ECONOMIC EVALUATION OF ALTERNATIVES

AGENDA

- Economic Evaluation
- Planning Horizon
- Life Cycle Costing
- Present Worth Analysis
- Equivalent Uniform Annual Worth Analysis
- Rate of Return Method
- Benefit/Cost Ratio Method
- Payback Period
- Inflation

ECONOMIC EVALUATION

Economic evaluation approach

- ❑ Generate a set of projects or purchases for investment consideration
- ❑ Establish the planning horizon for economic analysis
- ❑ Estimate the cash flow profile for each project
- ❑ Specify the minimum attractive rate of return (MARR)
- ❑ Establish the criterion for accepting or rejecting a proposal, or for selecting the best among a group of mutually exclusive proposals

ECONOMIC EVALUATION

Economic evaluation approach

- ❑ Perform sensitivity or uncertainty analysis
- ❑ Accept or reject a proposal based on the established criterion
- ❑ Equivalence needed to adjust the cash flow for a given alternative into some equivalent to enable comparisons

1. Present worth analysis
2. Equivalent uniform annual cost analysis
3. Internal rate of return method
4. Benefit/cost ratio method
5. Payback period

PLANNING HORIZON

- **Each alternative has its own service life**
- **Accordingly, in this analysis, careful consideration must be given to the time period covered by the analysis**
- **This is called the analysis period or the planning horizon**
- **There are three different analysis-period situations :**
  - The alternatives have equal useful life or analysis period
  - The alternatives have different useful lives or analysis period
  - There is an infinite analysis period for each mutually exclusive proposals

LIFE CYCLE COSTING

- **The concept of life cycle costing takes into account total costs for an investment during its life span**
- **Life cycle costs considers all significant costs of initial costs and ownership costs over economic life of each alternative**
  - **Initial costs**: including: initial construction cost, design cost, land cost and finance cost
  - **Ownership costs**: including operating costs (maintenance, repairs and utility bills)
  - **Replacement costs** (cost of replacing the project after it runs its economic life)

1.PRESENT WORTH ANALYSIS

- Present worth is most frequently used method to determine the present value of future money
- In present worth analysis, the alternative with the maximum present worth (PW) of benefits minus present worth of cost is always selected
- This is called the net present worth criterion (NPW)
- NPW = PW of benefits – PW of costs
- Careful consideration must be given to the time period covered by the analysis

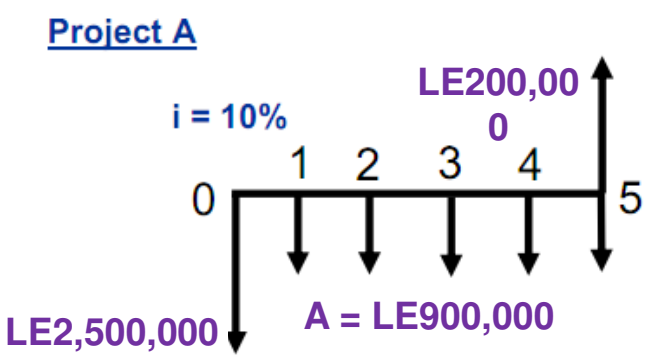
1.PRESENT WORTH ANALYSIS
EQUAL-LIVED ALTERNATIVES

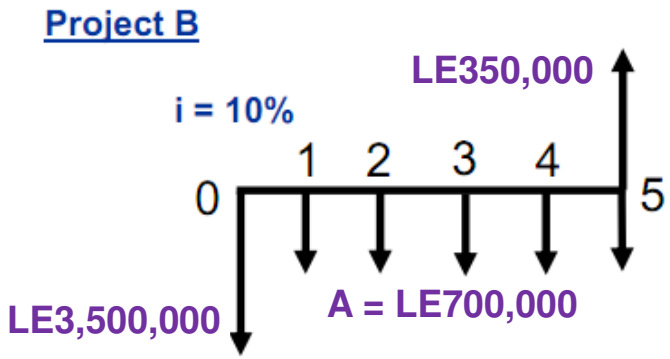
Example: Make a present-worth comparison of the equal-service life projects for which costs are shown below, if i = 10%. Which project would you select?

