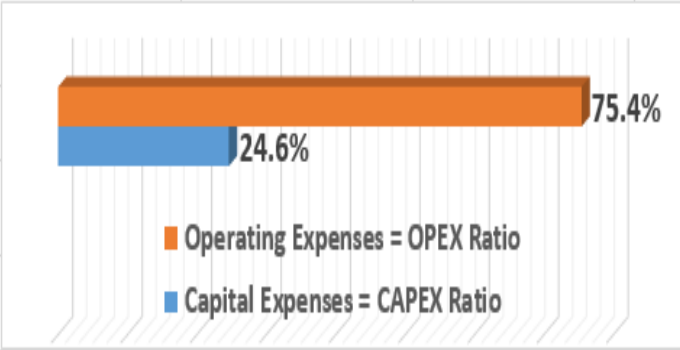
Total Fixed Costs	46,000,000
Variable Cost per Unit	760
Sales Price per Unit	1500

Break-Even Quantity	62162	units
Break-Even Ratio	62.2%	%
Factor of Safety	37.8%	%
Break-Even Value	93,243,243	$



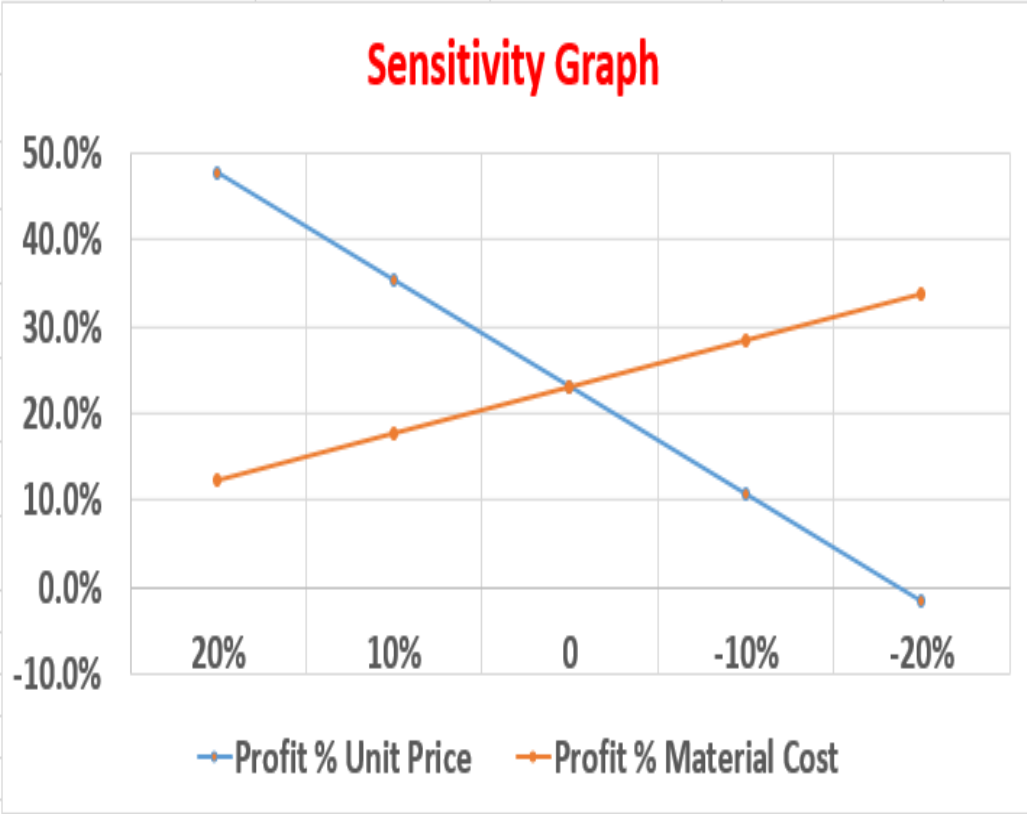
5) CAPEX / OPEX Analysis

Capital Expenses = CAPEX Ratio	24.6%
Operating Expenses = OPEX Ratio	75.4%

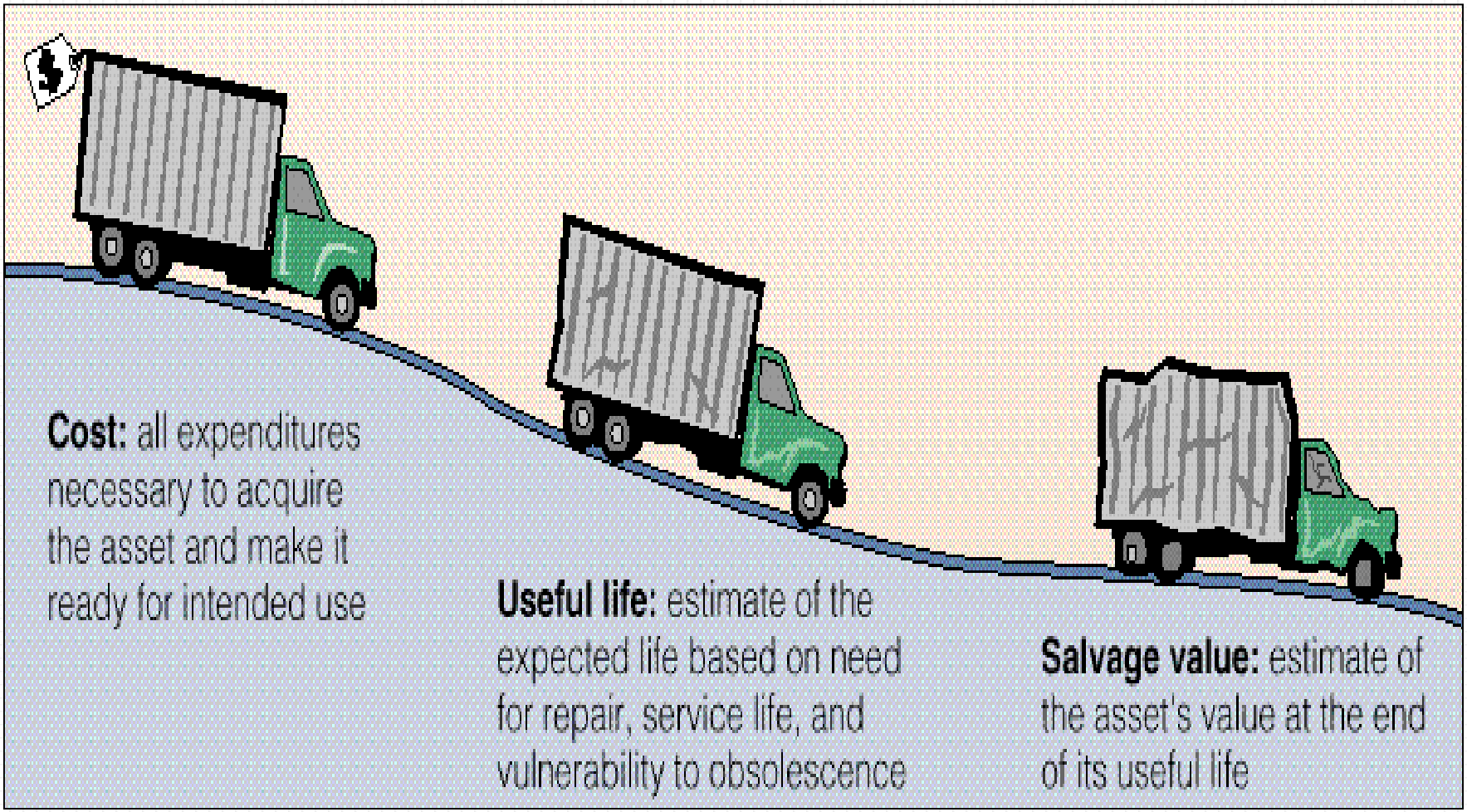


6) Sensitivity Analysis (±10%)

Change %	Profit %	
	Unit Price	Material Cost
20%	47.5%	12.3%
10%	35.2%	17.6%
0	23.0%	23.0%
-10%	10.7%	28.3%
-20%	-1.6%	33.6%

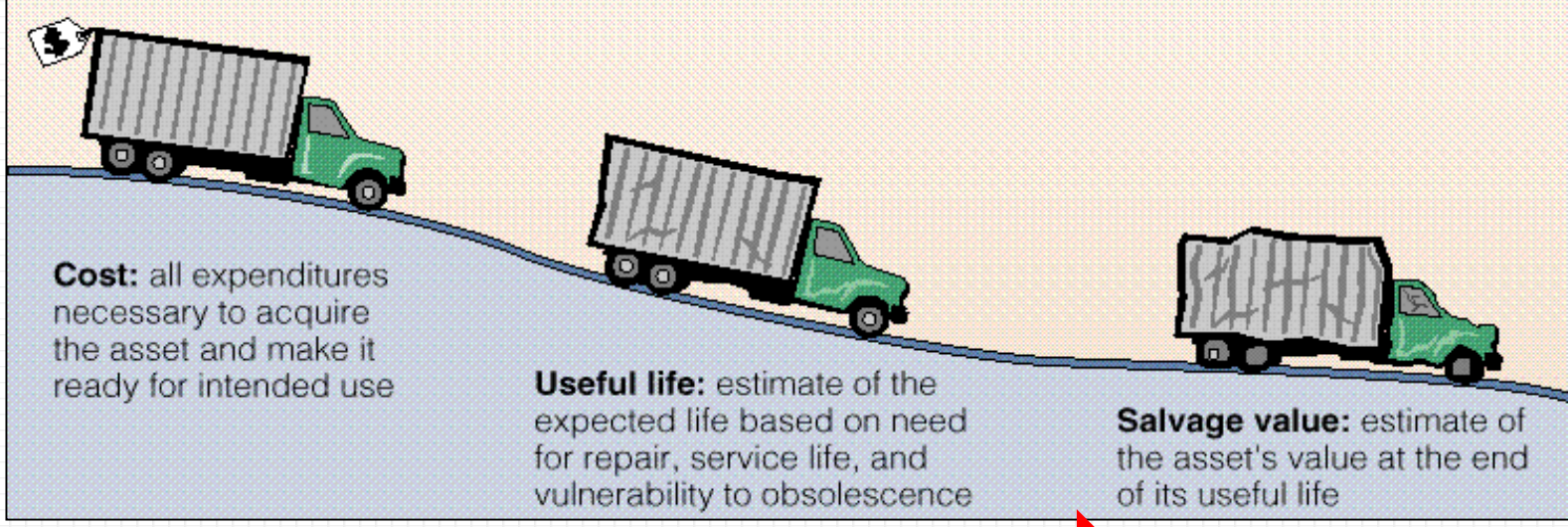


Depreciation Analysis



Depreciation is the systematic allocation of the cost of a depreciable asset to expense.

Example:



Initial Cost
$ 50,000

Life = 5 years

Straight Line = 40,000/5 = $ 8000 / year

Salvage Value
$ 10,000

Period	Book Value	Annual Dep.
0	50,000	
1	42,000	8000
2	34,000	8000
3	26,000	8000
4	18,000	8000
5	10,000	8000

Ok for financial feasibility study only
Not Ok for operational cost management

Main Defect in this method:

1) Neglect technical efficiency
2) Neglect value of many

Relative weight from time to time?

Depreciation Terms

- **Cost:** the price paid for the asset
- **Useful life:** number of years the asset is expected to be used in business
- **Salvage value:** expected market value of the asset at the end of its useful life
- **Book value:** the asset's original cost less accumulated depreciation

Example:

Calculate depreciation for a compressor with initial cost of $10,000, useful life of 5 years (from 2009 to 2013), and salvage value of $2,000.

Discuss & Analysis the depreciation under the following methods.

a) Straight-line depreciation "Constant Value"

b) Sum-of-the-years'-digits.

c) Double-declining balance "Constant ratio"

d) Units-of-Production Method ➔ Production Profile

Year	2009	2010	2011	2012	2013
Annual Running Hours	3000	2500	2000	1500	1000

Total Depreciation Value = (Initial cost – Salvage)
= 10,000 - 2,000 = 8,000

1) Straight-line depreciation:

Annual Depreciation = 8,000/5 = 1,600 $/year

Year	0	1	2	3	4	5
Dep.		1,600	1,600	1,600	1,600	1,600
Book Value	10,000	8,400	6,800	5,200	3,600	2,000

2) Sum-of-the-years'-digits:

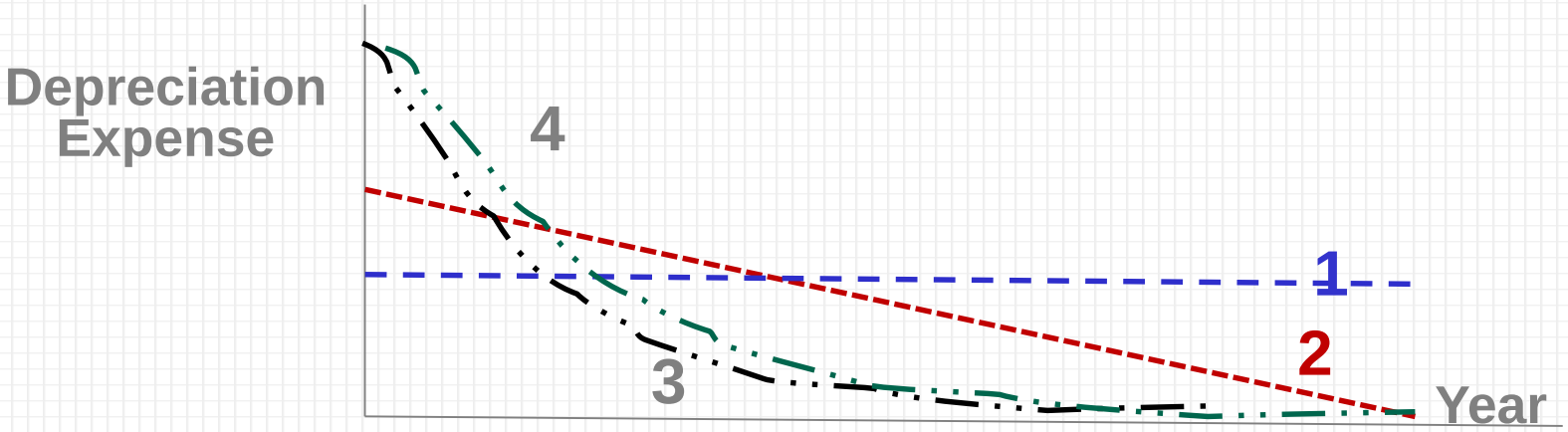
Year	0	1	2	3	4	5
Rel. weight		5	4	3	2	1
Factor		5/15	4/15	3/15	2/15	1/15
Dep.		2666.7	2133.3	1600	1066.7	533.3
Book Value	10,000	7333.3	5200	3600	2533.3	2,000

3) Double-declining balance : Constant ratio = 2/n = 0.4

Year	0	1	2	3	4	5
Dep.		3200	1920	1152	691.2	414.7
Book Value	10,000	6800	4880	3728	3036.8	2,000

4) Units-of-Production Method:

Year	0	1	2	3	4	5
Factor		0.3	0.25	0.20	0.15	0.10
Dep.		2400	2000	1600	1200	800
Book Value	10,000	7600	5600	4000	2800	2,000



Example:

Calculate depreciation for a new car with initial cost of $50,000, useful life of 5 years (from 2009 to 2013), and salvage value of 40% initial cost.

Discuss & Analysis the depreciation under the following methods.

a) Straight-line depreciation.

b) Sum-of-the-years'-digits.

c) Double-declining balance "Constant ratio"

d) Units-of-Production Method ➔ Production Profile

Year	2009	2010	2011	2012	2013
Annual Km	60000	50000	45000	30000	25000

Example:

A new excavator equipment with initial cost of $200,000, useful life of 5 years (from 2009 to 2013), and salvage value of 50% initial cost.

Discuss & Analysis the annual depreciation and the book value under the following methods:

a) Straight-line depreciation.

b) Sum-of-the-years'-digits.

c) Double-declining balance "Constant ratio"

d) Optimal constant ratio

e) Units-of-Production Method ➔ Production Profile

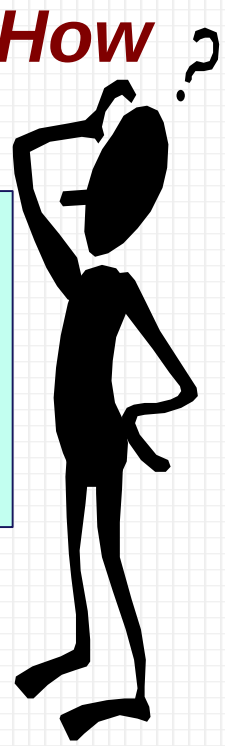
Year	2009	2010	2011	2012	2013
Annual performance(1000 m3)	60	80	100	80	60

Depreciation Information System ➔ Long term ➔ Blue Book

Asset / Equipment	Life, year	Salvage (% initial)	Dep. Method
Computer Units	5	10%	SYD
Building	50	zero	SL
Service Facilities System (SFS)	10	zero	Production units
Crude Oil Pipe Line	20	zero	Production units
Cars	10	10%	CR
Water Pump	10	10%	CR
Equipment (crane, excavator, ..)	20	10%	CR 10%

Project Financial Analysis (Long Term)

Cash Flow Analysis



Time is money;

there is a difference between $1000 today and $1000 after 3 years.

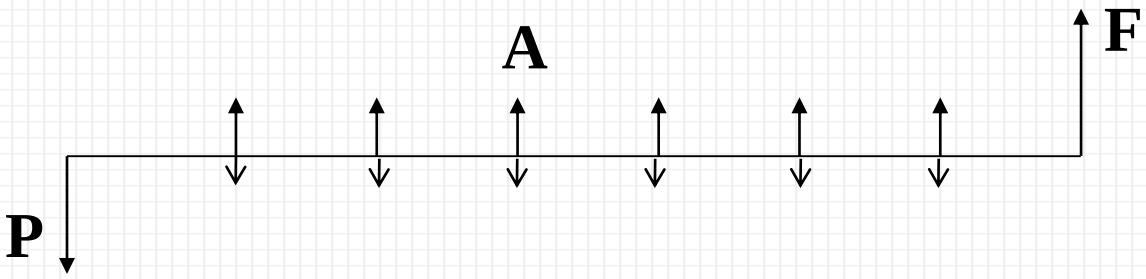
If the interest rate 10% annual; then:

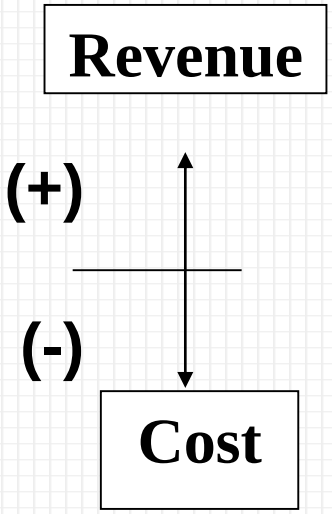
$ 1000 today = $ 1331 after 3 years

$$F = P\ (1 + i)^n \quad \Rightarrow \quad P = F / (1 + i)^n$$

Cash Flow Analysis

$$F = P\ (1 + i)^n$$





i = Interest rate (%)

P = Present value

F= Future value

A= Annual uniform value

n = Life time (year)

➔ Value at time = 0

➔ Value at time > 0

➔ Equal value over time

- Interest rate ➔ Certain bank ➔ i% given (10%)
- Minimum Attractive Rate of Return (MARR)
- Internal Rate return ➔ Cash In/out for Certain project

Project Financial Analysis:

1. **Payback Period**
2. **Net Present Value (NPV)**
3. **Profitability Index**
4. **Internal Rate of Return (IRR)**
5. **Minimum Attractive Rate of Return (MARR)**

Payback Period

Definition:

The length of time until the original investment has been recouped by the project

- ***Ignore time value of money***
- ***Does not consider profitability***
- ***A shorter payback period is better***

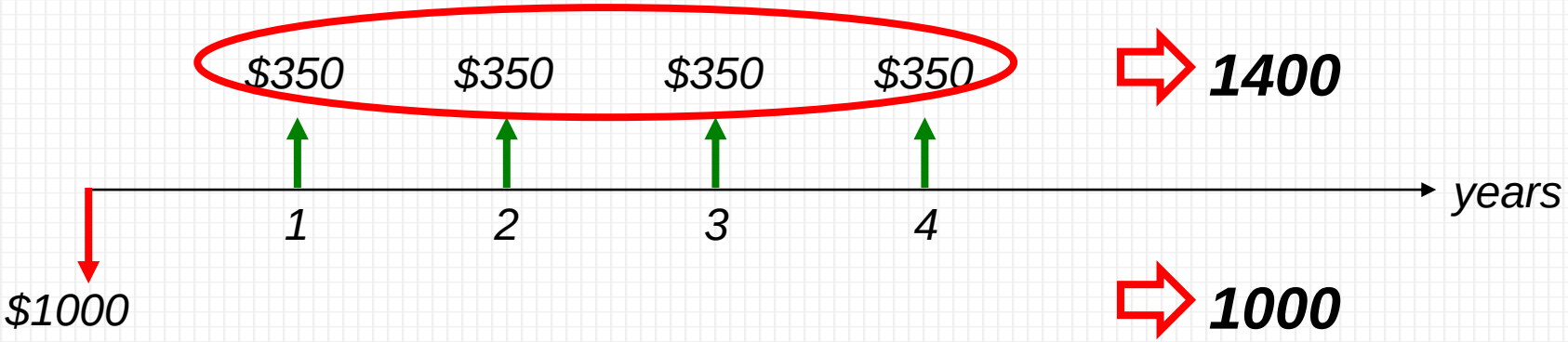
Example:

Year	Project X	Cumulative Cash Flow
0	–$100	–$100
1	25	–75
2	50	–25
3	75	50

Payback period = 2 + 25 / 75 = 2.333 years

Firm recovers its initial investment in 2.333 years

Example:

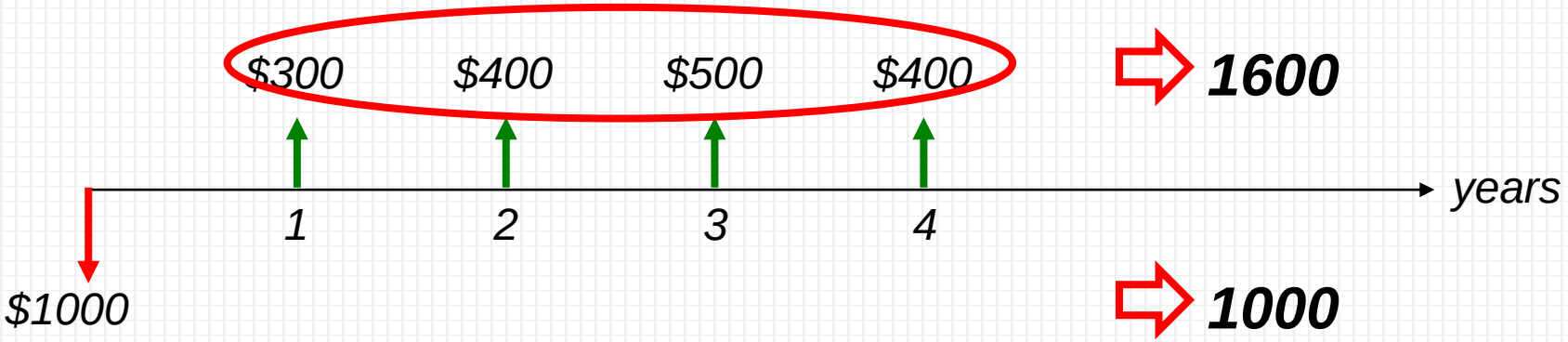


Year	0	1	2	3	4
Cost	-1000				
Revenue		+350	+350	+350	+350
Cumulative Cash Flow	-1000	- 650	- 300	+ 50	+400

Payback Period = (2 to 3) years

= 2 + 300/350 = 2.857 years = 2 years & 11 months

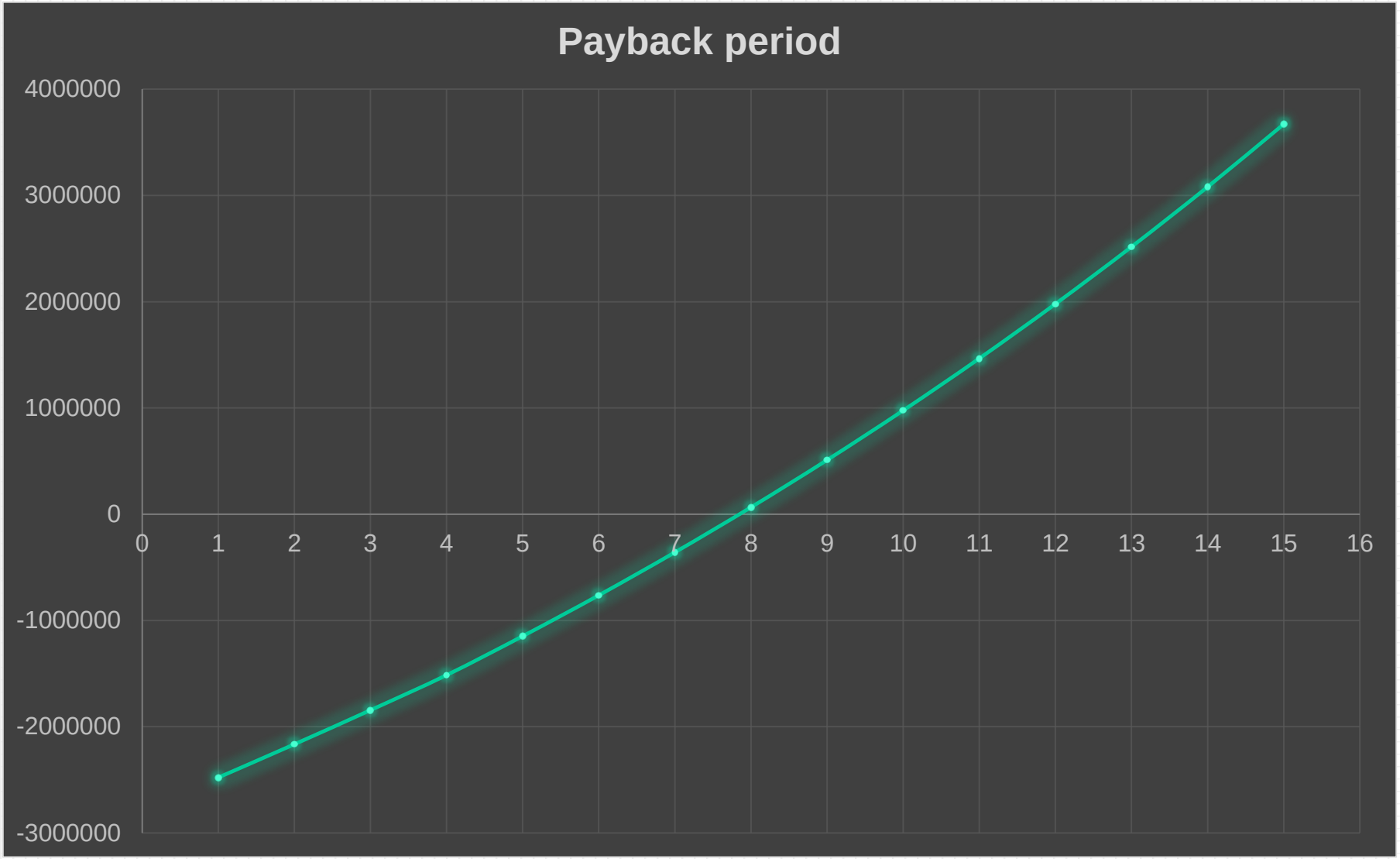
Example:



Year	0	1	2	3	4
Cost	-1000				
Revenue		+300	+400	+500	+400
Cumulative Cash Flow	-1000	- 700	- 300	+ 200	+600

Payback Period = (2 to 3) years

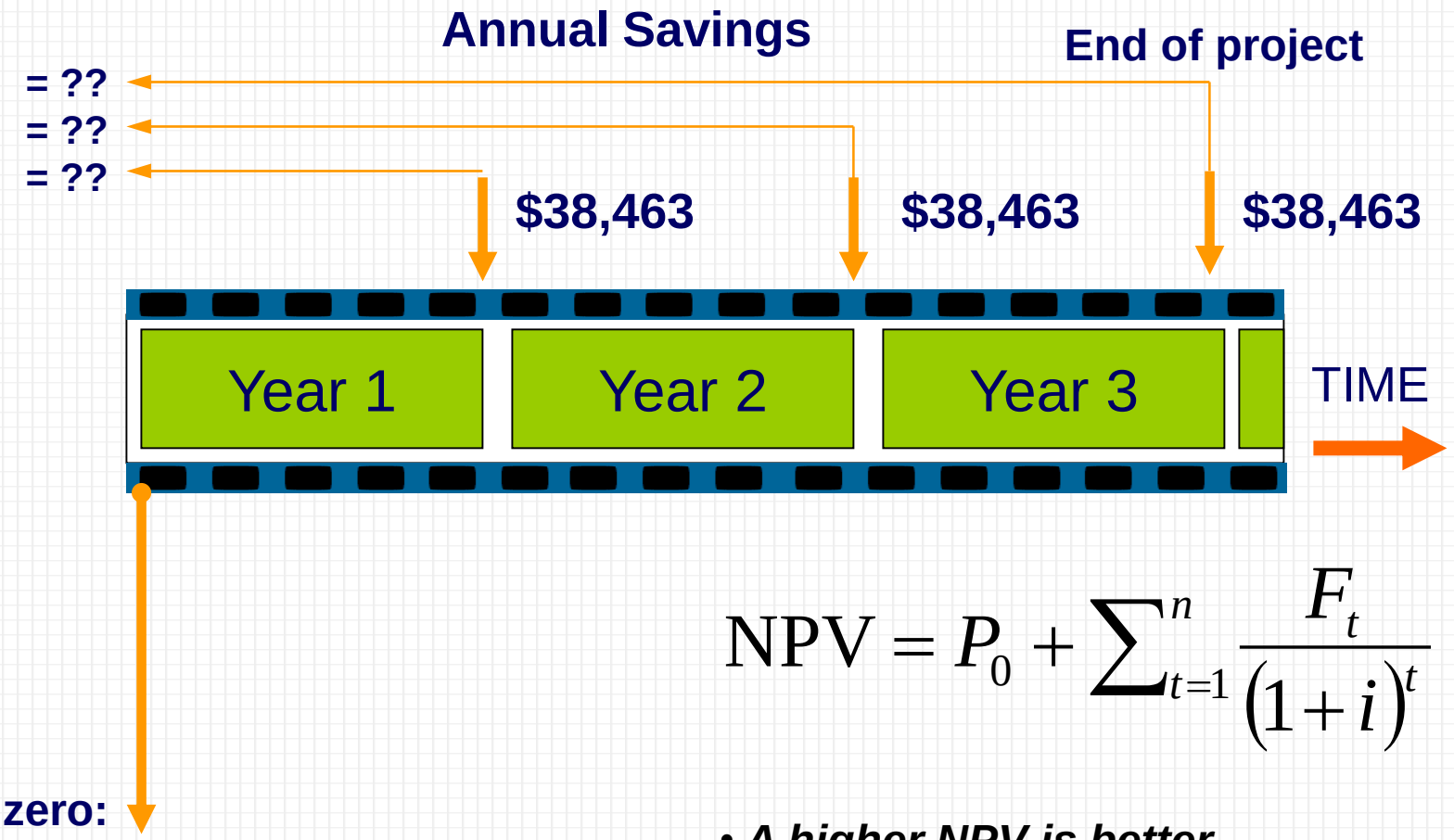
= 2 + 300/500 = 2.6 years = 2 years & 7.2 months



Based on the communitive cash flow the Payback period = 7.85 Years

Net Present Value (NPV)

Converting Cash Flows to Present Value

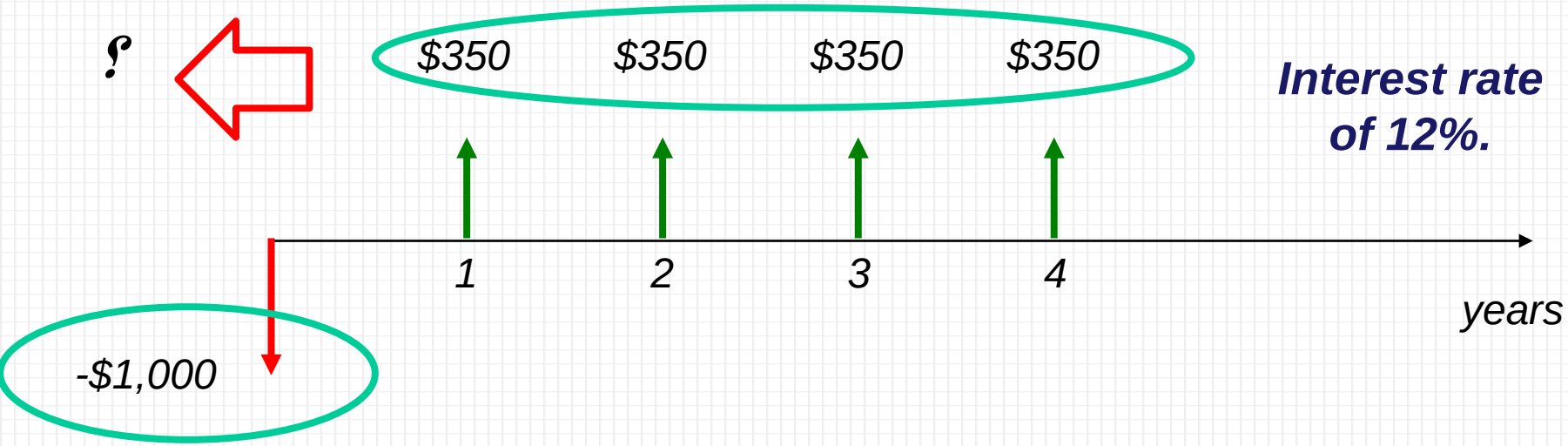


$$NPV = P_0 + \sum_{t=1}^{n} \frac{F_t}{(1+i)^t}$$

- *A higher NPV is better*
- *Higher the discount rate lower the NPV*

Example:

Net Present Value



$$P = F / (1 + i)^n$$

$$NPV(Investment)$$

$$= -1{,}000 + \frac{350}{1.12} + \frac{350}{1.12^2} + \frac{350}{1.12^3} + \frac{350}{1.12^4}$$

$$= -1{,}000 + 350*0.89 + 350*0.80 + 350*0.71 + 350*0.64$$

$$= +63$$

+

- x	IRR<i
0	IRR=i
+ y	IRR>i

Profitability Index:

- **Allows a comparison of the costs and benefits of different projects to be assessed and thus allow decision making to be carried out**

Cost Benefits

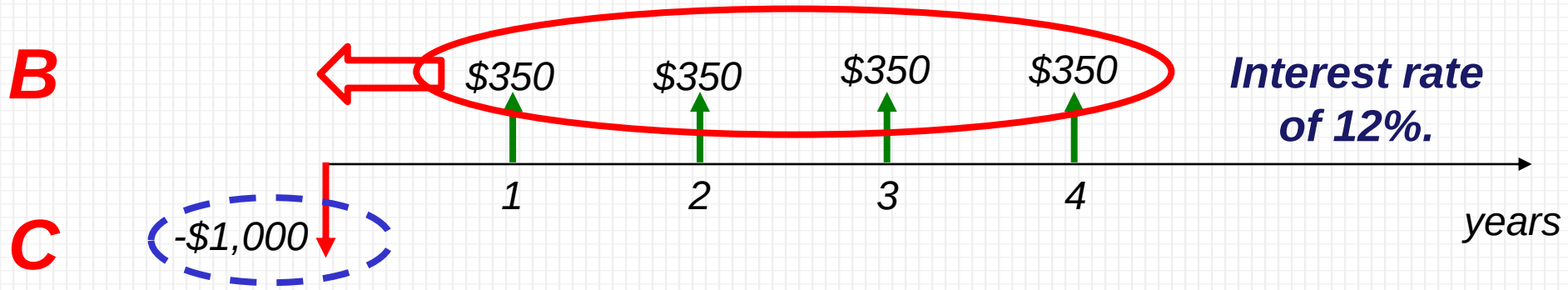
(B/C)

$$\text{Profitability Index} = \frac{\text{NPV (cash inflow)}}{\text{Initial Capital Cost}}$$

PI < 1.0 ➔ Losses ➔ Rejected (or Service projects)

PI = 1.0 ➔ Break even point ➔ short term projects

PI > 1.0 ➔ Profit ➔ Accepted (Best ≥ 1.20)



Profitability Index = 1063 / 1000 = 1.063 > 1.0 Accepted

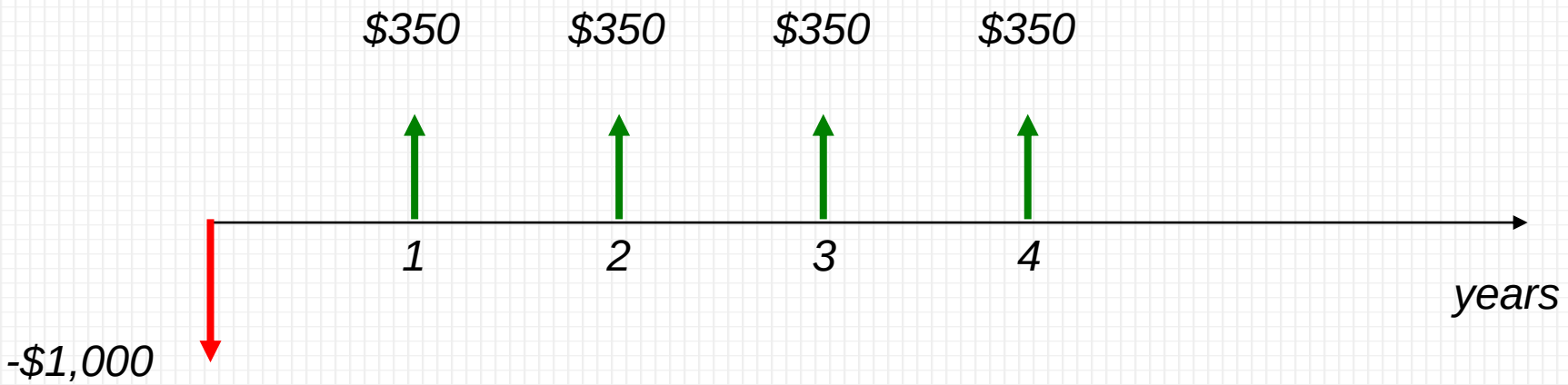
Example:

Internal Rate of Return

Definition:

The rate of return that yields a Net Present Value of zero.

Example:



$$P = F / (1 + i)^n$$

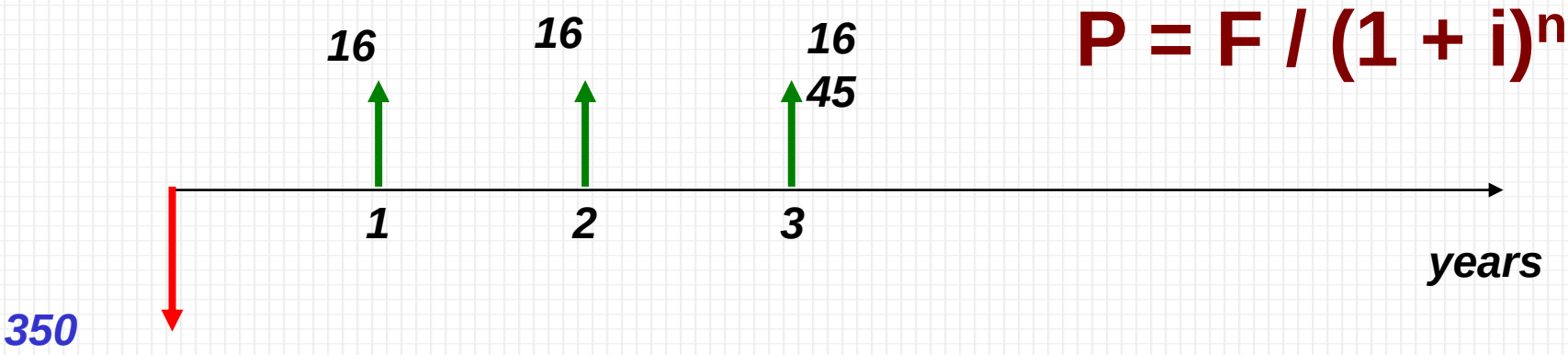
$$\frac{350}{1+IRR} + \frac{350}{(1+IRR)^2} + \frac{350}{(1+IRR)^3} + \frac{350}{(1+IRR)^4} - 1{,}000 = 0 \Rightarrow IRR = 0.15$$

14.96%

Example:

You can purchase a building for $350,000. The investment will generate $16,000 in cash flows (i.e. rent) during the first three years. At the end of three years you will sell the building for $450,000.

What is the IRR on this investment?



$$P = F / (1 + i)^n$$

$$0 = -350{,}000 + \frac{16{,}000}{(1+IRR)^1} + \frac{16{,}000}{(1+IRR)^2} + \frac{466{,}000}{(1+IRR)^3}$$

IRR = 12.96%

Example:

A manager is trying to decide between two projects (A or B):

Item	Project (A)	Project (B)
Initial Investment; M$	5	7
Annual Running Cost; M$/year	2	2
Annual Revenue; M$/year	4	5
Salvage Value; M$	1	2
Project Life; years	4	4

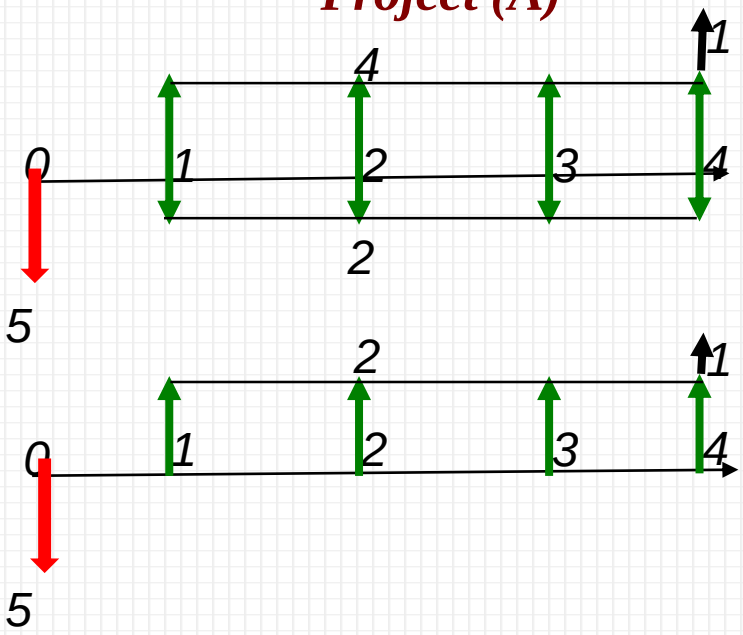
Minimum Attractive Rate of Return (MARR) 20%

Based on this information, discuss the following:

1. Cash Flow Diagram
2. Payback Period
3. Internal Rate of Return (IRR)
4. Which offer should you accept and why?
5. Sensitivity analysis for annual revenue, salvage value& initial investment (±10%)

Cash Flow Diagram:

Project (A)

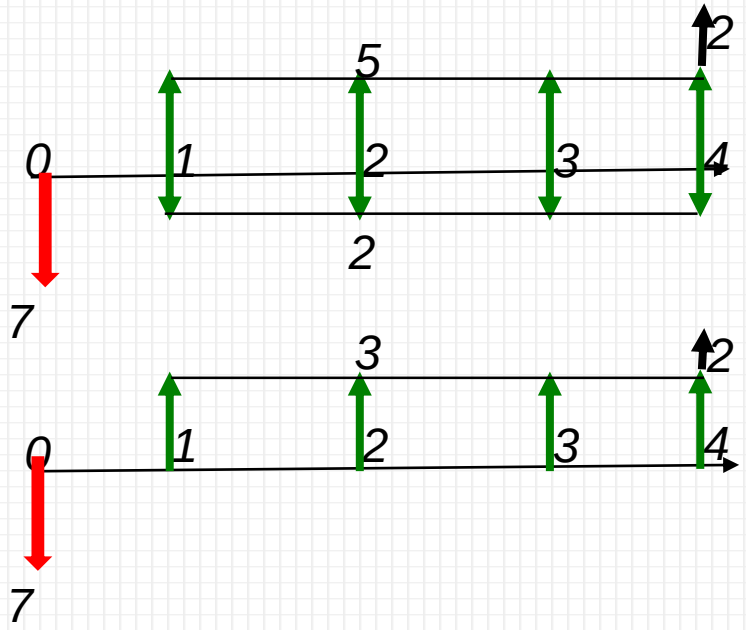


Payback Period = 5/2 = 2.5 years
= 2 years & 6 months

0 = - 5 +2/(1+i) + 2/(1+i)^2
+ 2/(1+i)^3 + 3/(1+i)^4

IRR = 26.40 % > 20% MARR (Accepted)

Project (B)



Payback Period = 7/3 = 2.33 years
= 2 years & 4 months

0 = - 7 +3/(1+i) + 3/(1+i)^2
+ 3/(1+i)^3 + 5/(1+i)^4

IRR = 31.56 % > 20% MARR (Accepted)

IRR (A) < IRR (B) < MARR
Project B is better than project A

Financial Analysis - Dr. Attia Gomaa - 2018

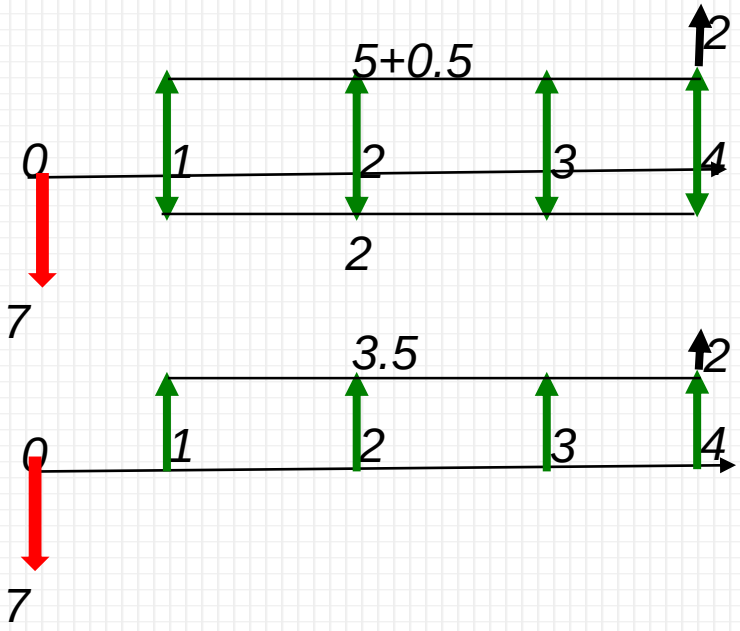
Time	Cost	Revenue	Net	Cumulative	Payback
0	5		-5	-5	FALSE
1	2	4	2	-3	FALSE
2	2	4	2	-1	FALSE
3	2	4	2	1	TRUE
4	2	5	3	4	TRUE
5			0	4	TRUE
6			0	4	TRUE
7			0	4	TRUE
8			0	4	TRUE
9			0	4	TRUE
10			0	4	TRUE
11			0	4	TRUE
12			0	4	TRUE
13			0	4	TRUE
14			0	4	TRUE

Bank Interest Rate		Given
	20.00%	
Internal Rate of Return (IRR)		=IRR(E4:E24)
	26.4%	
Net Present Value (NPV)		=NPV(I4,E5:E24)+E4
	0.7	20.00%
Profitability Index		=IF(E4>=0,"Don't Use PI.", NPV(I4,E5:E24)/ABS(E4))
	1.13	20.00%
Payback Period (year)		
	3	First Year Positive

Sensitivity Analysis for Project (B)

Annual revenue (±10%)

Project (B)

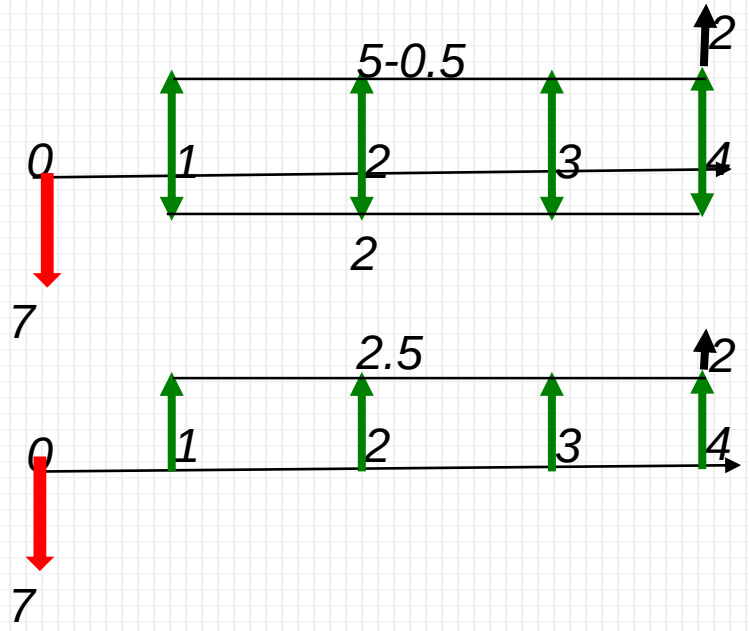


Payback Period = 7/3.5 = 2years

0 = - 7 +3.5/(1+i) + 3.5/(1+i)^2 + 3.5/(1+i)^3 + 5.5/(1+i)^4

IRR = 39.94 %

Project (B)