	Project A	Project B
First cost, P	LE 2,500,000	LE3,500,000
Annual operating cost, A	LE 900,000	LE 700,000
Salvage value, F	LE 200,000	LE 350,000
Project service life (years)	5	5

1.PRESENT WORTH ANALYSIS
EQUAL-LIVED ALTERNATIVES

- PA = LE2,500,000 + LE900,000 (P/A, 10%, 5) - LE200,000 (P/F, 10%, 5) = LE5,788,000
- PB = LE3,500,000 + LE700,000 (P/A, 10%, 5) - LE350,000 (P/F, 10%, 5) = LE5,936,000
- Project A should be selected since PA < PB





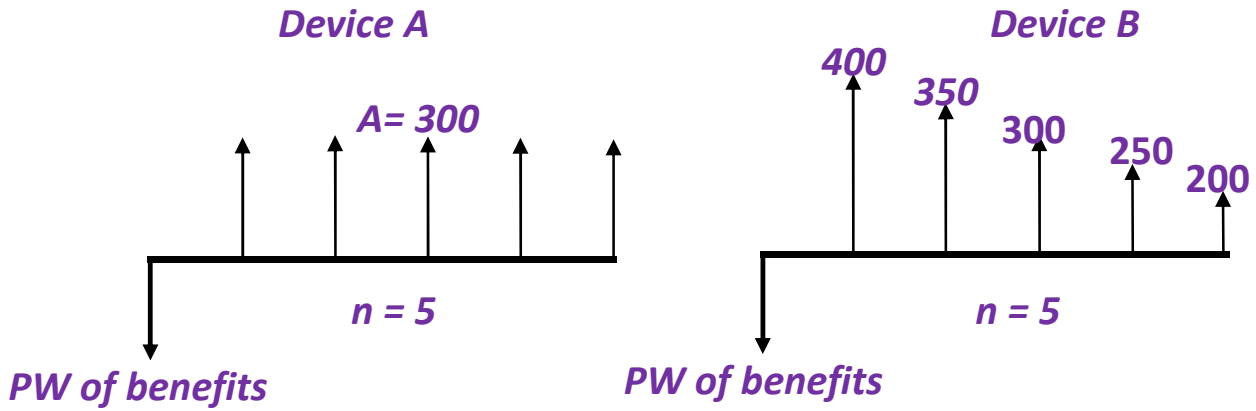
1.PRESENT WORTH ANALYSIS
EQUAL-LIVED ALTERNATIVES

Example: A firm is considering which of two mechanical devices to install to reduce costs in a particular situation. Both devices cost LE1000 and have useful lives of five years and no salvage value. Device A is expected to result in LE300 savings annually. Device B will provide savings for LE400 the first year but will decline LE50 annually. With interest rate 7%, which device should the firm purchase?

1.PRESENT WORTH ANALYSIS
EQUAL-LIVED ALTERNATIVES

- PWA = 300(P/A, 7%, 5) = 300(4.100) = LE1230
- PWB = 400(P/A, 7%, 5) – 50(P/G, 7%, 5)

  = 400(4.100) – 50(7.647) = LE1257.65
- Device B has the largest present worth of benefits, therefore, it the preferred alternative



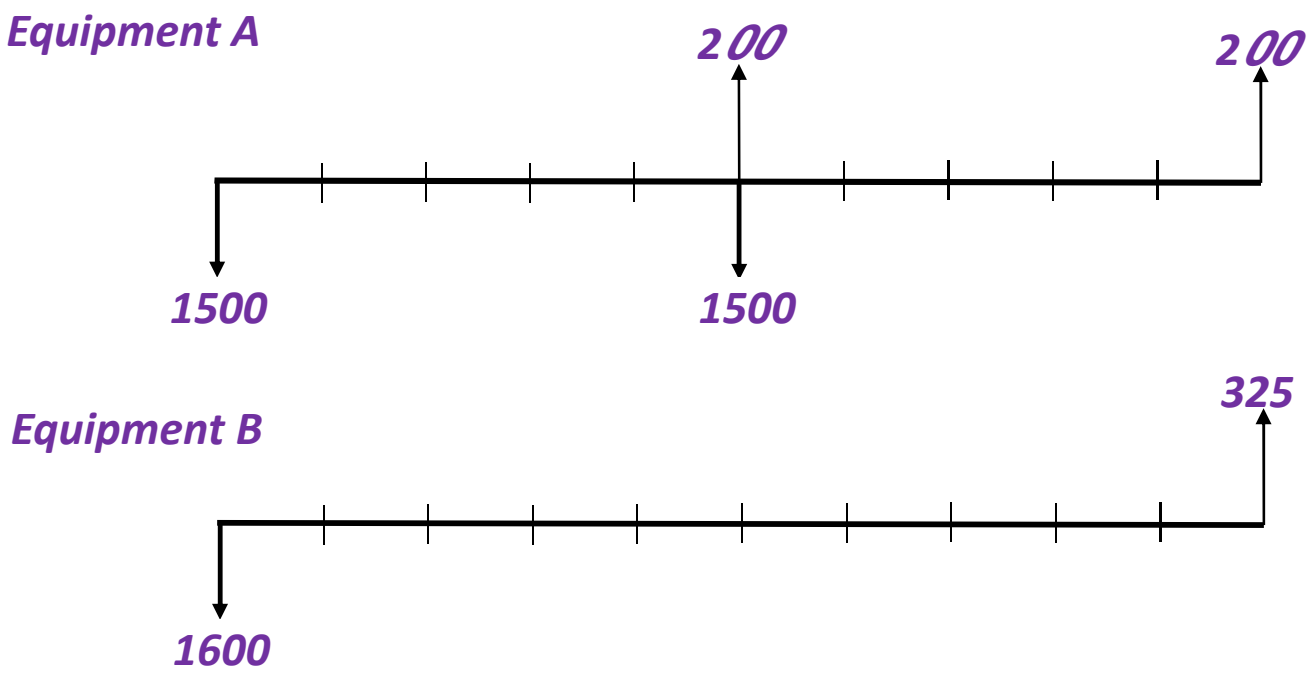
1.PRESENT WORTH ANALYSIS
UNEQUAL-LIVED ALTERNATIVES

Example: A purchasing agent is considering the purchase of new equipment for the mailroom. Two different quotations have been provided. Which equipment should be selected? Assume 7% interest rate and equal maintenance cost.

Manufacturer	Cost	Useful life, years	End-of-useful-life salvage value
A	LE1500	5	LE200
B	LE1600	10	EL325

1.PRESENT WORTH ANALYSIS
UNEQUAL-LIVED ALTERNATIVES

Analysis period = 10 years, which is the least common multiplier of the lives of both equipment



1.PRESENT WORTH ANALYSIS
UNEQUAL-LIVED ALTERNATIVES

PWA = LE1,500 + LE(1,500-200) (P/F, 7%, 5) – LE200 (P/F, 7%, 10)

= LE1,500 + 1300(0.713) – 200(0.5083) = LE2,325

PWB = LE1,600 – LE325 (P/F, 7%, 10)

= LE1,600 – 325(0.5083) = LE1,435

Equipment B should be selected since PWB < PWA

1.PRESENT WORTH ANALYSIS
UNEQUAL-LIVED ALTERNATIVES

Example: A company is trying to decide between two different garbage disposals. A regular (RS) disposal has an initial cost of LE65 and a life of 4 years. The alternative is a corrosion-resistant disposal constructed of stainless steel (SS). The initial cost of the SS disposal is LE110, but it is expected to last 10 years. The SS disposal is expected to cost LE5 per year more than the RS disposal. If the interest rate is 6%, which disposal should be selected, assuming both have no salvage value?.