Payback Period = 7/2.5 = 2.8 years = 2 years & 10 months

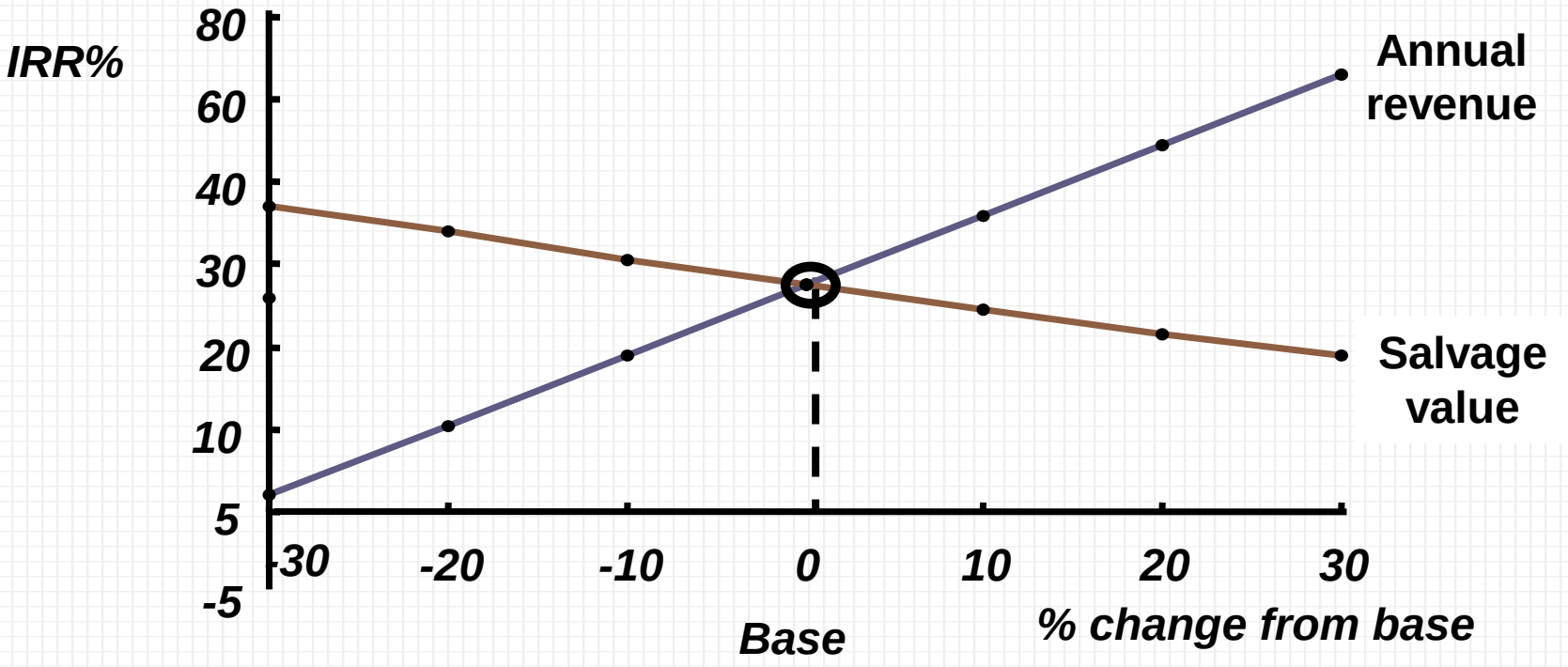
0 = - 7 +2.5/(1+i) + 2.5/(1+i)^2 + 2.5/(1+i)^3 + 4.5/(1+i)^4

IRR = 22.96

Sensitivity Analysis Graph for Project (B)

IRR Matrix

Deviation	-20%	-15%	-10%	-5%	0% Base	5%	10%	15%	20%
Annual revenue			22.96		31.56 %		39.94		
Salvage value					31.56 %				
Initial Investment					31.56 %				



Example:

A manager is trying to decide between two projects (A or B):

Item	Project (A)	Project (B)
Initial Investment; M$	4.5	5.0
Annual Running Cost; M$/year	1.1	1.2
Annual Revenue; M$/year	2.5	3.0
Salvage Value; M$	1.1	1.2
Project Life; years	4	4

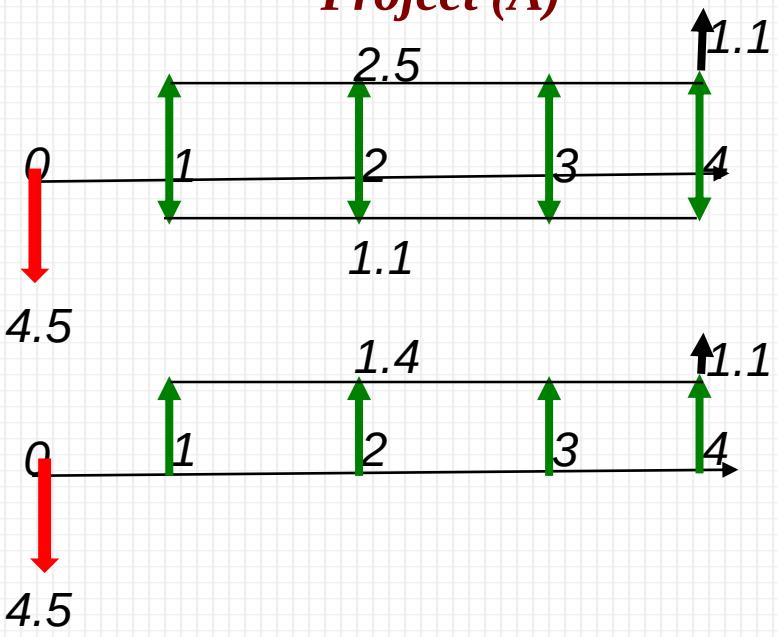
Minimum Attractive Rate of Return (MARR) 25%

Based on this information, discuss the following:

1. Cash Flow Diagram
2. Payback Period
3. Internal Rate of Return (IRR)
4. Which offer should you accept and why?
5. Sensitivity analysis for annual revenue, salvage value& initial investment (±10%)

Cash Flow Diagram:

Project (A)

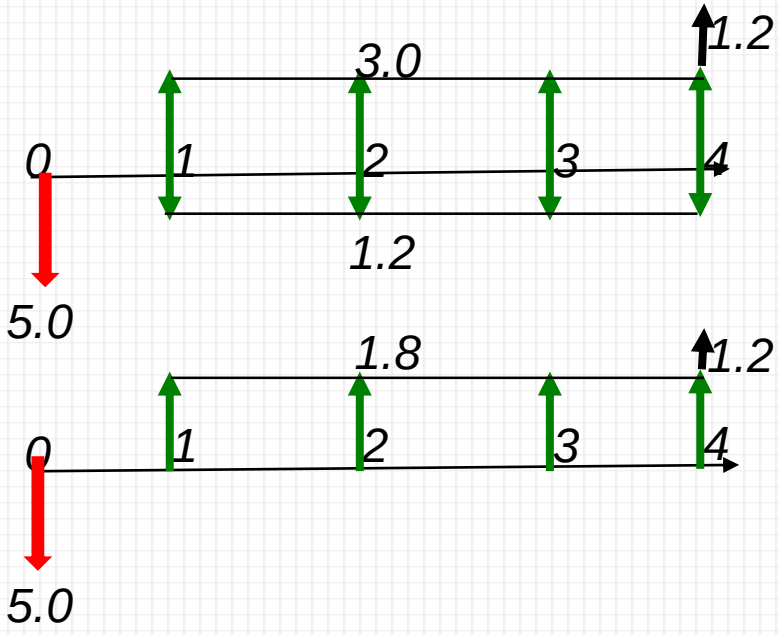


Payback Period = 3.21 years
= 3 years & 3 months

0 = - 4.5 +1.4/(1+i) + 1.4/(1+i)^2
+ 1.4/(1+i)^3 + 2.5/(1+i)^4

IRR = 16.25 % < 25% MARR (rejected)

Project (B)



Payback Period = 2.78 years
= 2 years & 10 months

0 = - 5.0 +1.8/(1+i) + 1.8/(1+i)^2
+ 1.8/(1+i)^3 + 3.0/(1+i)^4

IRR = 22.3 % < 25% MARR (rejected)

IRR (A) < IRR (B) < MARR
Project B is better than project A

Financial Analysis - Dr. Attia Gomaa - 2018

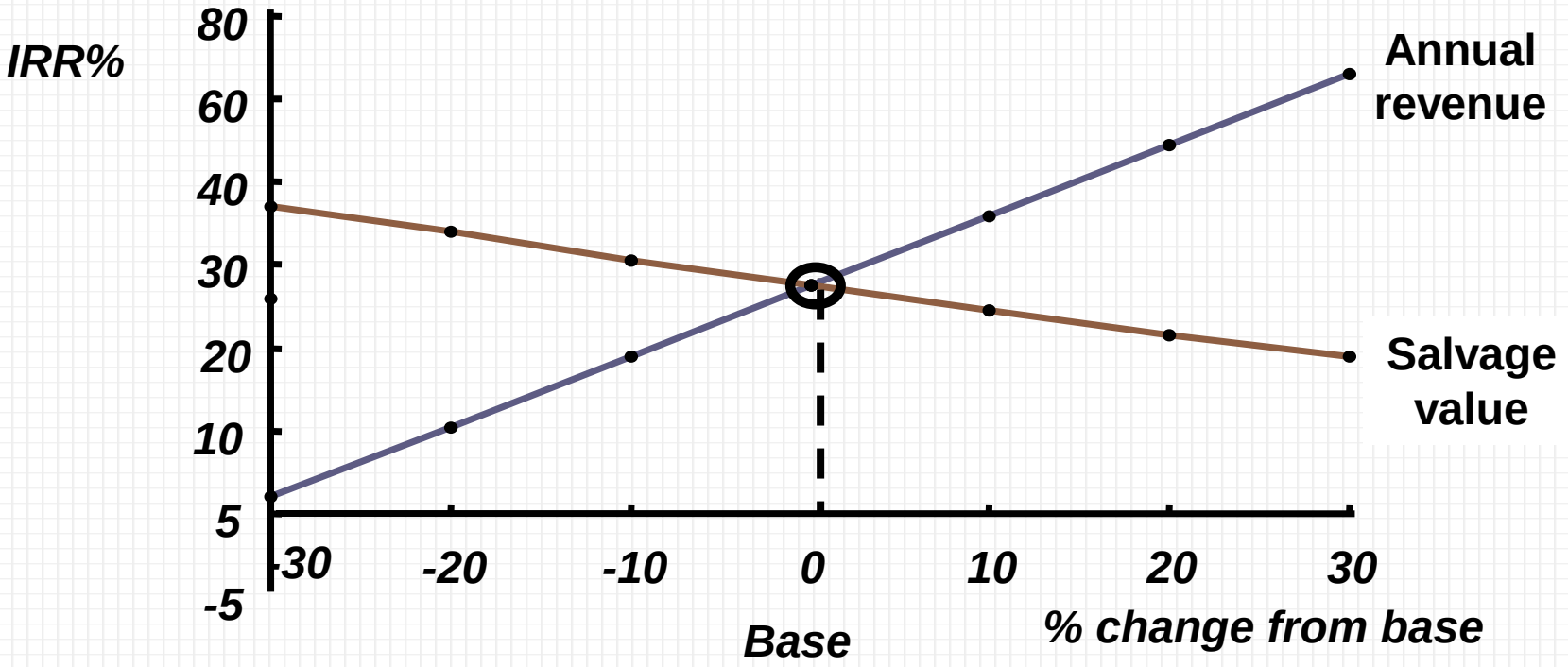
Time	Cost	Revenue	Net	Cumulative	Payback
0	4.5		-4.5	-4.5	FALSE
1	1.1	2.5	1.4	-3.1	FALSE
2	1.1	2.5	1.4	-1.7	FALSE
3	1.1	2.5	1.4	-0.3	FALSE
4	1.1	3.6	2.5	2.2	TRUE
5			0	2.2	TRUE
6			0	2.2	TRUE
7			0	2.2	TRUE
8			0	2.2	TRUE
9			0	2.2	TRUE
10			0	2.2	TRUE
11			0	2.2	TRUE
12			0	2.2	TRUE
13			0	2.2	TRUE
14			0	2.2	TRUE
15			0	2.2	TRUE

Bank Interest Rate		Given
	25.00%	
Internal Rate of Return (IRR)		=IRR(E4:E24)
	16.3%	
Net Present Value (NPV)		=NPV(I4,E5:E24)+E4
	(0.7)	25.00%
Profitability Index		=IF(E4>=0,"Don't Use PI.", NPV(I4,E5:E24)/ABS(E4))
	0.83	25.00%
Payback Period (year)		
	4	First Year Positive

Sensitivity Analysis Graph for Project (B)

IRR Matrix

Deviation	-20%	-15%	-10%	-5%	0% Base	5%	10%	15%	20%
Annual revenue			22.96		22.3 %		39.94		
Salvage value					22.3 %				
Initial Investment					22.3 %				



Example:

Item	Scenario		
	Worst	Base	Best
Probability; %	25%	50%	25%
Initial Investment; M$	6	5	4
Annual Running Cost; M$/year	5	4	3
Annual Revenue; M$/year	4	5	6
Salvage Value; M$	1	2	3
Project Life; years	4	4	4

Based on this information, discuss the following:

1. Cash Flow Diagram
2. Payback Period
3. Internal Rate of Return (IRR)
4. Which project is better investment?

Example:

A manager is trying to decide between two projects (A or B):

Item	Project (A)	Project (B)
Construction Period	One year	One year
Initial Investment; M$	4	5
Annual Running Cost; M$/year	1	2
Annual Revenue; M$/year	3	5
Salvage Value; M$	1	1
Life after construction; years	4	4

Loan 15%

MARR = 20%

Based on this information, discuss the following:

1. Cash Flow Diagram
2. Payback Period
3. Internal Rate of Return (IRR)
4. Which offer should you accept and why?
5. Sensitivity analysis for market price change (±10%)

Example:

A manager is trying to decide between two projects (A or B):

Item	Project (A)	Project (B)
Construction Period	One year	Two years
Construction investment	$ 100,000 Down payment (t=0) $ 300,000 Final payment	$ 100,000 Down payment (t=0) 200,000 after one year 100,000 after two years
Running cost after construction	$ 100,000 / year	50,000 first year 100,000 second year 150,000 third year 200,000 forth year
Revenue after construction	$ 250,000 / year	150,000 first year 300,000 second year 500,000 third year 400,000 forth year
Life after construction	**Four years**	**Four years**
Salvage value	$ 100,000	$ 100,000

Bank Interest Rate 10% Annual Minimum Attractive Rate of Return (MARR) 25%

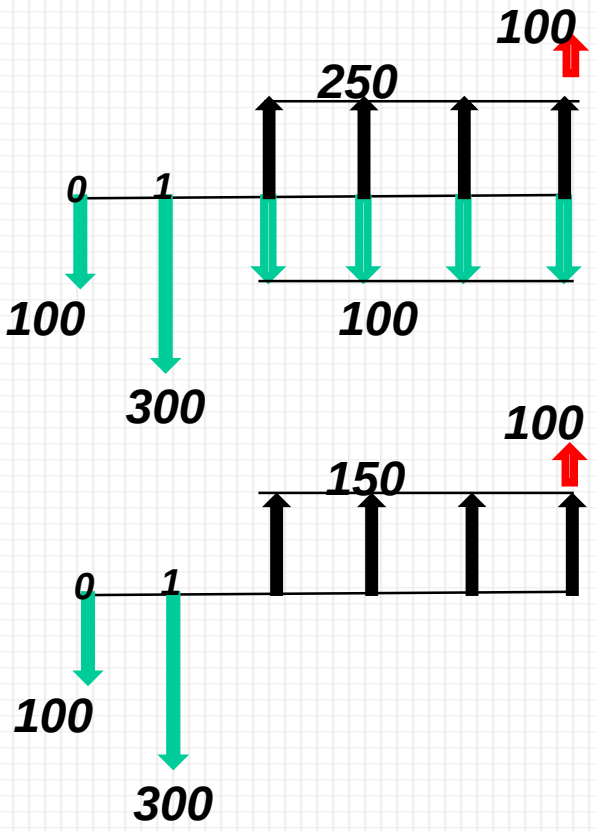
Based on this information, discuss & select the best alternative.

Example:

A manager is trying to decide between two projects (A or B):

Item	Project (A)
Construction Period	One year
Construction investment	$ 100,000 Down payment (t=0) $ 300,000 Final payment
Running cost after construction	$ 100,000 / year
Revenue after construction	$ 250,000 / year
Life after construction	**Four years**
Salvage value	$ 100,000

Minimum Attractive Rate of Return (MARR) 25%

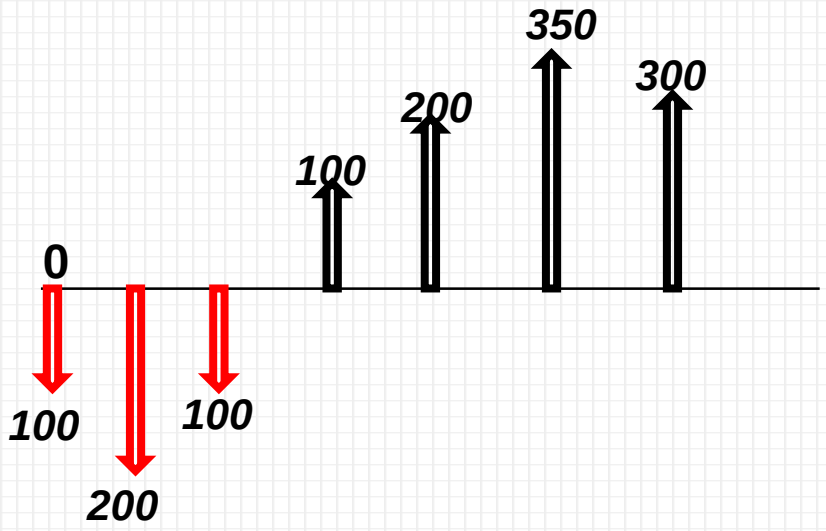


IRR = 21.7 < 25%
(Rejected)

Example:

A manager is trying to decide between two projects (A or B):

Item	Project (B)
Construction Period	Two years
Construction investment	$ 100,000 Down payment (t=0) 200,000 after one year 100,000 after two years
Running cost after construction	50,000 first year 100,000 second year 150,000 third year 200,000 forth year
Revenue after construction	150,000 first year 300,000 second year 500,000 third year 400,000 forth year
Life after construction	**Four years**
Salvage value	$ 100,000



IRR = 25.25% 25% (Accepted)

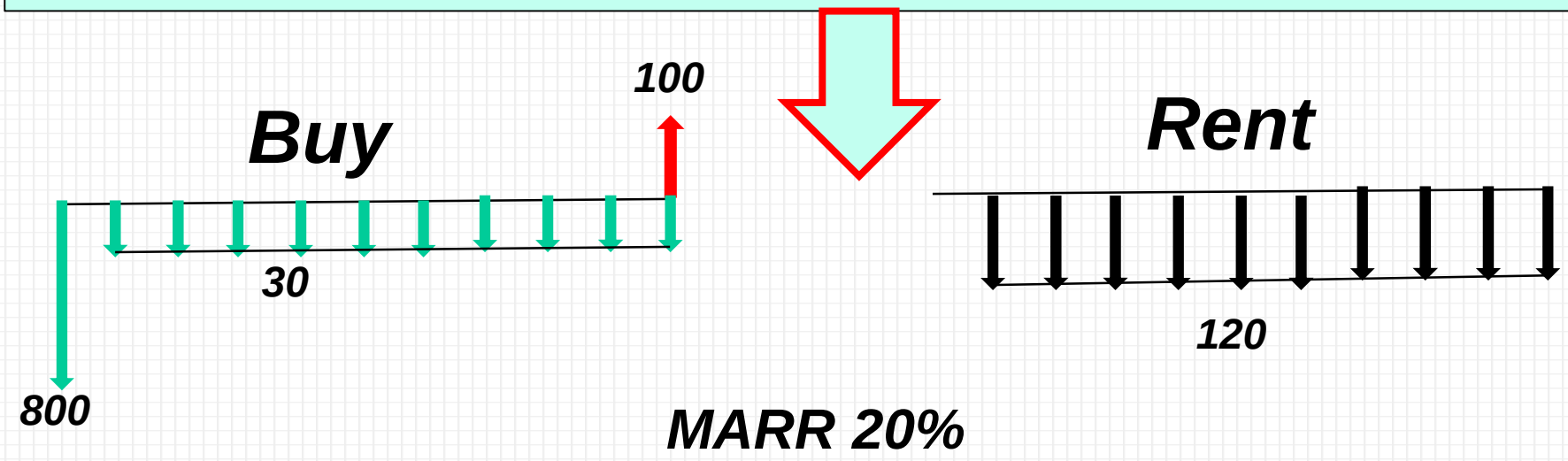
Example:

A company needs **a mobile crane** for the **next 10 years**. Two alternatives are available to buy or to lease the crane.

1) The buy decision includes a first cost of **800,000 LE** with a market value **after 10 years of 100,000 LE** and **annual O&M cost of 30,000 LE**.

2) To lease a similar crane, the annual charge will be 120,000 LE including everything.

If the company earns 20% annually which alternative is to be selected.



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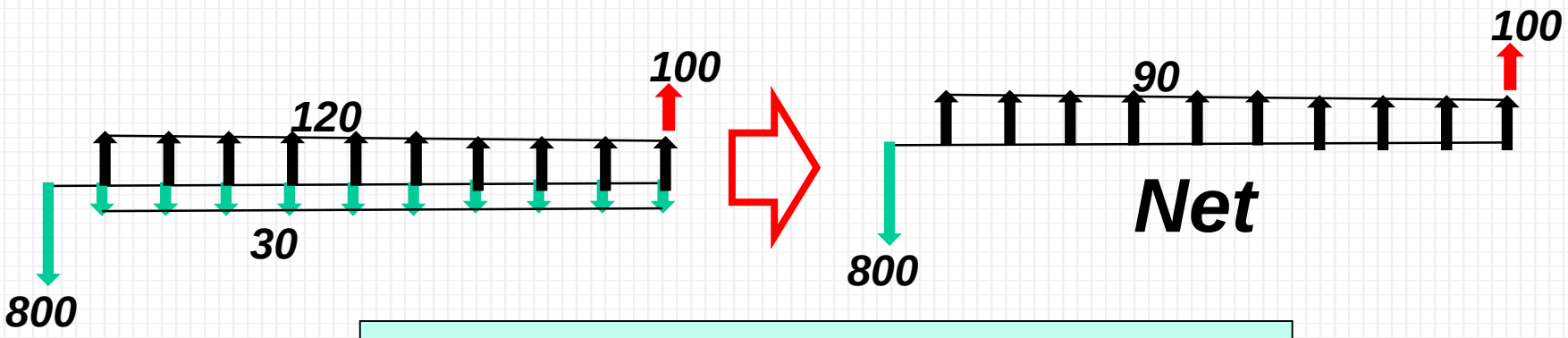


IRR = 3.94 < 20% (Rent)
or NPV(20%) = - 909.62

Example:

Standard Information

There are two ways (A and B) to construct a power line:

Item	Project (A)	Project (B)
Method	Under lake	Around lake
Length	5 km	15 km
First Cost	$ 25,000/km	$ 5,000/km
Annual Maintenance Cost	$ 400/km	$ 200/km
Capital Maintenance	- $/ x years	- $/ x years
Expected Life	20 year	15 year
Salvage Value	$ 5000/km	$ 3000/km
Annual Power Losses	$ 500/km	$ 400/km

Interest rate 12% (Loan)

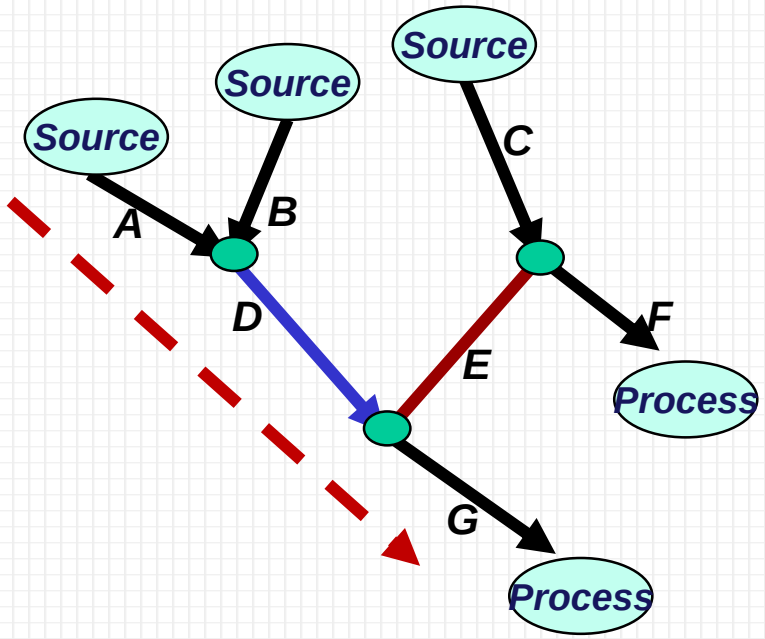
Based on this information, discuss & select the best alternative.

Sensitivity analysis for first cost change (±20%) and line length (±10%).

Project Cost Analysis

Project: Water Pipeline Network

ID	Name	Duration (Day)	Pred.	Number of Crews	Material Cost, $
A	Line A	2	-	2	4000
B	Line B	3	-	1	3000
C	Line C	5	-	2	10000
D	Line D	6	A,B	2	12000
E	Line E	8	C	2	16000
F	Line F	2	C	2	4000
G	Line G	4	D,E	2	8000



Planned duration = 17 day
Average Crew Cost Rate = 100 $/day

Maximum number of crew = 4 (fixed)
Margin Factor = 30% from direct cost

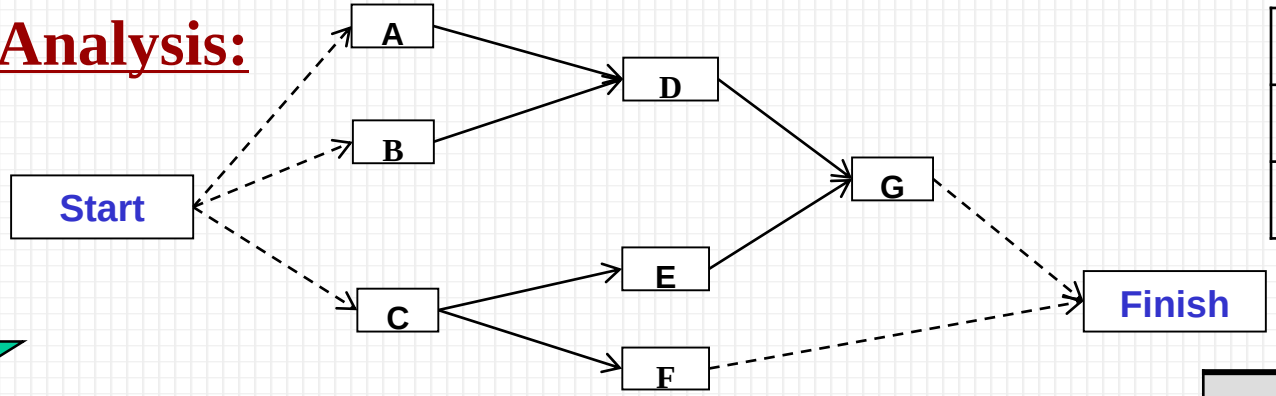
Based on this information, discuss & analysis the following:

1) Network
2) Gantt Chart
3) Workers Profile
4) Cost Analysis
5) Cash In/ Out Analysis

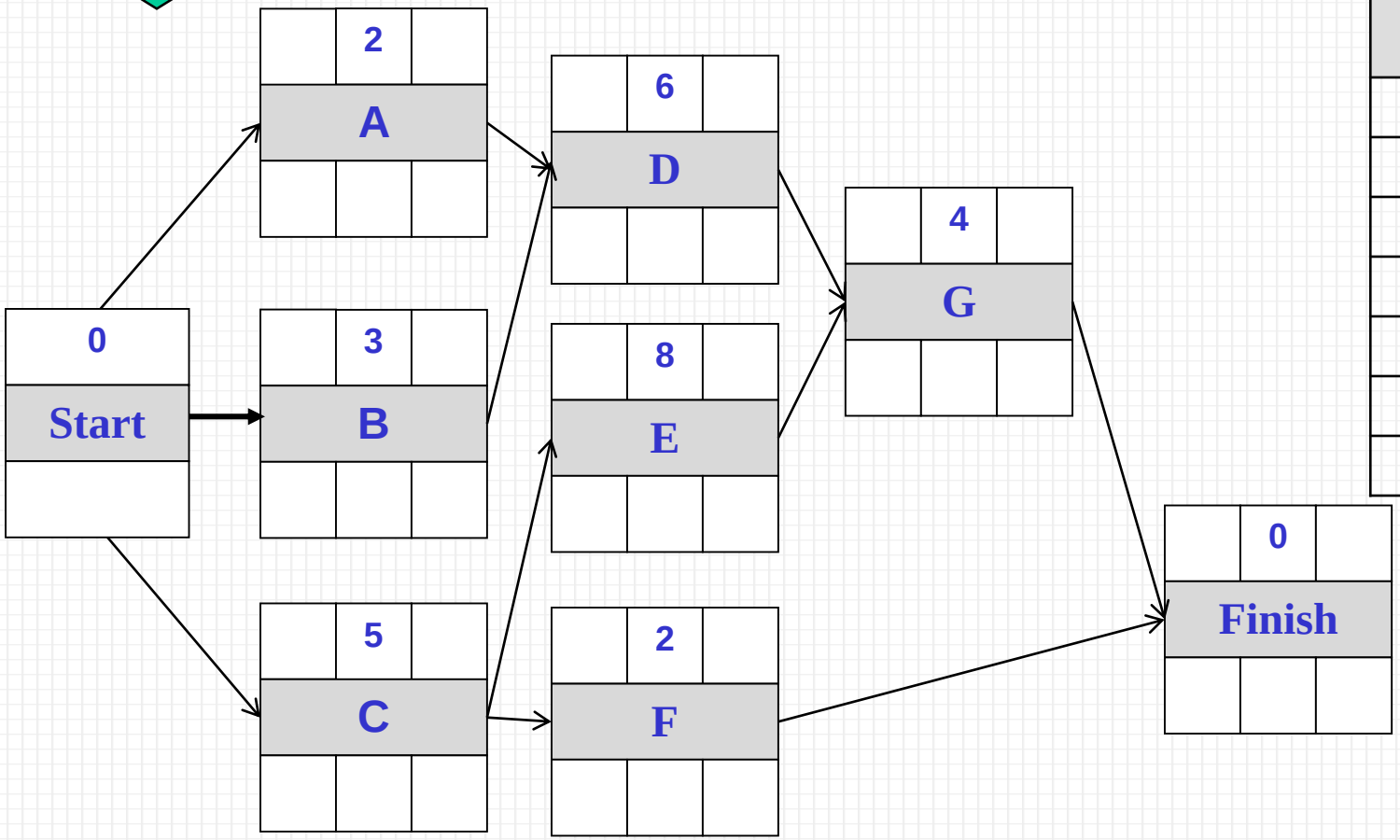
Payment Conditions:

1) 25% Down Payment
2) 25% After One Week
3) 25% After Two Weeks
4) 25% Final Payment

Network Analysis:

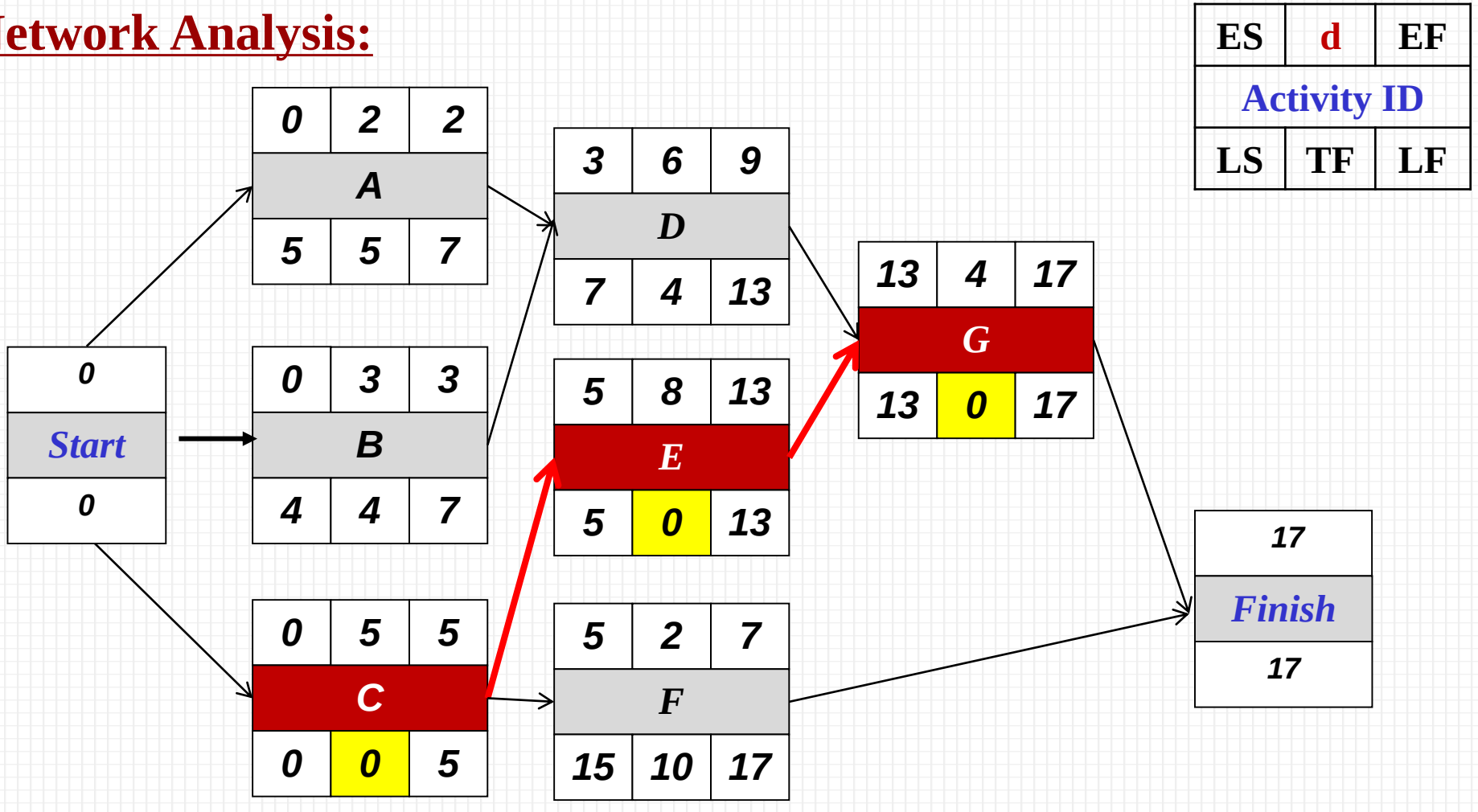


ES	d	EF
Activity ID		
LS	TF	LF



ID	Pred. (FS=0)	Day
A	-	2
B	-	3
C	-	5
D	A,B	6
E	C	8
F	C	2
G	D,E	4

Network Analysis:



Planned Duration = 17 **Critical Path: C-E-G**

It is recommended that risk analysis be considered for critical and near-critical path work in the schedule because such work carries the greatest likelihood of affecting timely completion

Gantt Chart:

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A				2	2												
B	1	1	1														
C	2	2	2	2	2												
D						2	2	2	2	2	2						
E						2	2	2	2	2	2	2	2				
F												2	2				
G														2	2	2	2
Workers	3	3	3	4	4	4	4	4	4	4	4	4	4	2	2	2	2

Project: Water Pipeline Network

Cost Analysis:

ID	Name	Duration (Day)	Pred.	Number of Crews	Material Cost, $	Labor Cost, $	Direct Cost, $	Item Cost, $	Item Cost Rate $/day
A	Line A	2	-	2	4000	400	4400	5720	2860.0
B	Line B	3	-	1	3000	300	3300	4290	1430.0
C	Line C	5	-	2	10000	1000	11000	14300	2860.0
D	Line D	6	A,B	2	12000	1200	13200	17160	2860.0
E	Line E	8	C	2	16000	1600	17600	22880	2860.0
F	Line F	2	C	2	4000	400	4400	5720	2860.0
G	Line G	4	D,E	2	8000	800	8800	11440	2860.0
				Total	57000	5700	62700	81510	

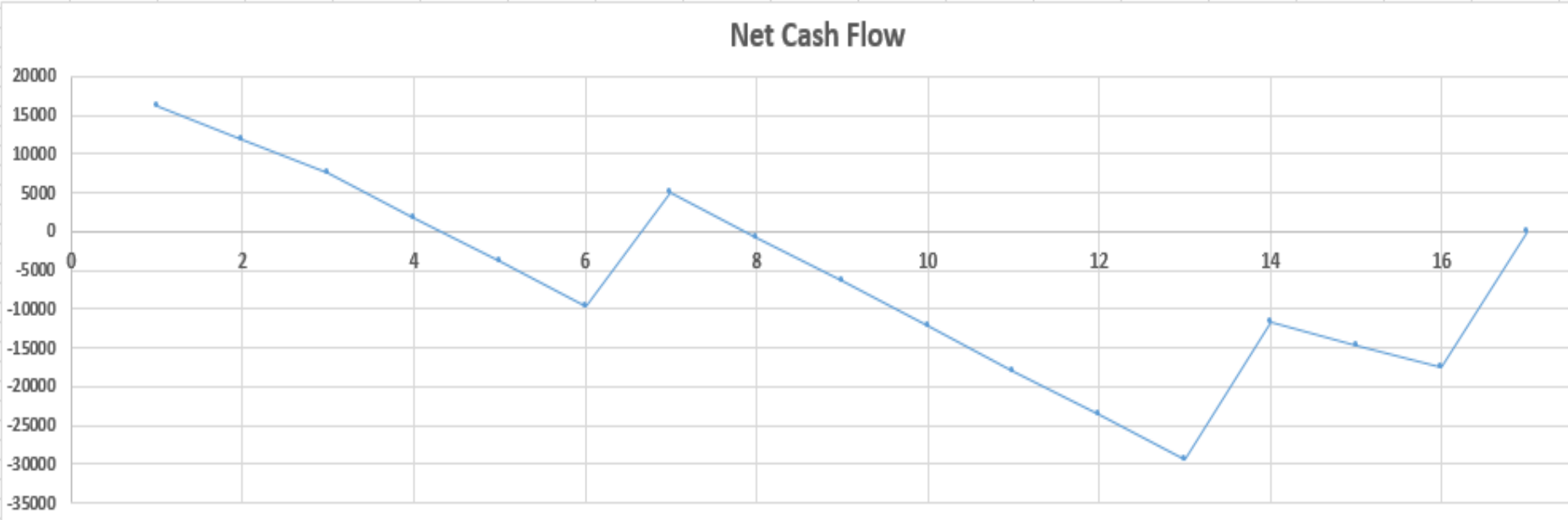
Payment Conditions:

Down Payment	25%	20377.5
After One Week	25%	20377.5
After Two Weeks	25%	20377.5
Final Payment	25%	20377.5
	Total	81510

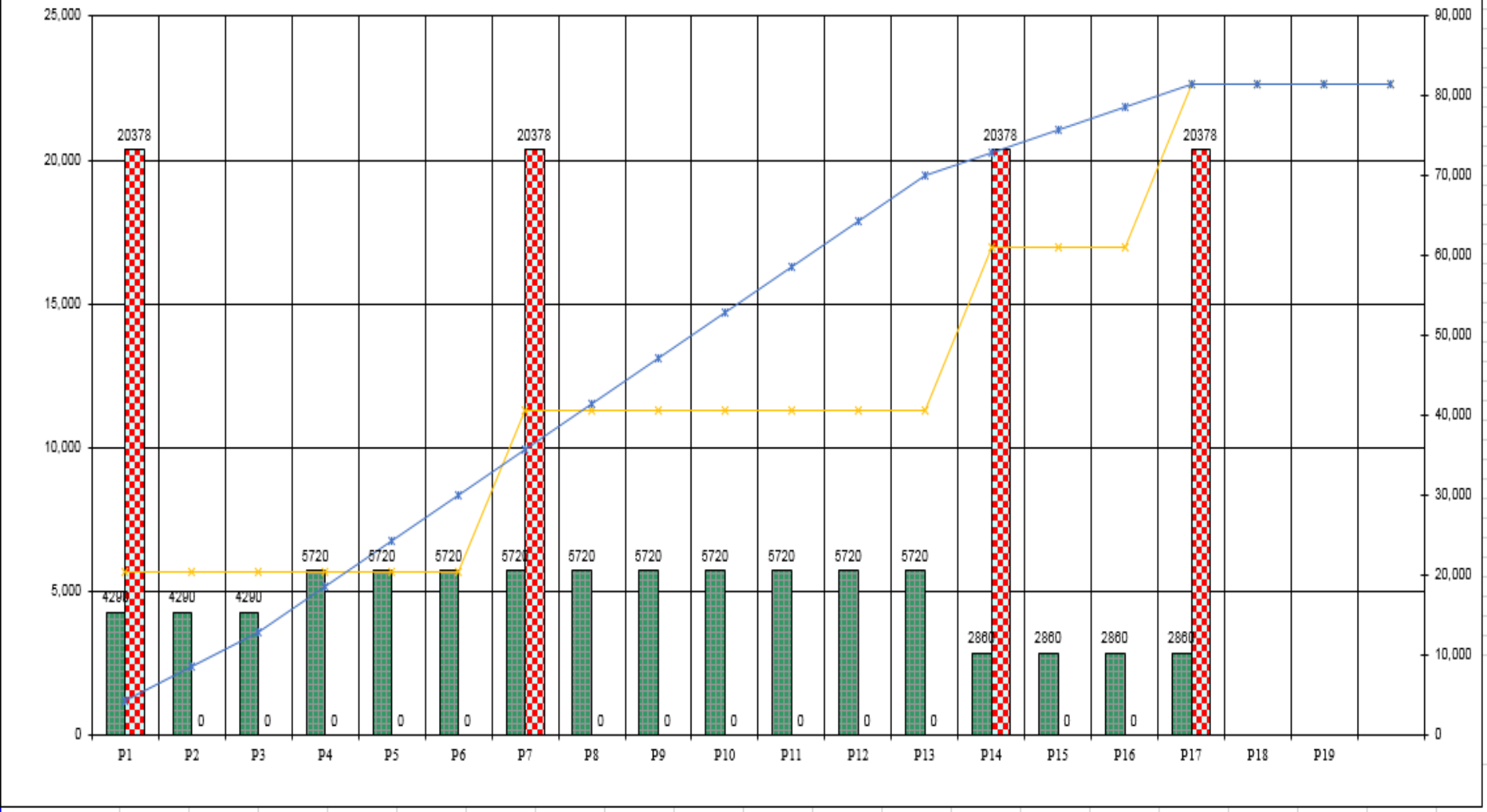
Average Crew Cost Rate =	100
Margin Factor =	30%

Cash In/ Out Analysis

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A				2860	2860												
B	1430	1430	1430														
C	2860	2860	2860	2860	2860												
D						2860	2860	2860	2860	2860	2860						
E						2860	2860	2860	2860	2860	2860	2860	2860				
F												2860	2860				
G														2860	2860	2860	2860
Cash Out	4290	4290	4290	5720	5720	5720	5720	5720	5720	5720	5720	5720	5720	2860	2860	2860	2860
	4290	8580	12870	18590	24310	30030	35750	41470	47190	52910	58630	64350	70070	72930	75790	78650	81510
Cash In	20377.5						20377.5							20377.5			20377.5
	20377.5	20377.5	20377.5	20377.5	20377.5	20377.5	40755	40755	40755	40755	40755	40755	40755	61132.5	61132.5	61132.5	81510
Net Cash Flow	16087.5	11797.5	7507.5	1787.5	-3932.5	-9652.5	5005	-715	-6435	-12155	-17875	-23595	-29315	-11798	-14658	-17518	0



Cash In/ Out Analysis



	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	
Planned (M $)	4290	4290	4290	5720	5720	5720	5720	5720	5720	5720	5720	5720	5720	2860	2860	2860	2860			
Planned (cumm.)	4290	8580	12870	18590	24310	30030	35750	41470	47190	52910	58630	64350	70070	72930	75790	78650	81510	81510	81510	81510
Paymentl (M $)	20378	0	0	0	0	0	20378	0	0	0	0	0	0	20378	0	0	20378			
Payment (cumm.)	20378	20378	20378	20378	20378	20378	40755	40755	40755	40755	40755	40755	40755	61133	61133	61133	81510	81510	81510	81510

Example; Building

Project Cost Analysis

ID	Duration (weeks)	Predecessor	Direct Cost $
A	5	-	15,000
B	3	-	30,000
C	8	A	33,000
D	7	A	42,000
E	7	-	57,000
F	4	C, E	61,000
G	5	F	72,000

Planned Duration = 22 weeks

Margin Factor = 30% from direct cost

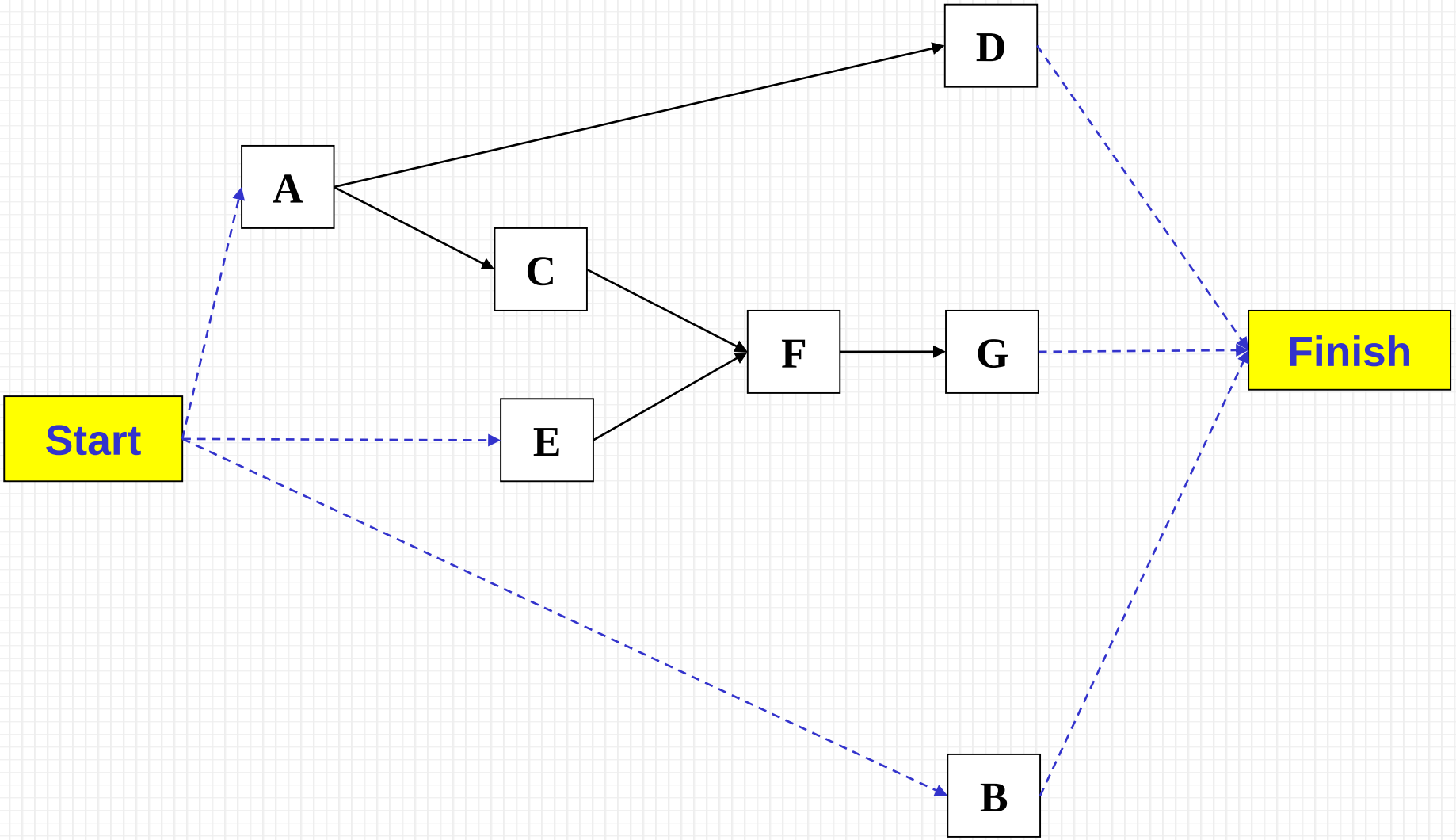
Based on this information, discuss & analysis the following:

1) Network
2) Gantt Chart
3) Cost Analysis
4) Cost Smoothing
5) Cash Flow (In/ Out) Analysis

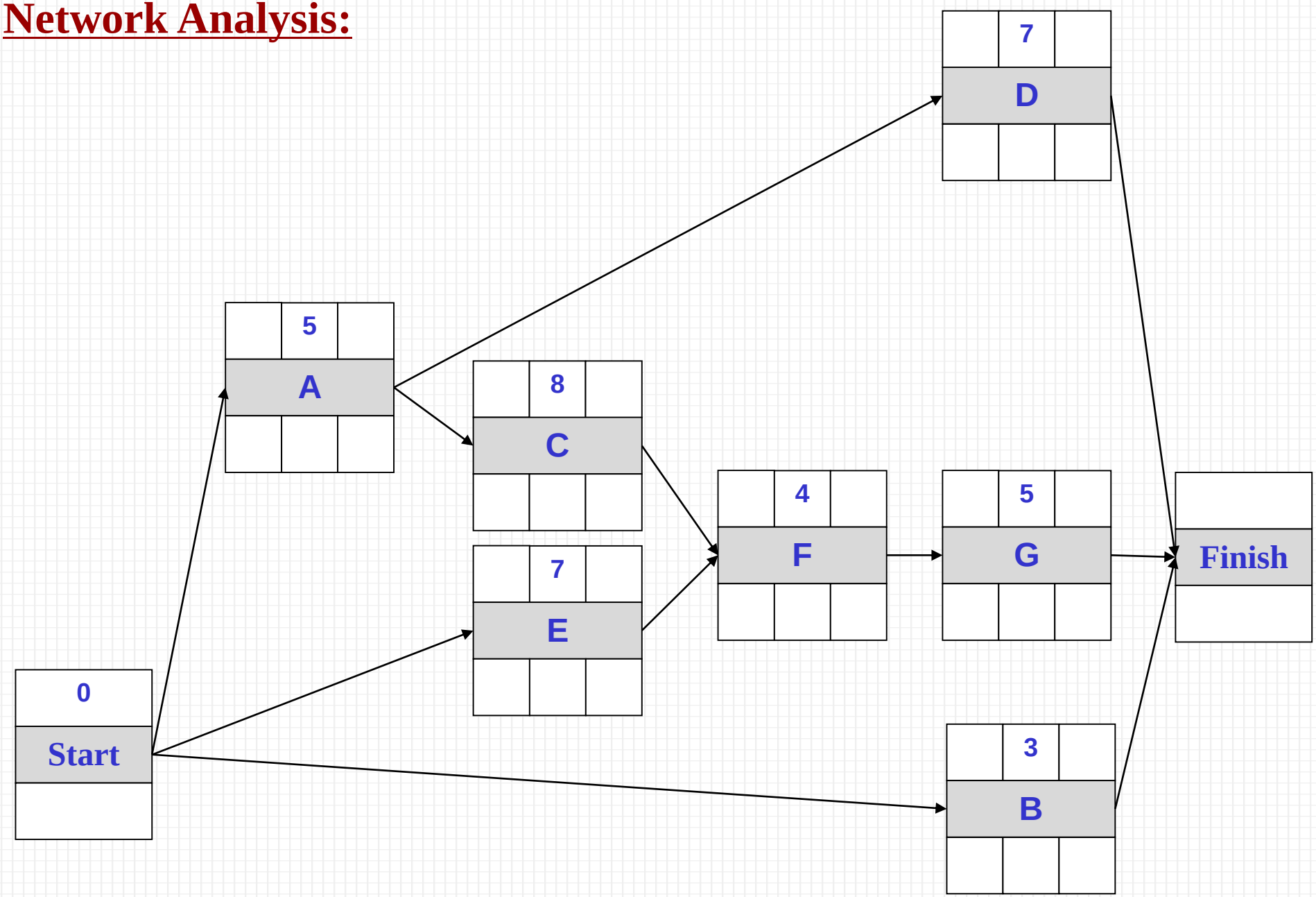
Payment Conditions:

1) 25% Down Payment
2) 25% After 8 Weeks
3) 25% After 16 Weeks
4) 25% Final Payment

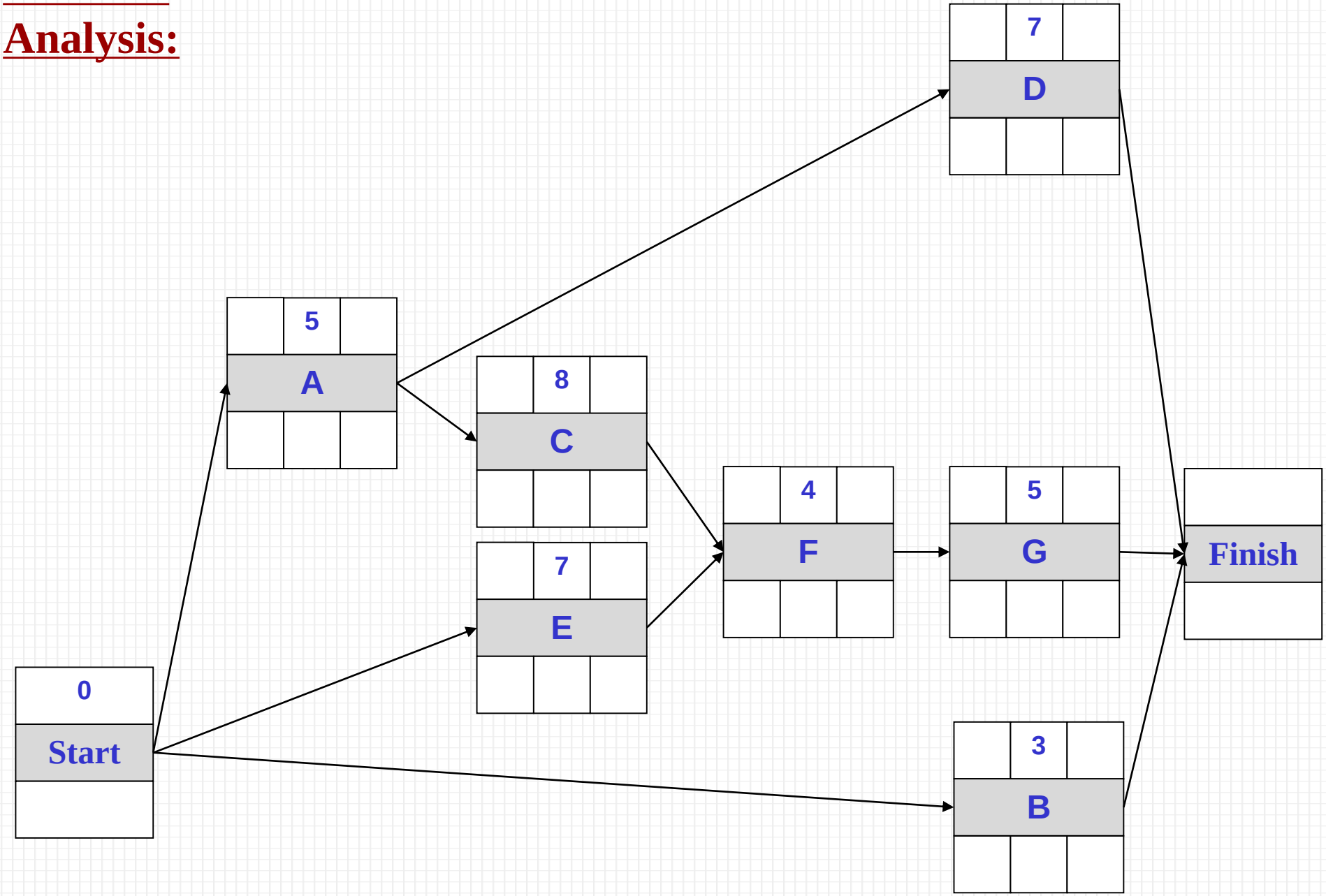
Logic Diagram:



Network Analysis:



Network Analysis:



Gantt Chart:

ID	Day	Pred	Weeks																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	5	-	X	X	X	X	X																	
B	3	-	X	X	X																			
C	8	A						X	X	X	X	X	X	X	X									
D	7	A						X	X	X	X	X	X	X										
E	7	-	X	X	X	X	X	X	X															
F	4	C, E														X	X	X	X					
G	5	F																		X	X	X	X	X

Example;

Project Cost Analysis

ID	Duration (weeks)	Predecessor	Direct Cost $
A	5	-	15000
B	3	-	30000
C	8	A	33000
D	7	A	42000
E	7	-	57000
F	4	C, E	61000
G	5	F	72000

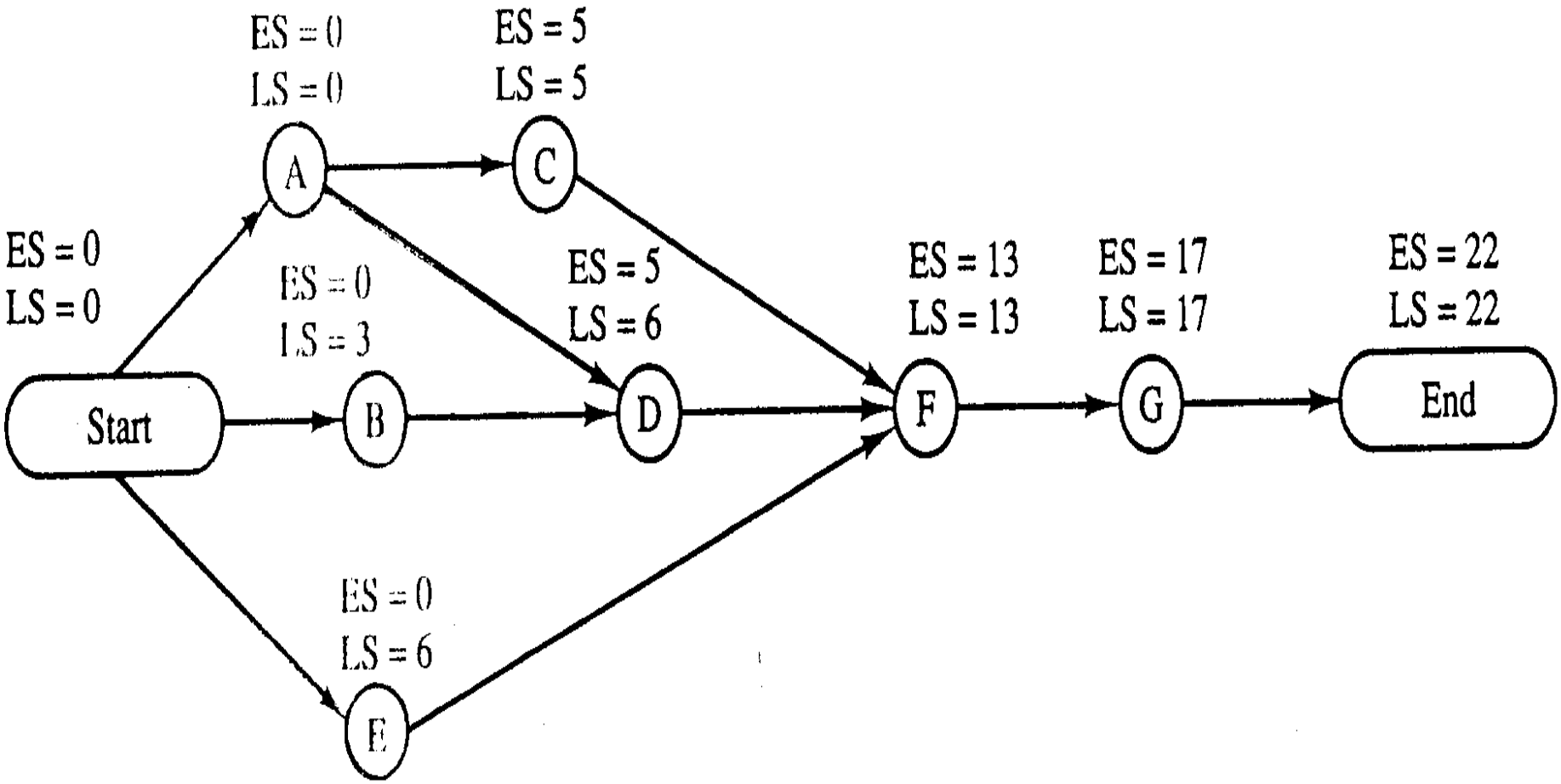
Planned Duration = 22 weeks **Margin Factor = 30% from direct cost**

Based on this information, discuss & analysis the following:

1) Network
1) Gantt Chart
2) Cost Analysis
3) Cash Flow (In/ Out) Analysis

Payment Conditions:

1) 25% Down Payment
2) 25% After 8 Weeks
3) 25% After 16 Weeks
4) 25% Final Payment



We have found that (A,C,F,G) is the critical path, which has a length 22 weeks. The critical activities are A, C, F, and G, while activities B, E, and D have either free or total slack that can be used for budget planning.

TABLE 8-4 CASH FLOW OF AN EARLY START SCHEDULE

Week	Activity A	B	C	D	E	F	G	Weekly cost	Cumulative cost
1	300	1,000			814.3			2,114	2,114
2	300	1,000			814.3			2,114	4,229
3	300	1,000			814.3			2,114	6,343
4	300				814.3			1,114	7,457
5	300				814.3			1,114	8,571
6			412.5	600	814.3			1,827	10,398
7			412.5	600	814.3			827	12,225
8			412.5	600				1,013	13,238
9			412.5	600				1,013	14,250
10			412.5	600				1.013	15,263
11			412.5	600				1,013	16,275
12			412.5	600				1,013	17,288
13			412.5					412	17,700
14						1,525		1,525	19,225
15						1,525		1,525	20,750
16						1,525		1,525	22,275
17						1,525		1,525	23,800
18							1,440	1,440	25,240
19							1,440	1,440	26,680
20							1,440	1,440	28,120
21							1,440	1,440	29,560
22							1,440	1,440	31,000
	1,500	3,000	3,300	4,200	5,700	6,100	7,200	31,000	

TABLE 8-5 CASH FLOW OF THE LATE START SCHEDULE

Week	Activity A	B	C	D	E	F	G	Weekly cost	Cumulative cost
1	300							300	300
2	300							300	600
3	300	1,000						1,300	1,900
4	300	1,000						1,300	3,200
5	300	1,000						1,300	4,500
6			412.5					412	4,913
7			412.5	600	814.3			1,827	6,739
8			412.5	600	814.3			1,827	8,566
9			412.5	600	814.3			1,827	10,393
10			412.5	600	814.3			1,827	12,220
11			412.5	600	814.3			1,827	14,046
12			412.5	600	814.3			1,827	15,873
13			412.5	600	814.3			1,827	17,700
14						1,525		1,525	19,225
15						1,525		1,525	20,750
16						1,525		1,525	22,275
17						1,525		1,525	23,800
18							1,440	1,440	25,240
19							1,440	1,440	26,680
20							1,440	1,440	28,120
21							1,440	1,440	29,560
22							1,440	1,440	31,000
	1,500	3,000	3,300	4,200	5,700	6,100	7,200	31,000	

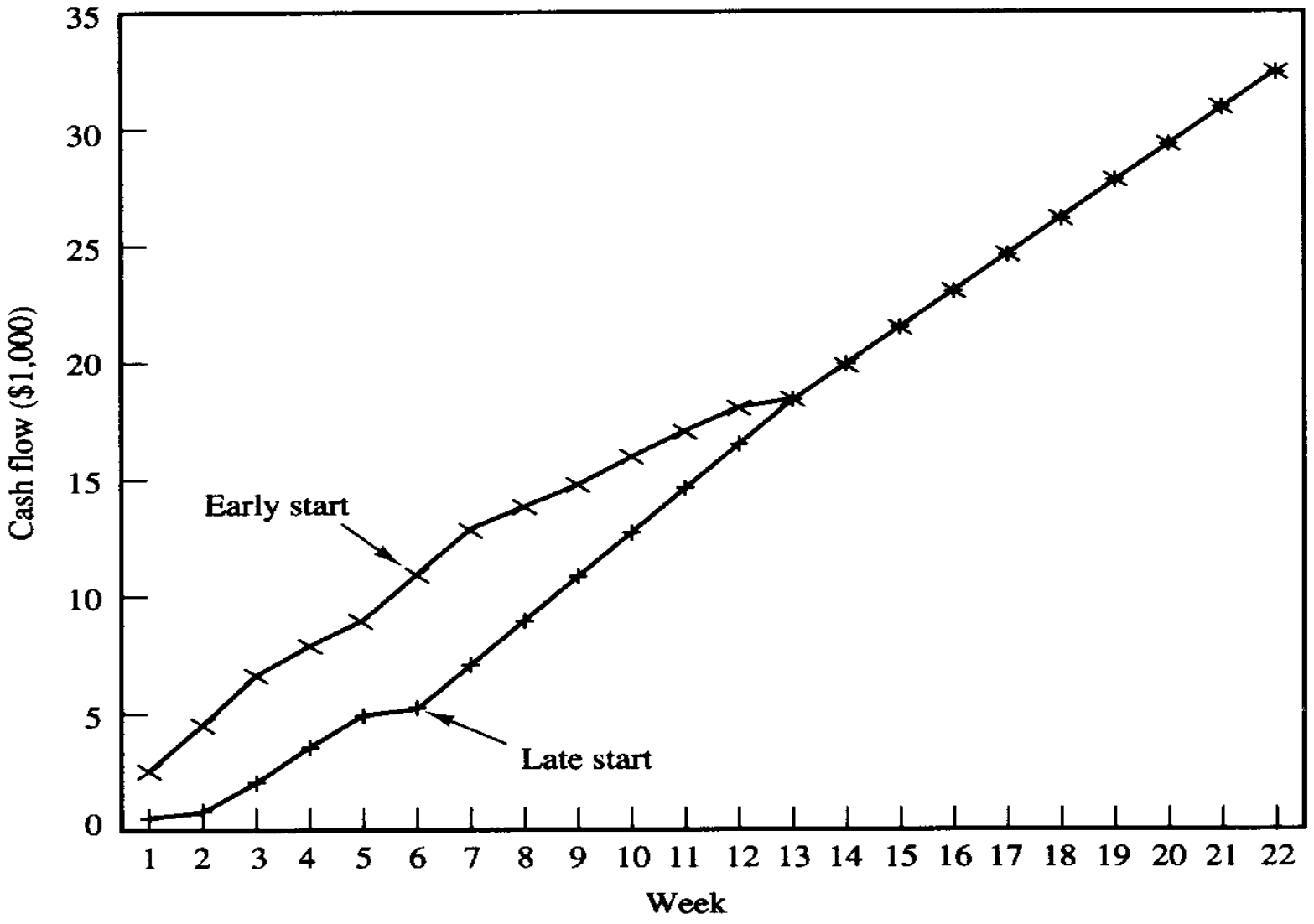
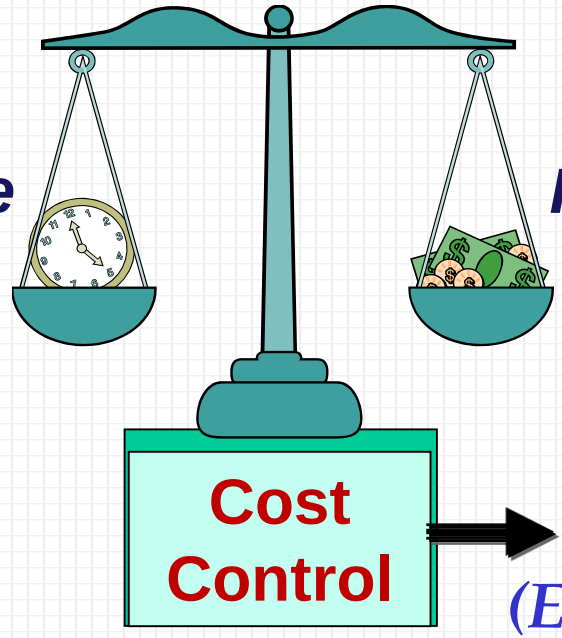


Figure 8-2 Cumulative cash flow for early start and late start schedules.

Project Co$t Control



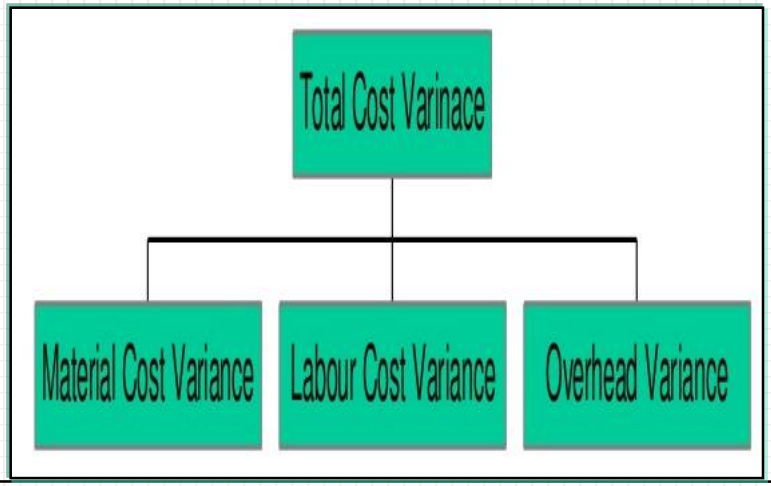
Planned Performance

Actual Performance

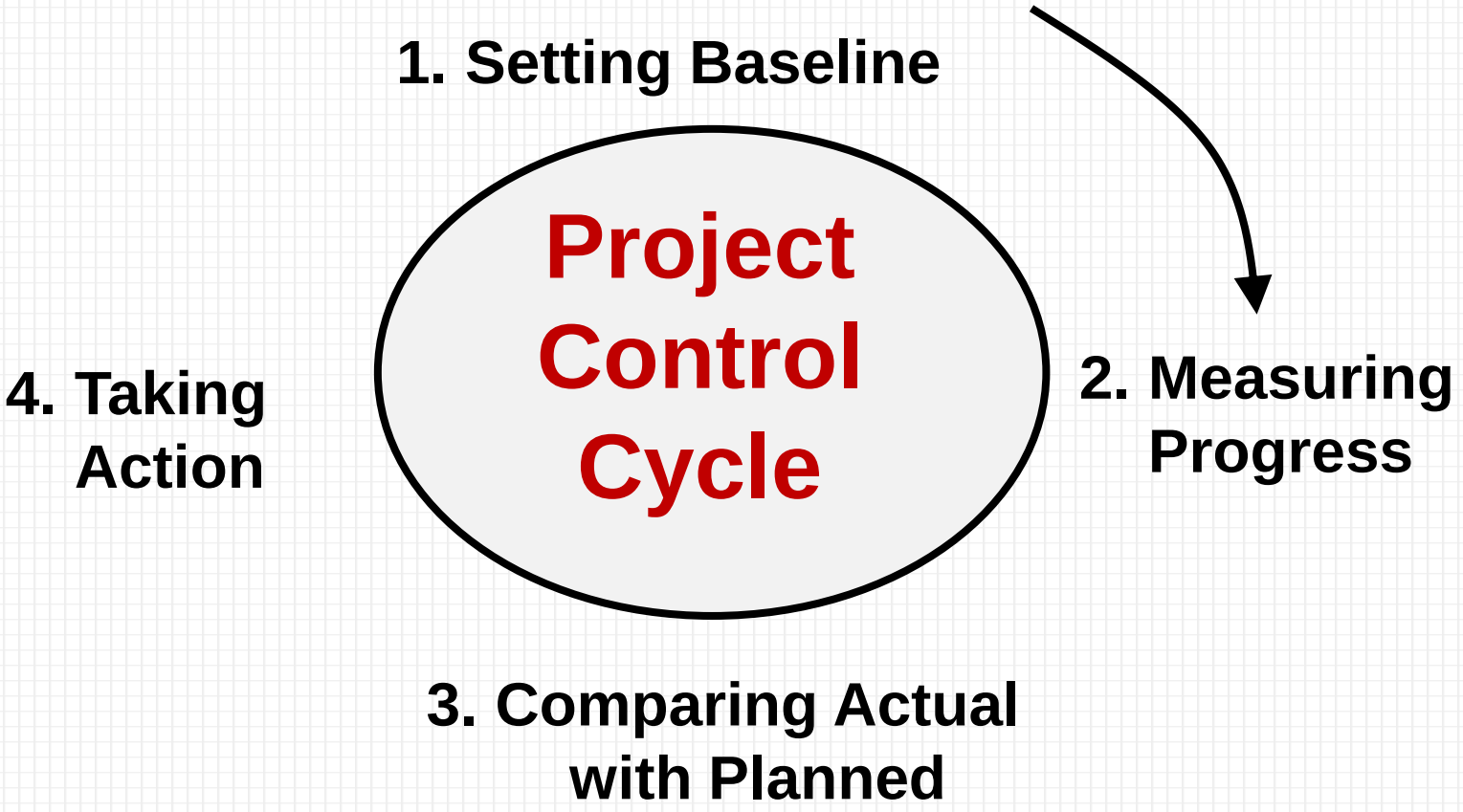
Cost Control

KPIs report

(Earned Value Analysis)



Project Cost Control



Project Cost Control

(Earned Value Analysis)

(1)

52% of all projects finish at 189% of their initial budget

(2)

30% of completed projects have a cost variance of ≥10%

(3)

50% of completed projects have a schedule variance of ≥10%

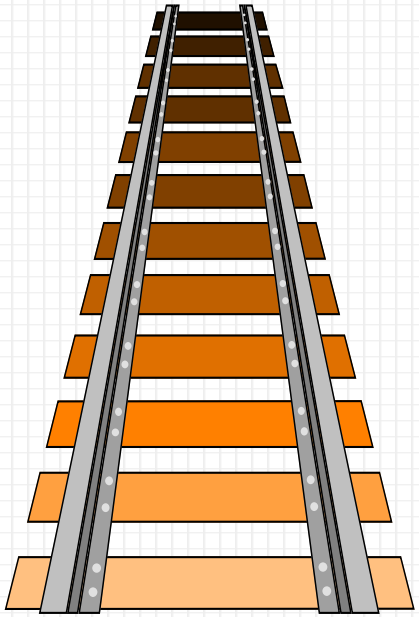
(4)

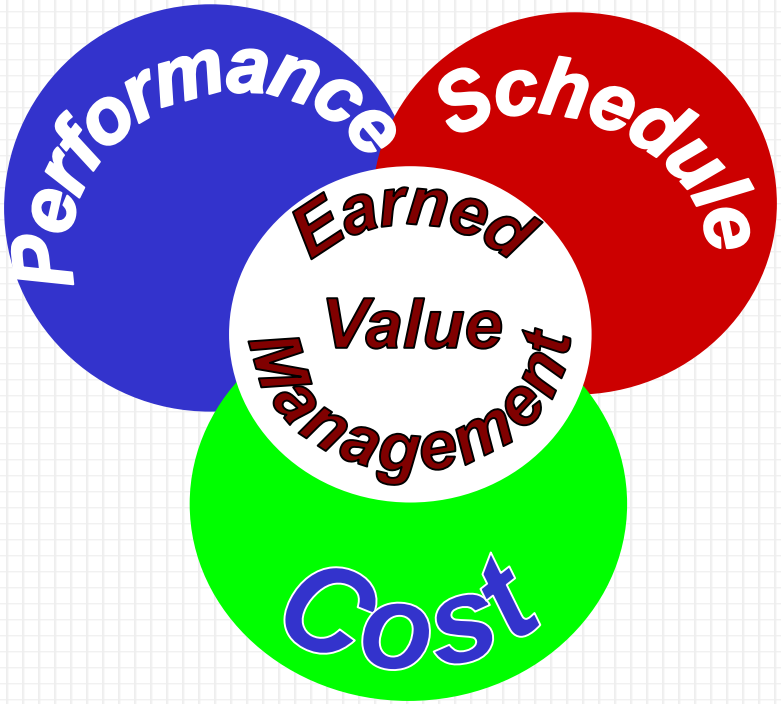
70% of projects are over budget and/or behind schedule

Cost control is a Part of Cost Management.

Earned Value Management Systems measure progress

***EVM** is a project management tool that integrates the project **performance** with **schedule** and **cost** elements.*





***EVM** is a cost management technique where the value of completed work is compared to actual costs and the scheduled costs*

Earned Value Analysis

Planned Value = PV = BCWS
(Budget Cost for the Work Schedule) ➔ Base line

Actual Value = AV = ACWP
(Actual Cost for the Work Performed)

Earned Value = EV = BCWP
(Budget Cost for the Work Performed) ➔ Invoice

Schedule Variance

$$SV = EV - PV$$

Cost Variance

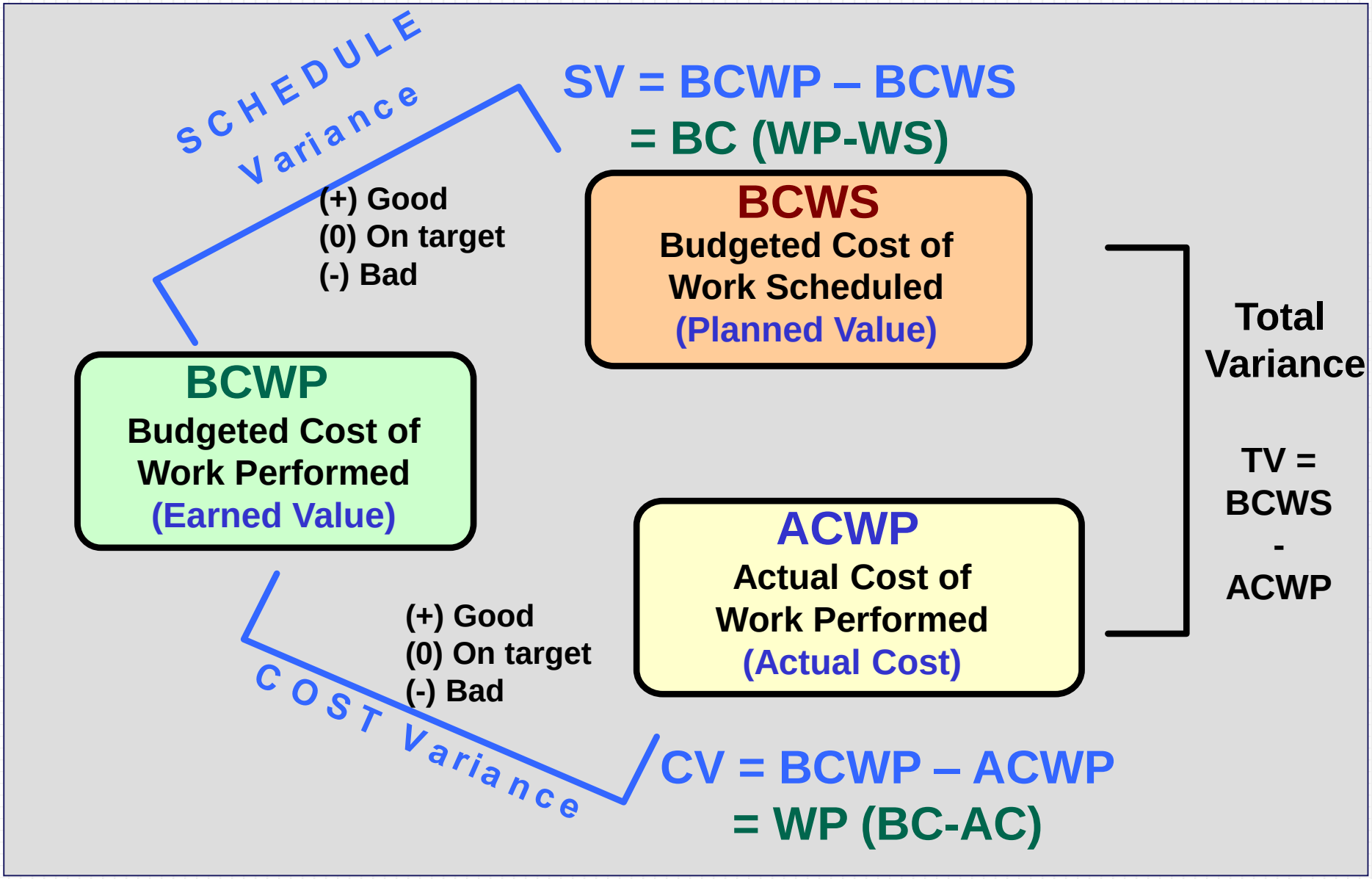
$$CV = EV - AC$$

Schedule Performance Index

$$SPI = \frac{EV}{PV}$$

Cost Performance Index

$$CPI = \frac{EV}{AC}$$


SCHEDULE Variance
SV = BCWP – BCWS
= BC (WP-WS)
(+) Good
(0) On target
(-) Bad
BCWS
Budgeted Cost of Work Scheduled
(Planned Value)
Total Variance
TV = BCWS - ACWP
BCWP
Budgeted Cost of Work Performed
(Earned Value)
ACWP
Actual Cost of Work Performed
(Actual Cost)
(+) Good
(0) On target
(-) Bad
COST Variance
CV = BCWP – ACWP
= WP (BC-AC)

Earned Value Analysis

- **Schedule Variance** **SV = BCWP – BCWS**

  (**>0** is ahead, **0** is on target, **<0** is behind)

- **Schedule Performance Index** **SPI = BCWP/BCWS**

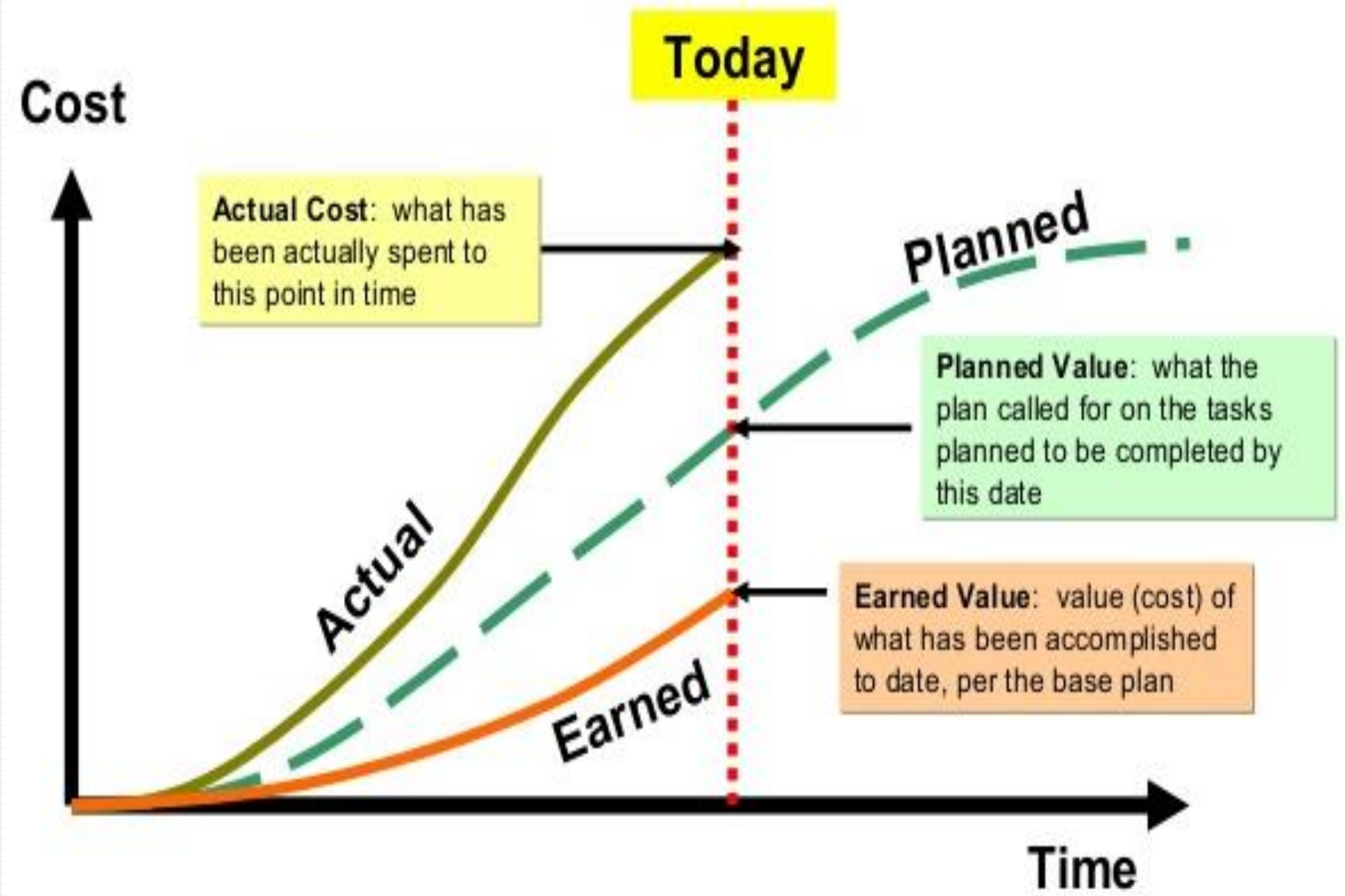
  (**>1** is ahead, **1** is on target, **<1** is behind)

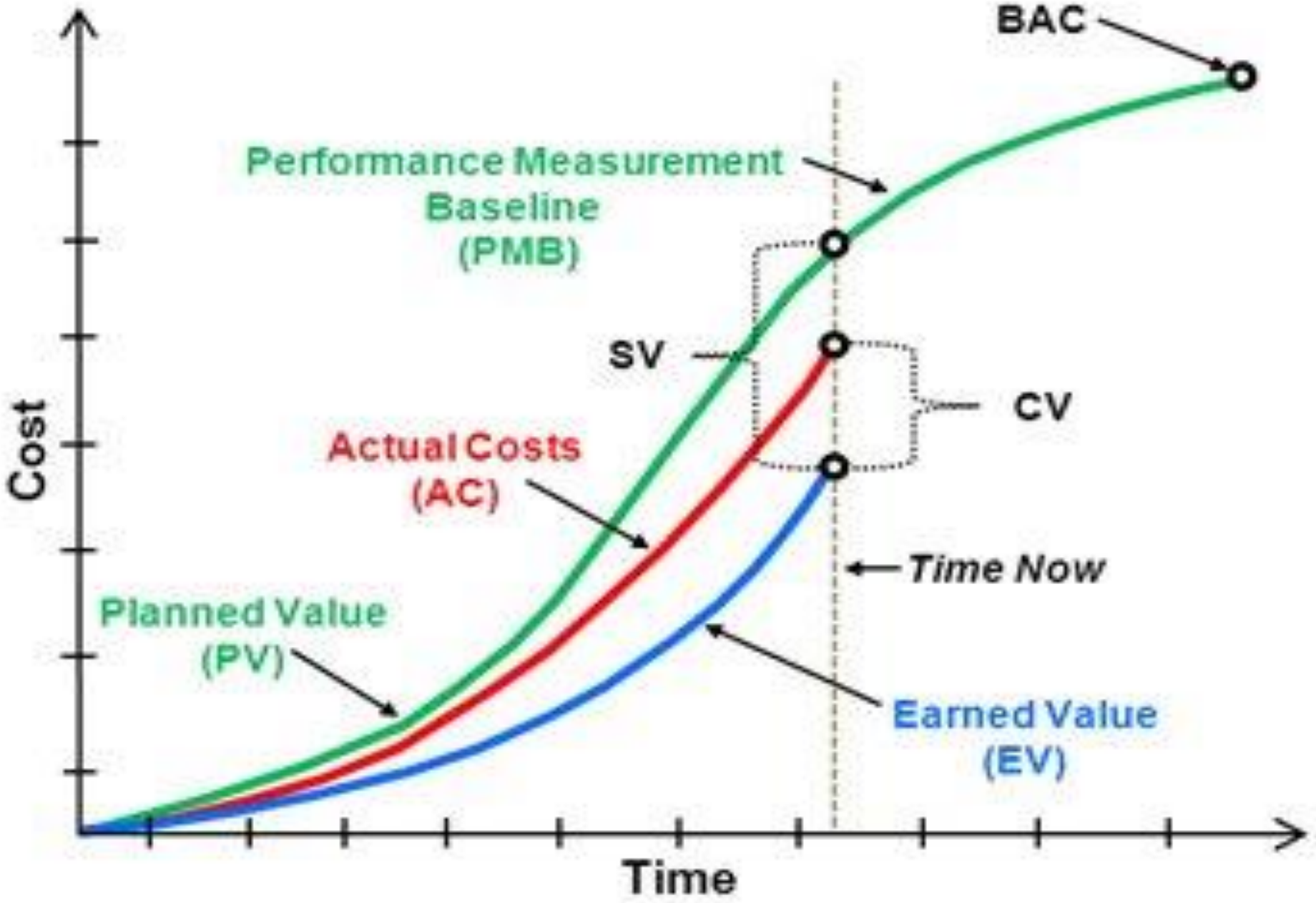
- **Cost Variance** **CV = BCWP – ACWP**

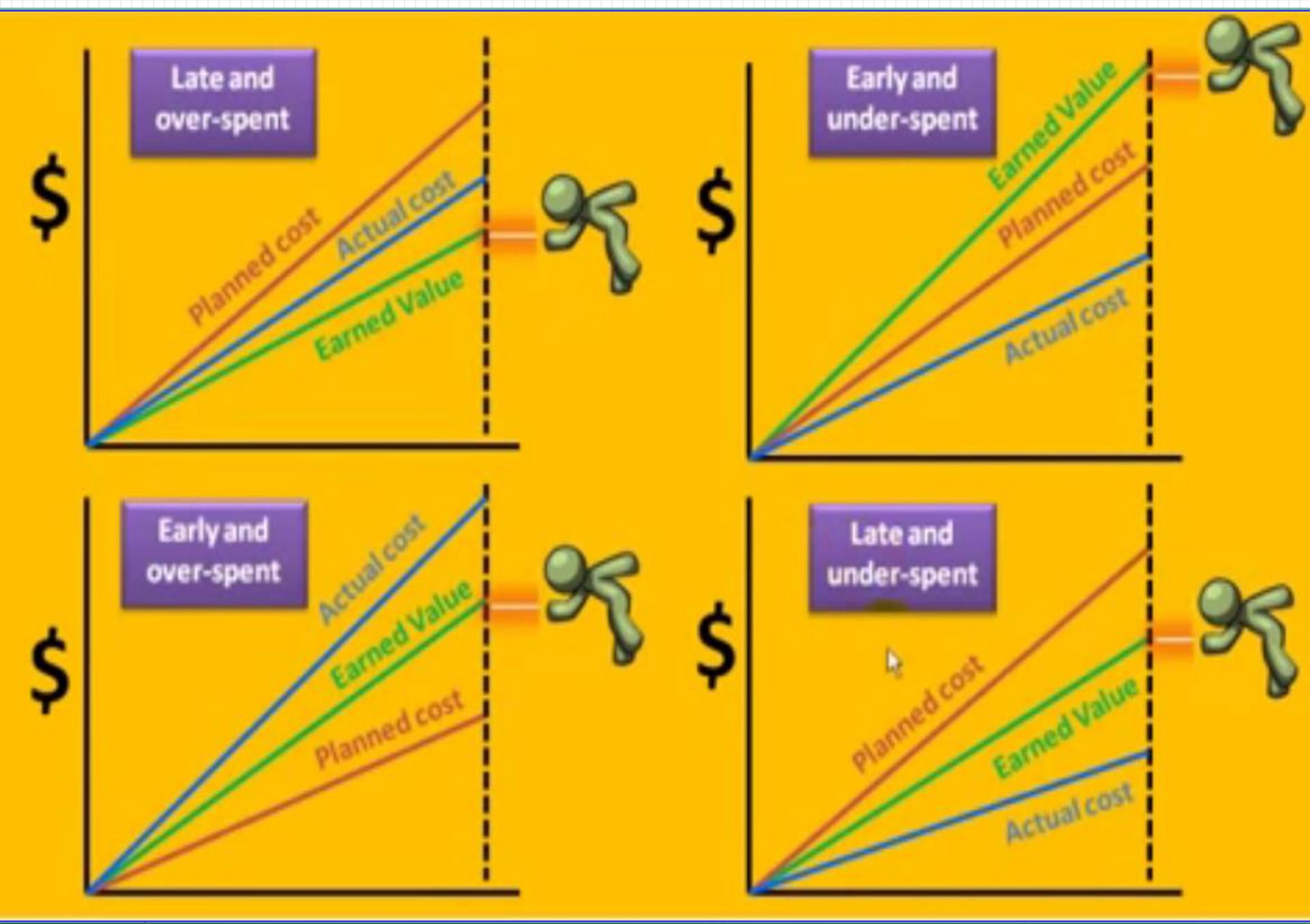
  (**>0** is under-run, **0** is on target, **<0** is overrun)

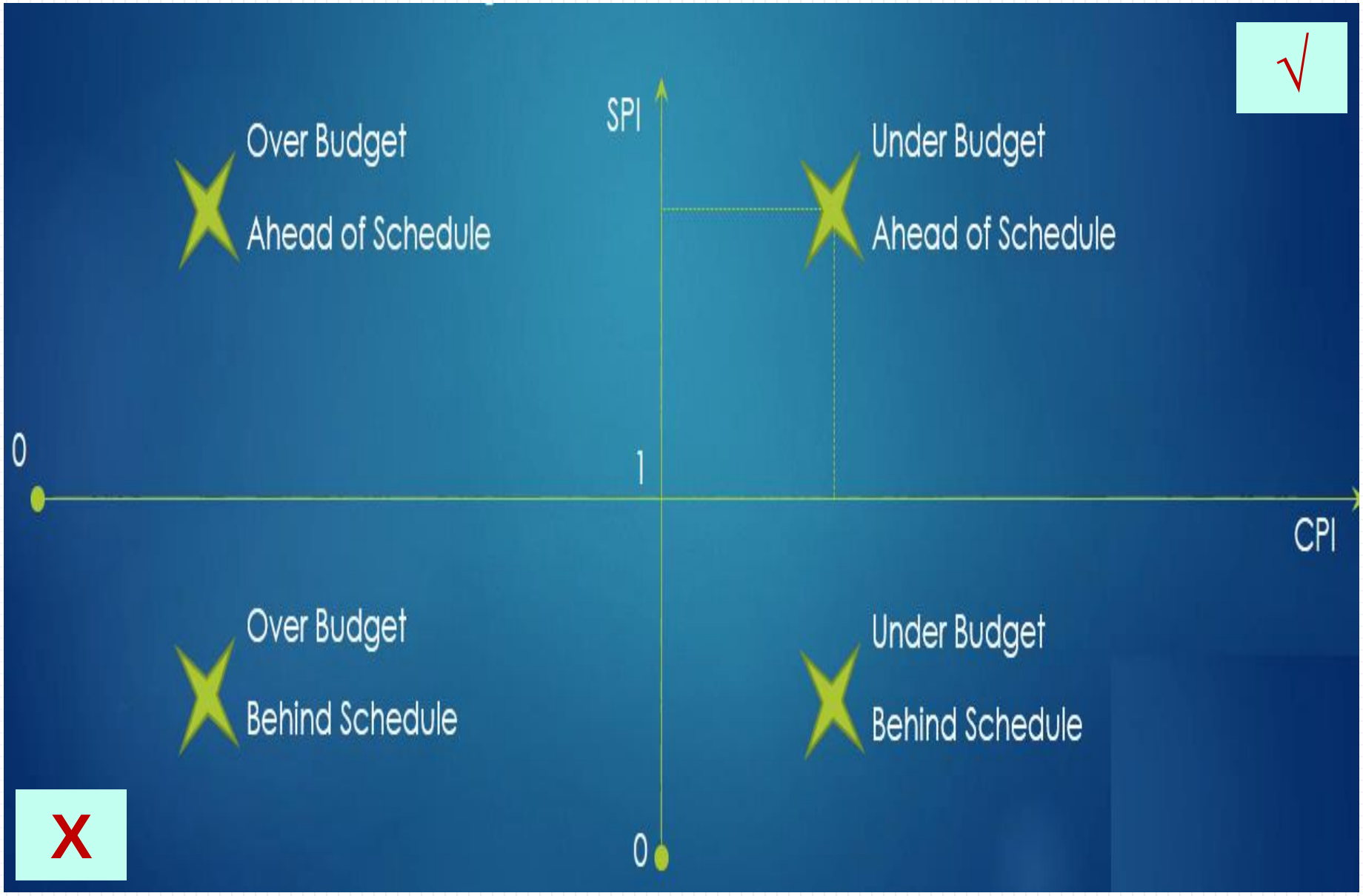
- **Cost Performance Index** **CPI = BCWP/ACWP**

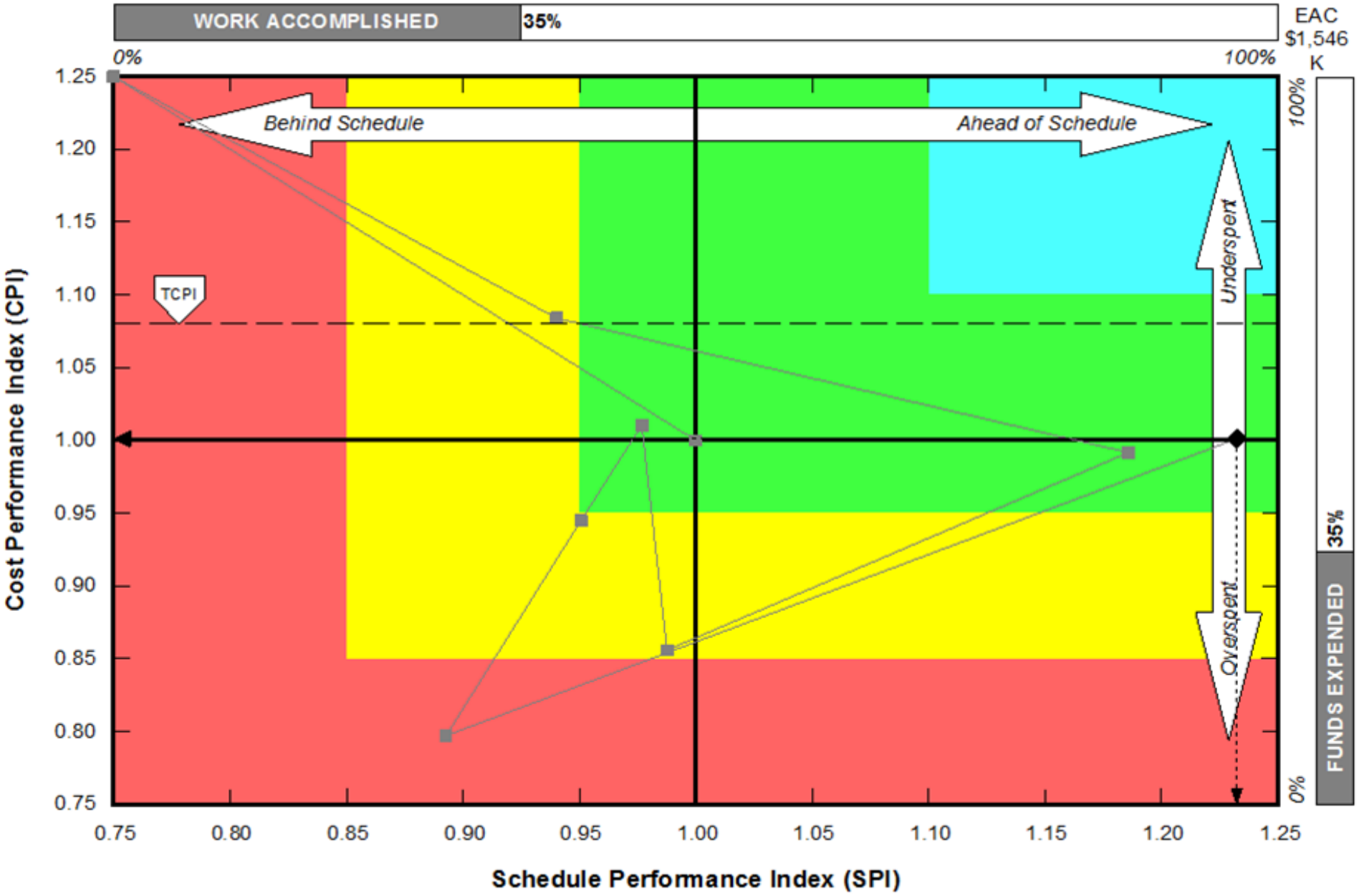
  (**>1** is under-run, **1** is on target, **<1** is over-run)


Today
Cost
Actual Cost: what has been actually spent to this point in time
Planned
Planned Value: what the plan called for on the tasks planned to be completed by this date
Actual
Earned Value: value (cost) of what has been accomplished to date, per the base plan
Earned
Time


BAC
Performance Measurement
Baseline
(PMB)
SV
CV
Actual Costs
(AC)
Time Now
Planned Value
(PV)
Earned Value
(EV)
Cost
Time

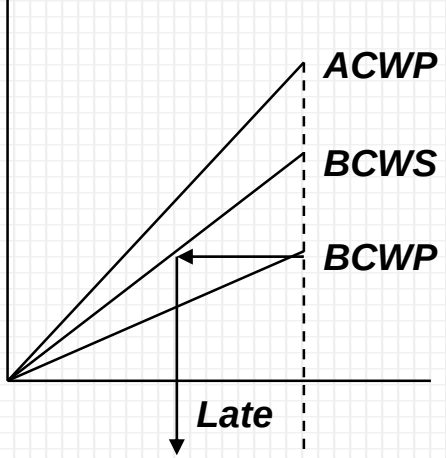

Late and over-spent
$
Planned cost
Actual cost
Earned Value
Early and under-spent
$
Earned Value
Planned cost
Actual cost
Early and over-spent
$
Actual cost
Earned Value
Planned cost
Late and under-spent
$
Planned cost
Earned Value
Actual cost


√
SPI
Over Budget
Ahead of Schedule
Under Budget
Ahead of Schedule
0
1
CPI
Over Budget
Behind Schedule
Under Budget
Behind Schedule
X
0


WORK ACCOMPLISHED
35%
EAC
$1,546
K
0%
100%
Behind Schedule
Ahead of Schedule
TCPI
Underspent
Overspent
100%
0%
35%
FUNDS EXPENDED
Cost Performance Index (CPI)
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.75
0.80
0.85
0.90
0.95
1.00
1.05
1.10
1.15
1.20
1.25
Schedule Performance Index (SPI)

Item #1:

BC = 5000 LE/unit	*WS= 600 units*	*BCWS= 3000000 LE*
AC = 5500 LE/unit	*WP= 560 units*	*ACWP= 3080000 LE*
BC = 5000 LE/unit	*WP= 560 units*	*BCWP= 2800000 LE*



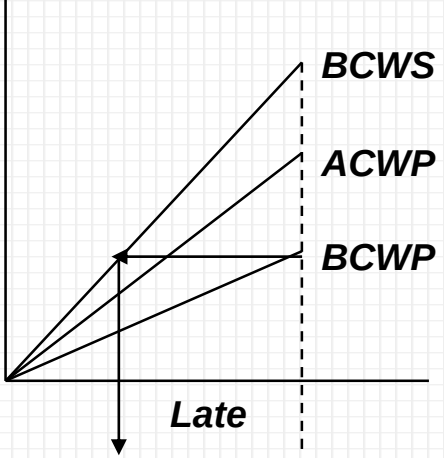
- **Schedule Variance = SV = BCWP – BCWS = 2800000 – 3000000 = -200000**
  (**>0** is ahead, **0** is on target, **<0** is behind)
- **Schedule Performance Index = SPI = BCWP/BCWS = 2800000/3000000=0.93**
  (**>1** is ahead, **1** is on target, **<1** is behind)
- **Cost Variance = CV = BCWP – ACWP = 2800000 – 3080000 = -280000**
  (**>0** is under-run, **0** is on target, **<0** is overrun)
- **Cost Performance Index = CPI = BCWP/ACWP = 2800000/3080000 = 0.9**
  (**>1** is under-run, **1** is on target, **<1** is over-run)

Item #2:

BC = 50 LE/unit WS= 5000 units BCWS= 250,000 LE

AC = 60 LE/unit WP= 3500 units ACWP= 210000 LE

BC = 50 LE/unit WP= 3500 units BCWP= 175000 LE



- **Schedule Variance = SV = BCWP – BCWS =** 175000 **–** 250,000 **= -75,000**

  (**>0** is ahead, **0** is on target, **<0** is behind)

- **Schedule Performance Index = SPI = BCWP/BCWS =** 175000 **/** 250,000 **=0.70**

  (**>1** is ahead, **1** is on target, **<1** is behind)

- **Cost Variance = CV = BCWP – ACWP =** 175000 **–** 210000 **= -35,000**

  (**>0** is under-run, **0** is on target, **<0** is overrun)

- **Cost Performance Index = CPI = BCWP/ACWP =** 175000 **/** 210000 **= 0.83**

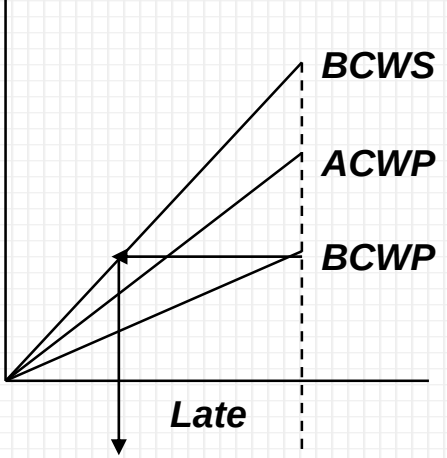
  (**>1** is under-run, **1** is on target, **<1** is over-run)

Item #3:

BC = 100 LE/unit WS= 5000 units BCWS= 500,000 LE

AC = 90 LE/unit WP= 5200 units ACWP= 468000 LE

BC = 100 LE/unit WP= 5200 units BCWP= 520000 LE



- **Schedule Variance = SV = BCWP – BCWS =** 520000 **–** 500,000 **= + 20,000**
  (>0 is ahead, 0 is on target, <0 is behind)

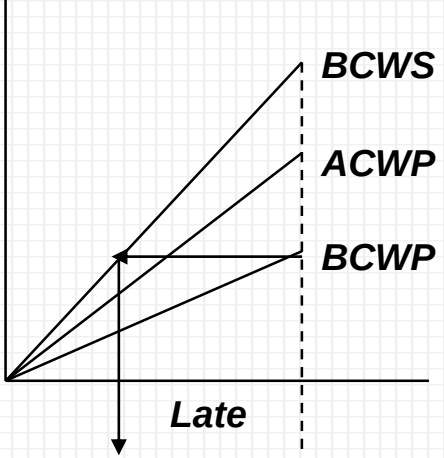
- **Schedule Performance Index = SPI = BCWP/BCWS =** 520000 **/** 500,000 **= 1.04**
  (>1 is ahead, 1 is on target, <1 is behind)

- **Cost Variance = CV = BCWP – ACWP =** 520000 **–** 468000 **= + 52,000**
  (>0 is under-run, 0 is on target, <0 is overrun)

- **Cost Performance Index = CPI = BCWP/ACWP =** 520000 **/** 468000 **= 1.11**
  (>1 is under-run, 1 is on target, <1 is over-run)

Item #4:

BC = 10,000 LE/unit	*WS= 10 units*	*BCWS= 100,000 LE*
AC = 11,000 LE/unit	*WP= 8 units*	*ACWP= 88,000 LE*
BC = 10,000 LE/unit	*WP= 8 units*	*BCWP= 80,000 LE*



- **Schedule Variance = SV = BCWP – BCWS =** 80,000 **–** 100,000 **= - 20,000**
  (**>0** is ahead, **0** is on target, **<0** is behind)

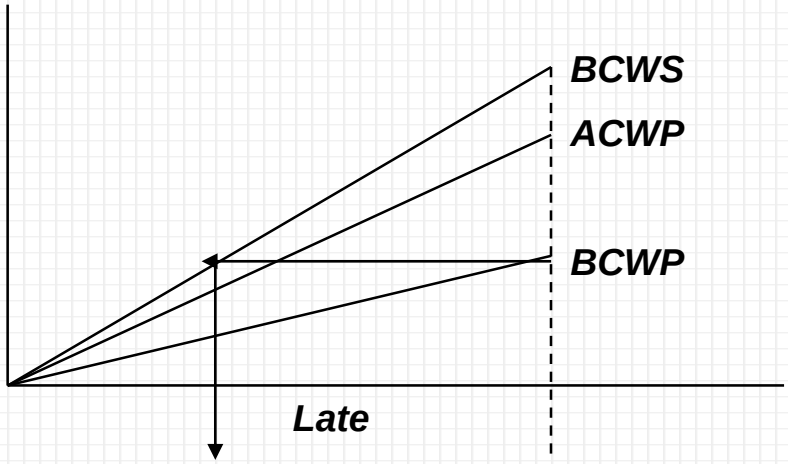
- **Schedule Performance Index = SPI = BCWP/BCWS =** 80,000 **/** 100,000 **= 0.80**
  (**>1** is ahead, **1** is on target, **<1** is behind)

- **Cost Variance = CV = BCWP – ACWP =** 80,000 **–** 88,000 **= - 8,000**
  (**>0** is under-run, **0** is on target, **<0** is overrun)

- **Cost Performance Index = CPI = BCWP/ACWP =** 80,000 **/** 88,000 **= 0.90**
  (**>1** is under-run, **1** is on target, **<1** is over-run)

Project: A Construction Project

Item	Planned Value (BCWS)	Actual Cost (ACWP)	Earned Value (BCWP)
#1	3000000	3080000	2800000
#2	250000	210000	175000
#3	500000	468000	520000
#4	100000	88000	80000



EVM Report:

Item	BCWS	ACWP	BCWP	SV	SPI	CV	CPI	Comments	
								Schedule	Cost
#1	3000000	3080000	2800000	-200000	0.93	-280000	0.91	Behind 7%	Over run 9%
#2	250000	210000	175000	-75000	0.70	-35000	0.83	Behind 30%	Over run 17%
#3	500000	468000	520000	20000	1.04	52000	1.11	Ahead 4%	Under run 11%
#4	100000	88000	80000	-20000	0.80	-8000	0.91	Behind 20%	Over run 9%
Total	3850000	3846000	3575000	-275000	0.93	-271000	0.93	Behind 7%	Over run 7%

Brainstorming: Earned Value Analysis

Project: Office Building

Item (main activity): Excavation works

Planned Performance (Baseline):

Bill of Quantity (BOQ)	= 500 m3
Unit Price	= 10 $/m3
Duration	= 10 day

Actual Performance (Status Report after 6 days):

Actual Quantity	= 320 m3
Actual Cost	= 3300 $

Based on this information, calculate and analyze the following:

a) What is the cost variance?
b) What is the Schedule variance?
c) What is the Cost Performance Index?
d) What is the Schedule Performance Index?
e) How would you describe this project?

Budget At Completion (BAC) = 500 * 10 = 5000 $

Planned quantity after 6 days = WS = 500 * (6/10) = 300 m3

BCWS = 3000 **BCWP = 3200** **ACWP = 3300**

- **What is the cost variance?**
  - **BCWP – ACWP =3200 – 3300 = -100**
- **What is the Schedule variance?**
  - **BCWP – BCWS = 3200 – 3000 = +200**
- **What is the Cost Performance Index?**

  CPI = BCWP/ACWP = 3200/3300 =0.97 = 97%
- **What is the Schedule Performance Index?**

  SPI = BCWP/BCWS = 3200/3000 =1.07 = 107%
- **How would you describe this project?**

  The project is ahead schedule (good), but over run cost (bad)

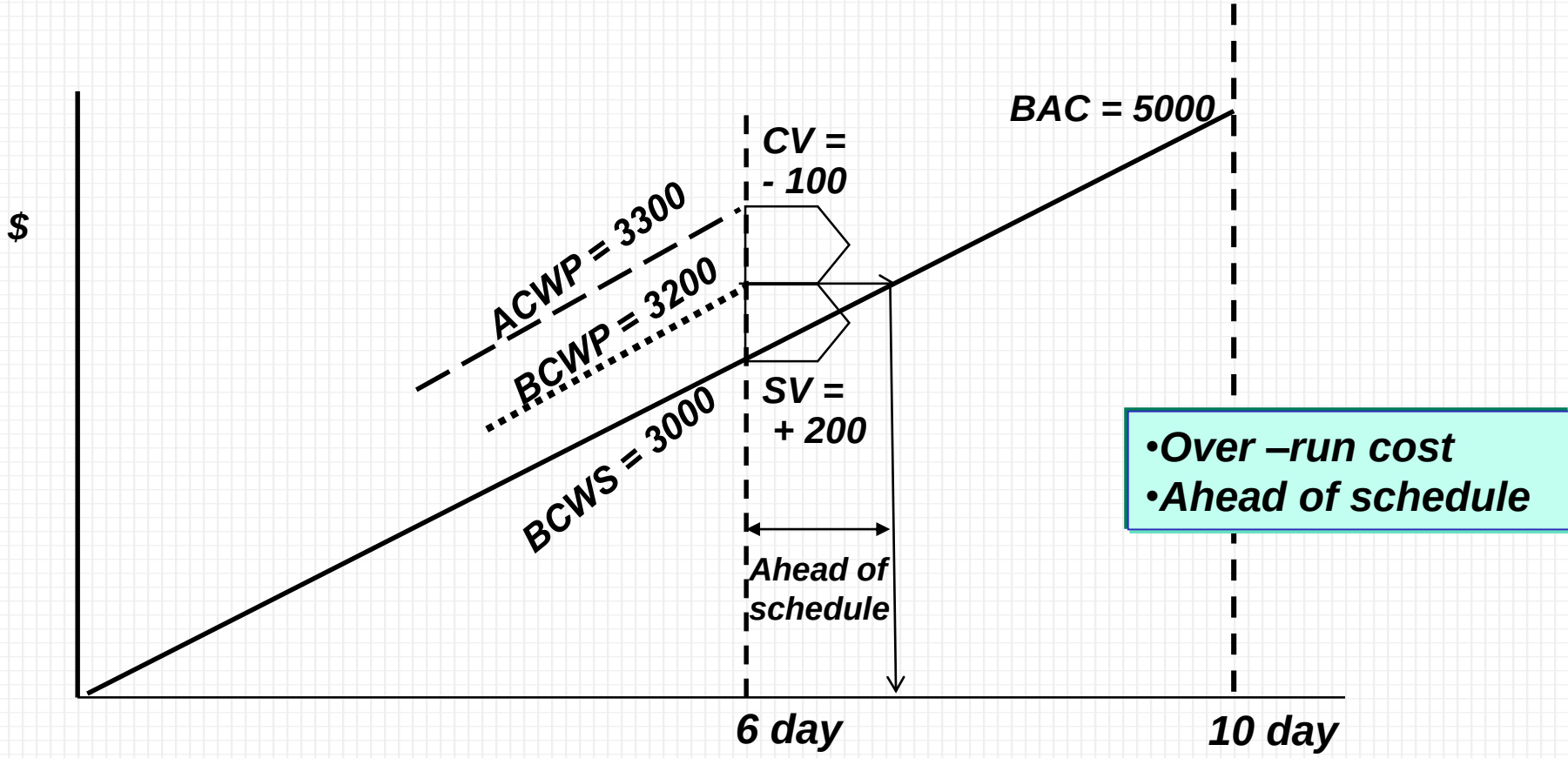
Example:

Project: Gas Pipeline ***Activity: Excavation***

Bill of Quantity (BOQ) = 500 m3 ***Unit Price = 10 LE/m3*** ***Duration= 10 day***

Status Report after 6 day:

Actual Quantity = 320 m3 ***Actual Cost = 3300 LE***



Brainstorming: Earned Value Analysis

Project: Office Building

Item (main activity): Excavation works

Planned Performance (Baseline):

Bill of Quantity (BOQ)	= 600 m3
Unit Price	= 10 $/m3
Duration	= 10 day

Actual Performance (Status Report after 6 days):

Actual Quantity	= 300 m3
Actual Cost	= 3300 $

Based on this information, calculate and analyze the following:

a) What is the cost variance?
b) What is the Schedule variance?
c) What is the Cost Performance Index?
d) What is the Schedule Performance Index?
e) How would you describe this project?

Brainstorming: Earned Value Analysis

Project: Gas Pipeline 12 km 6 inch

Item (main activity): Excavation works

Planned Performance (Baseline):

Bill of Quantity (BOQ)	= 500 m3
Unit Price	= 10 $/m3
Duration	= 10 day

Actual Performance (Status Report after 6 days):

Actual Quantity	= 320 m3
Actual Cost	= 3300 $

Based on this information, calculate and analyze the following:

a) What is the cost variance?
b) What is the Schedule variance?
c) What is the Cost Performance Index?
d) What is the Schedule Performance Index?
e) How would you describe this project?

Case Study:

Project Status Report:

Activity ID	Planned Cost	Planned Date		Actual Performance at period #10
		Start	Finish	
A	4000	1	4	Completed
B	10000	3	6	Completed
C	12000	6	9	In Progress
D	4000	9	12	In Progress
G	6000	9	12	Not Started
H	6000	11	14	Not Started
I	10000	14	17	Not Started

Based on this information; discuss the earned value analysis using the 50-50 rule?

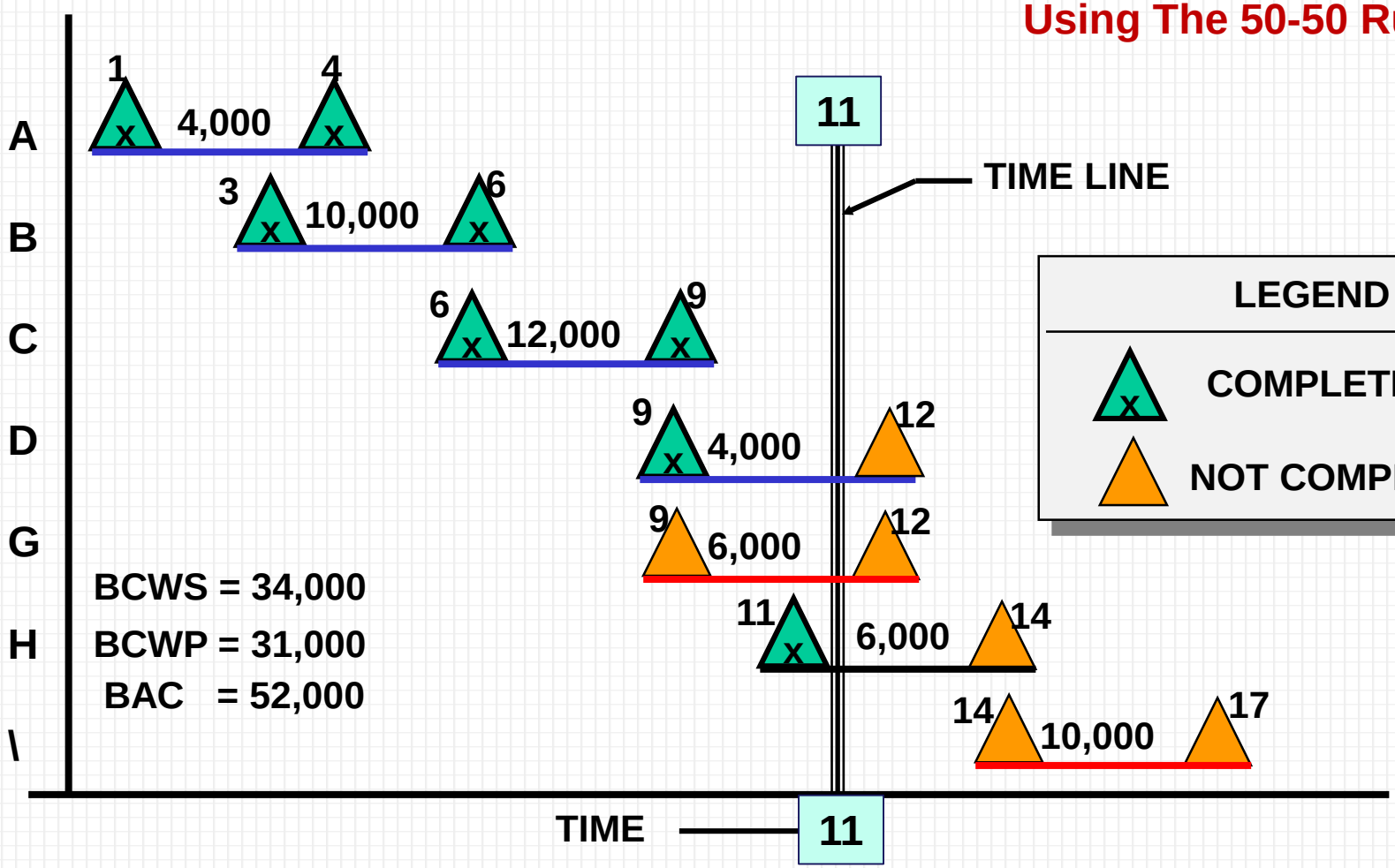
Case Study:

Project Status Report:

Activity ID	Planned Cost	Planned Date		Actual Performance at period #11
		Start	Finish	
A	4000	1	4	Completed
B	10000	3	6	Completed
C	12000	6	9	Completed
D	4000	9	12	Started
G	6000	9	12	Not Started
H	6000	11	14	Started
I	10000	14	17	Not Started

Based on this information; discuss the earned value analysis using the 50-50 rule?

Using The 50-50 Rule



Planned Value = BCWS = 4000+10000+12000+4000*0.5+6000*0.5+6000*0.5 = 34000

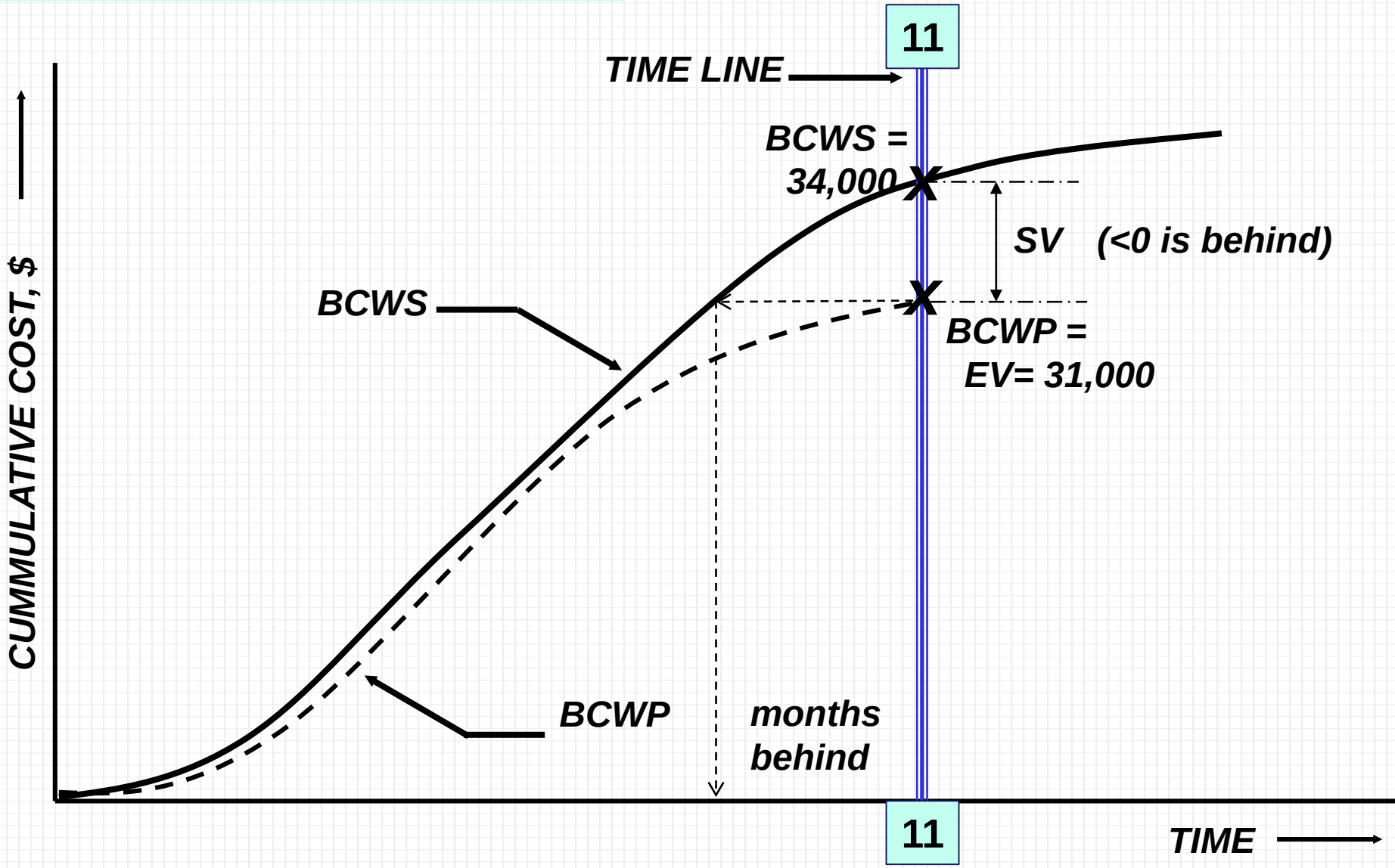
Earned Value = BCWP = 4000+10000+12000+4000*0.5+6000*0+6000*0.5 = 31000

Schedule Variance = SV = BCWP – BCWS = 31000 - 34000 = - 3000 (<0 is behind)

Schedule Performance Index SPI = BCWP / BCWS = 31000 / 34000 = 0.91 (<1 is behind 9%)

Budget at Complete; BAC=4000+10000+12000+4000+6000+6000+10000= 52000

Cost Graph (S-Curve):



Translating schedule variance into lead/lag

Example:

Activity	BAC	Planned Day		Performance at period 9		
		Start	finish	BCWS	ACWP	BCWP
A	30	1	30	9	8	6
B	30	1	30	9	8	12
Project	60	1	30	18	16	18

Based on this information; discuss the following:

1. **Total Variance (TV)**
2. **Cost Variance (CV)**
3. **Schedule Variance (SV)**
4. **Estimate At Completion (EAC)**
5. **Variance At Completion (VAC)**

Example:

Activity	BCWS	ACWP	BCWP
A	**9**	**8**	**6**
B	**9**	**8**	**12**
Project	**18**	**16**	**18**

Activity	TV= BCWS –ACWP	CV= BCWP – ACWP	SV= BCWP – BCWS
A	**1**	**-2**	**-3**
B	**1**	**4**	**3**
Project	**2**	**2**	**0**

Activity	BAC	Performance at period 9			EAC	VAC
		BCWS	ACWP	BCWP		
A	30	9	8	6	40	- 10
B	30	9	8	12	20	+10
Project	60	18	16	18	60	0

Estimate To Completion ➔ Forecasting

ETC = BAC * ACWP/BCWP = 30 * (8/6) = 40 (activity A)

Variance To Completion

VTC= BAC- EAC = 30 – 40 = - 10 (activity A)

Basics of EV – Old Vocabulary

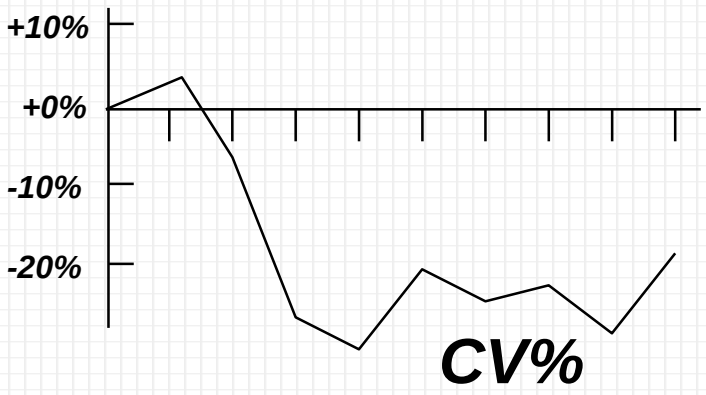
- ACWP
  - Actual Cost of Work Performed
  - replaced by **AC**
- BCWP
  - Budgeted Cost of Work Performed
  - replaced by **EV**
- BCWS
  - Budgeted Cost of Work Scheduled
  - replaced by **PV**

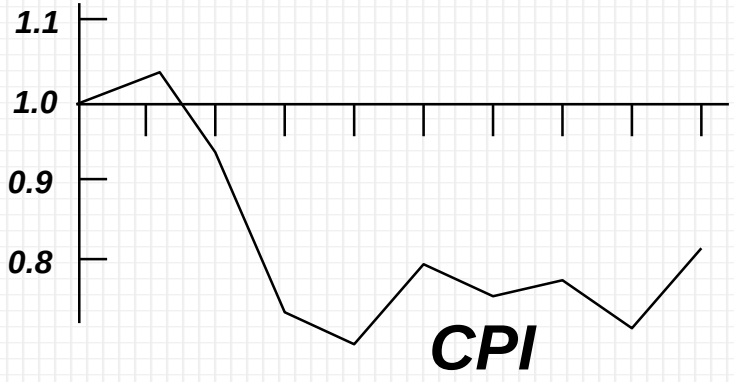
Cost Performance Index	CPI = EV / AC
Cost Variance	CV = EV - AC
Earned Value (for a task)	EV = PV * %Complete
Estimate To Complete	ETC = EAC - AC
Schedule Performance Index	SPI = EV / PV
Schedule Variance	SV = EV - PV
Variance At Completion	VAC = BAC - EAC
Estimate At Completion (EAC)	EAC has a separate set of equations

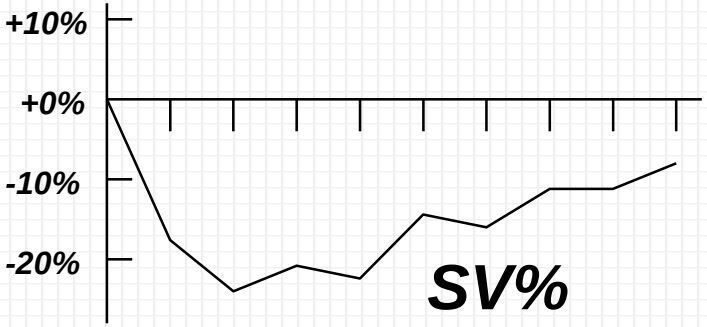
Estimate At Completion

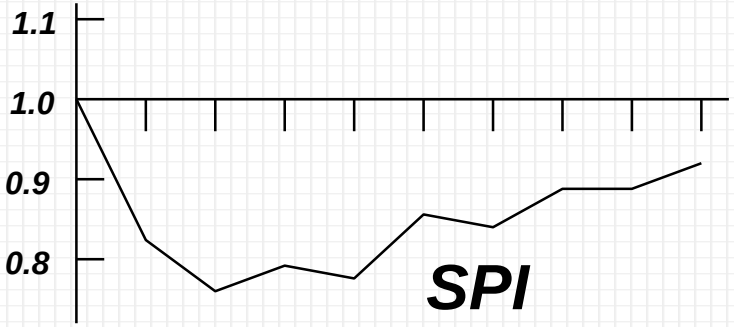
EAC = AC + ETC	Re-Estimated
EAC = AC + (BAC - EV)	Atypical
EAC = AC + ((BAC - EV) / CPI)	Typical
EAC = BAC / CPI	Typical

Discuss the following figures:









Critical Ratio

$$\frac{\text{actual progress}}{\text{scheduled progress}} \times \frac{\text{budgeted cost}}{\text{actual cost}}$$

If ratio is 1 everything is probably on target

The further away form 1 the ratio is, the more we may need to investigate

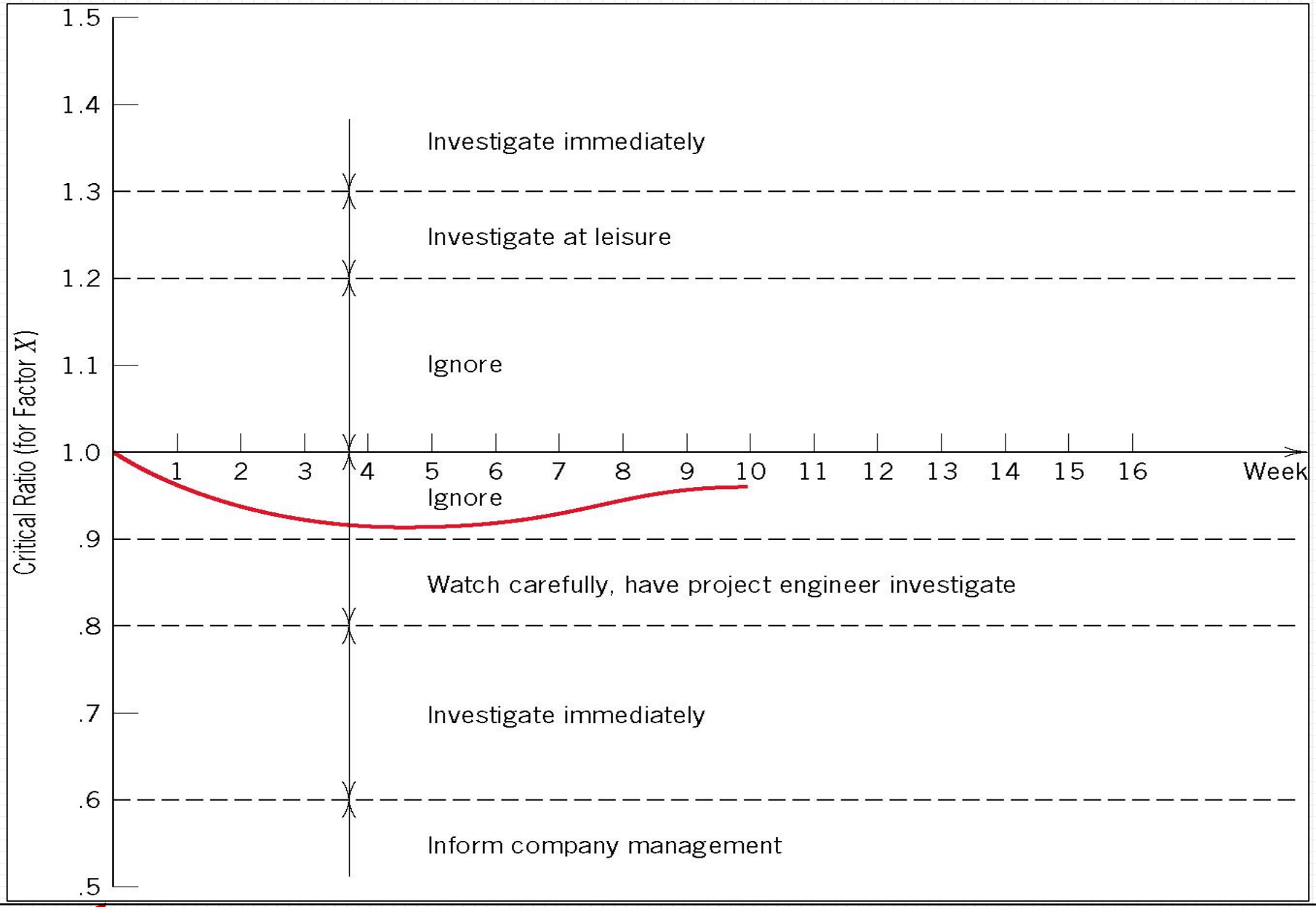
Task Number	Actual Progress		Scheduled Progress		Budgeted Cost		Actual Cost		Critical Ratio
1	(2	/	3)	X	(3	/	2)	=	1.00
2	(2	/	3)	X	(6	/	6)	=	0.67
3	(3	/	3)	X	(4	/	6)	=	0.67
4	(3	/	2)	X	(6	/	6)	=	1.50
5	(3	/	3)	X	(6	/	4)	=	1.50

Critical ratio example

Calculate the critical ratios for the following activities and indicate which are probably on target and need to be investigated.

Activity	Baseline		Actual		Critical ratio (CR)
	Scheduled Progress	Budgeted Cost	Actual progress	Actual cost	
A	4 days	60	4 days	40	
B	2 days	50	3 days	50	
C	3 days	30	2 days	20	
D	1 day	20	1 day	30	
E	4 days	25	2 days	25	

Critical Ratio Control Limits



Establishing an EVMS

ANSI/EIA 748 Standard ***Criteria provides a list of guidelines***

- ***Organization***
- ***Planning, Scheduling, and Budgeting***
- ***Accounting Considerations***
- ***Analysis and Management Reports***
- ***Revisions and Data Maintenance (change management)***

ANSI/EIA 748 doesn't identify 'approved systems'

Earned Value Management is a tool for performance measurement (cost and schedule) and forecasting

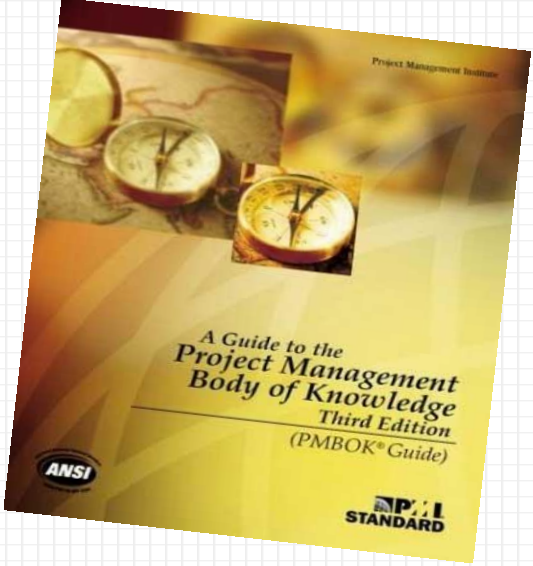
Glossary of Terms

EV	**Earned value for a task is simply the percent complete times its original budget. Stated differently, EV is the percent of the original budget that has been earned by actual work completed.**
PV	**The planned time-phased baseline of the value of the work scheduled. An approved cost estimate of the resources scheduled in a time-phased cumulative baseline [BCWS—budgeted cost of the work scheduled].**
AC	**Actual cost of the work completed. The sum of the costs incurred in accomplishing work. [ACWP—actual cost of the work performed].**
CV	**Cost variance is the difference between the earned value and the actual costs for the work completed to date where CV = EV – AC.**
SV	**Schedule variance is the difference between the earned value and the baseline line to date where SV = EV – PV.**
BAC	**Budgeted cost at completion. Total budgeted cost of the baseline or project cost accounts.**
TAC	**The duration of the critical path**
EAC	**Estimated cost at completion.**
ETC	**Estimated cost to complete remaining work.**
VAC	**Cost variance at completion. VAC indicates expected actual over- or under-run cost at completion.**

Reference Books:

FastForwardMBA in Project Management

The Project Management Body of Knowledge
http://www.PMI.org



- www.pmi-ctt.org
- www.projectkickstart.com/html/tips.htm
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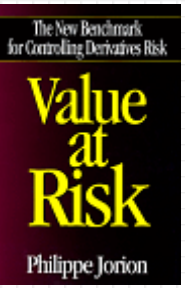

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Irwin Professional Pub; ISBN: 0786308486 ; Dimensions (in inches): 1.20 x 9.33 x 6.34

•Managing Financial Risk : A Guide to Derivative Products, Financial Engineering and Value Maximization (Irwin Library of Investment & Finance) -
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- Engineering Economy, William G. Sullivan (Editor), Elin M. Wicks, James T. Luxhoj , May 2005, Publisher: Prentice Hall.

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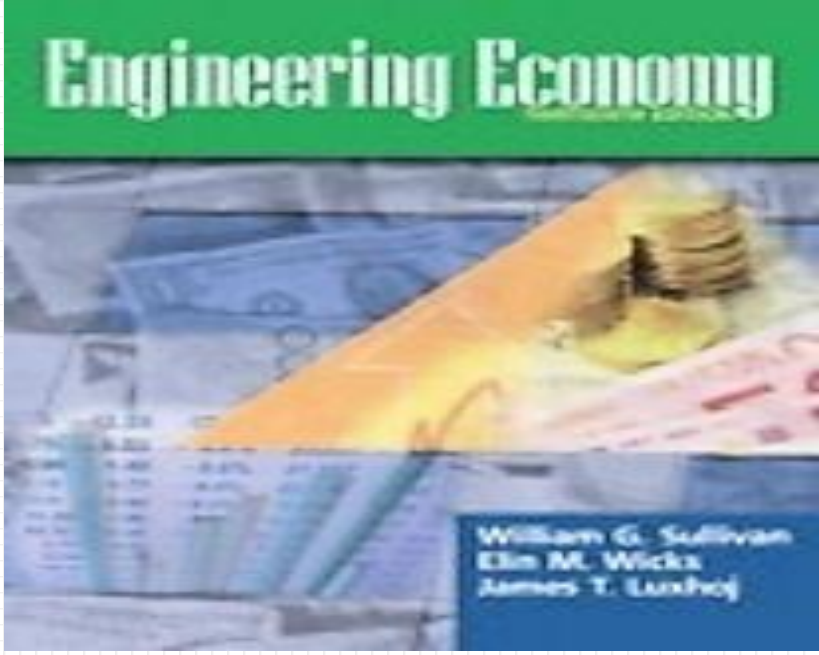
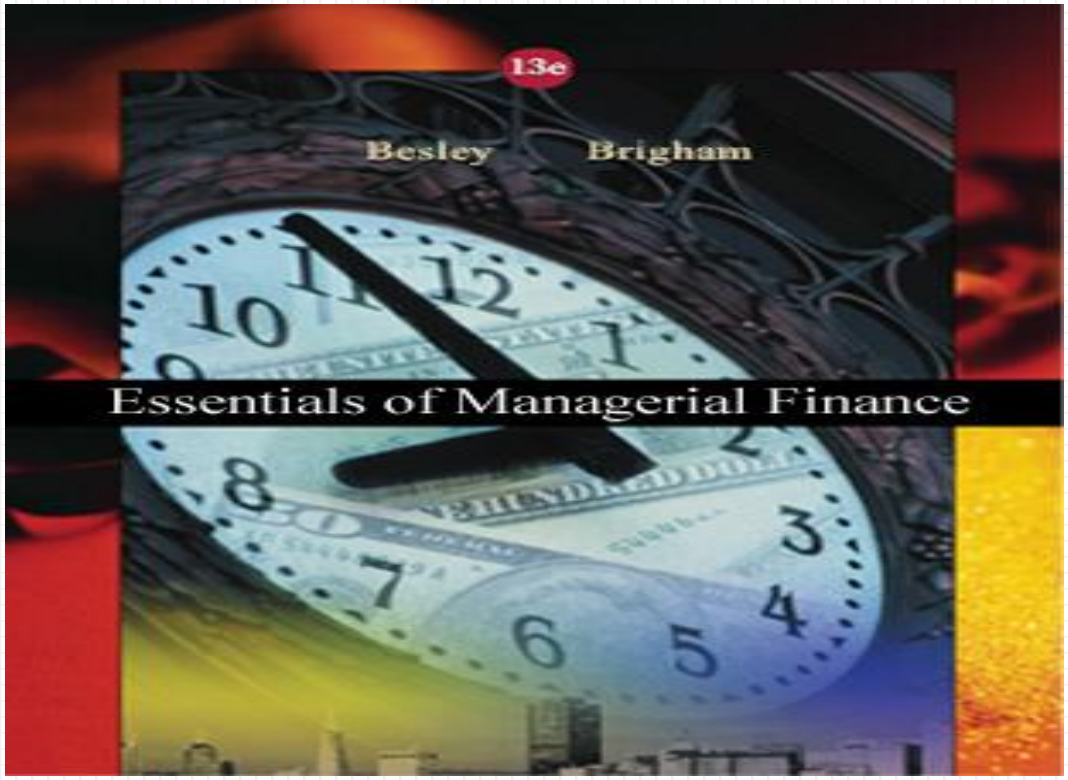
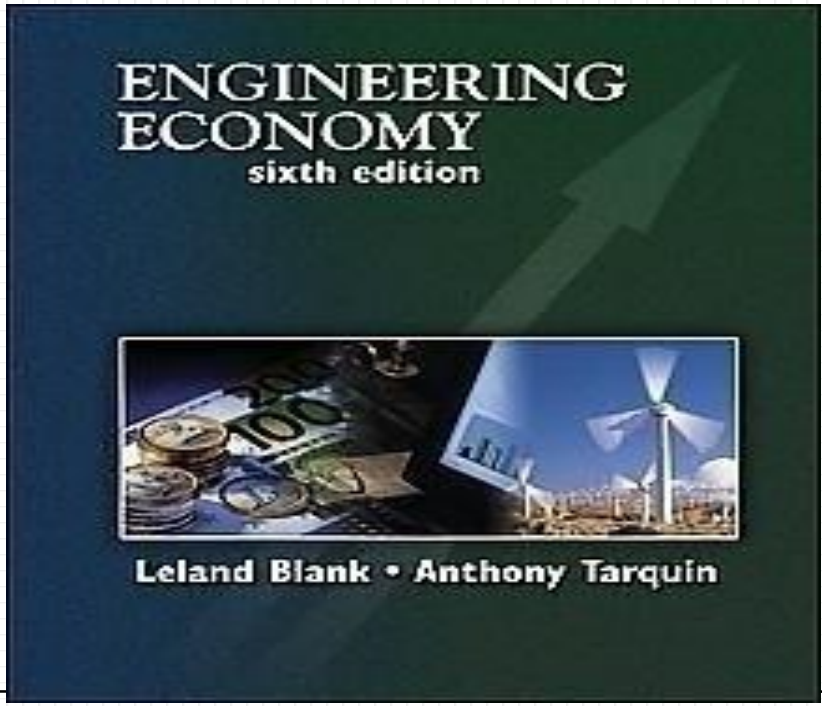
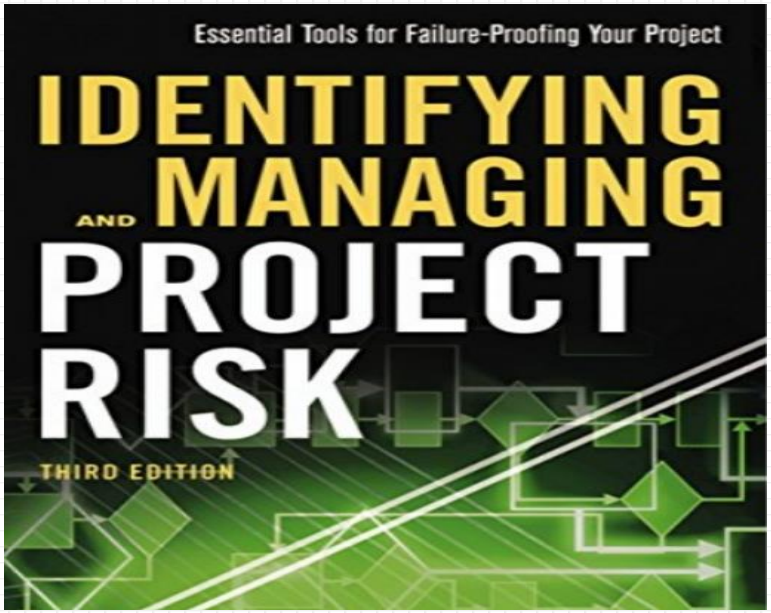
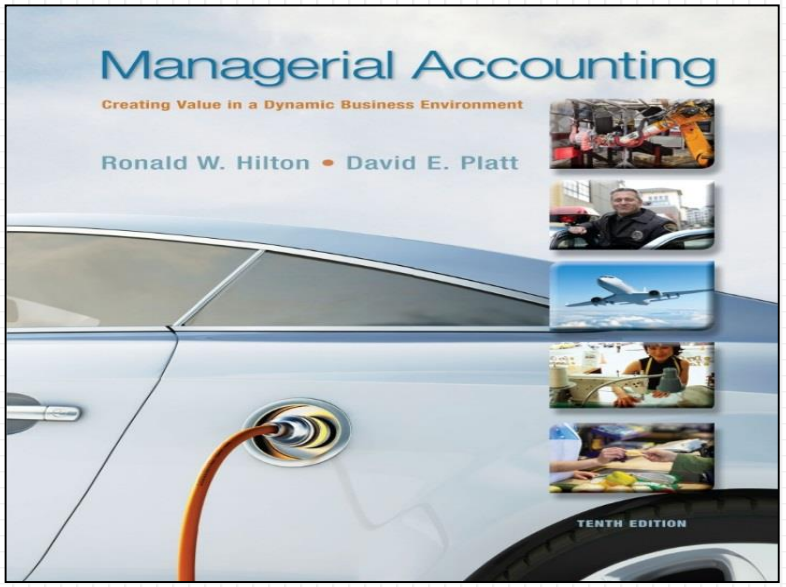






Reference Books:





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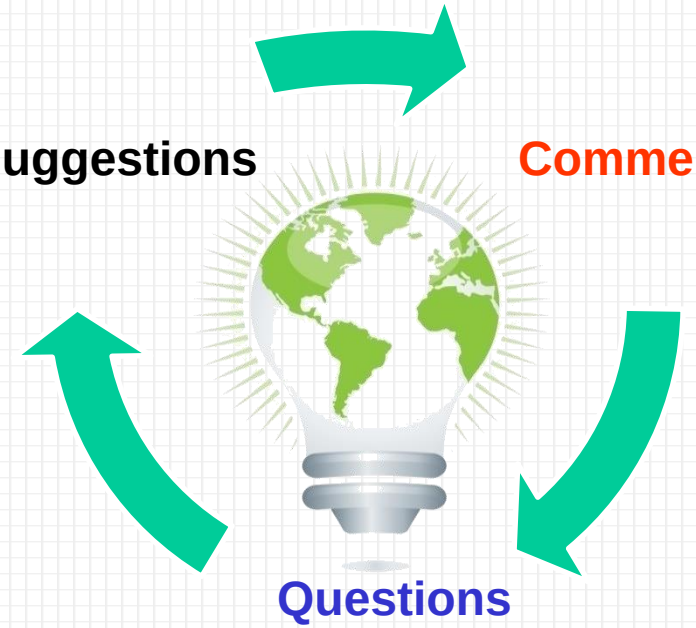
Thank you for your attention!

Useful Science For the Sake of Allah

اللهم تقبل هذا العلم



قَالُوا سُبْحَانَكَ لا عِلْمَ لَنَا إِلا مَا
عَلَّمْتَنَا إِنَّكَ أَنتَ العَلِيمُ الحَكِيمُ"

(سورة البقرة آية 32)

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