1.PRESENT WORTH ANALYSIS
UNEQUAL-LIVED ALTERNATIVES

Since the disposals have different lives, so they compared over the least common multiple of years, which is 20 years

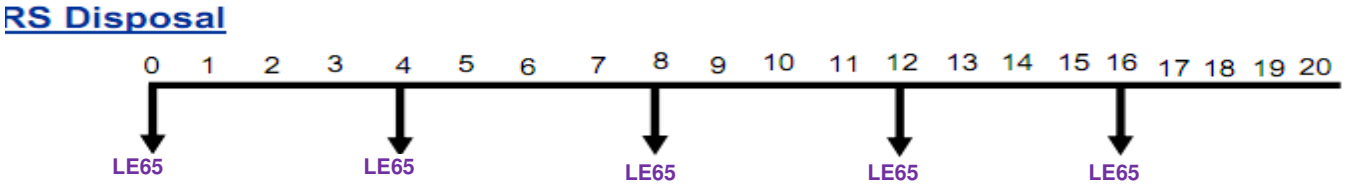
	RS	SS
Initial cost	LE65	LE110
Additional cost per year	-	LE5
Salvage value, F	-	-
Service life (years), n	4	10

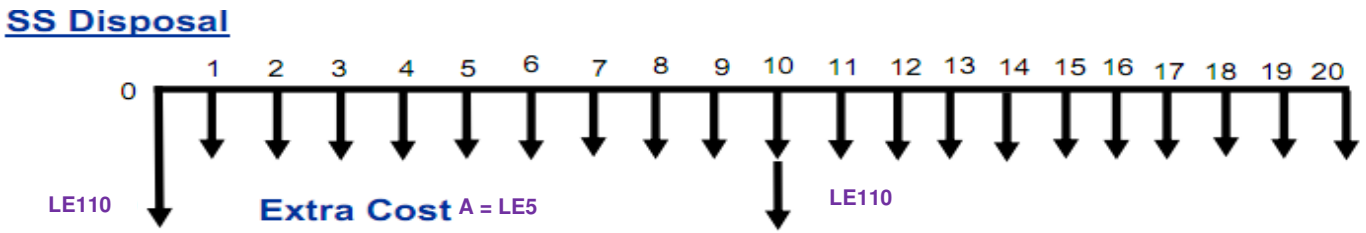
1.PRESENT WORTH ANALYSIS
UNEQUAL-LIVED ALTERNATIVES

PRS = LE65 + LE65 (P/F, 6%, 4) + LE65 (P/F, 6%, 8) + LE65 (P/F, 6%, 12) + LE65 (P/F, 6%, 16) = LE215

PSS = LE110 + LE110 (P/F, 6%, 10) + LE5 (P/A, 6%, 20) = LE229

Disposal RS should be selected since PRS < PSS





1.PRESENT WORTH ANALYSIS
INFINITE ANALYSIS PERIODS

- Sometimes an infinite analysis period ($n = \infty$) is encountered
- Alternatives such as roads, dams, bridges or whatever is sometimes considered permanent
- This analysis is called capitalized cost.
- A capitalized cost is the present sum of money that would need to be set aside now, at some interest rate, to yield the funds required to provide the service indefinitely

1.PRESENT WORTH ANALYSIS

INFINITE ANALYSIS PERIODS

Example: A city plans a pipeline to transport water from a distant watershed area to the city. The pipeline will cost LE8 million and have an expected life of seventy years. The city anticipates it will need to keep the water line in service indefinitely. Compute the capitalized cost assuming 7% interest

1.PRESENT WORTH ANALYSIS
INFINITE ANALYSIS PERIODS

- In this case, the LE8 million repeats every 70 years. We can find A first based on a present LE8 million disbursement.
- A = P(A/P, i, n) = LE8,000,000(0.0706) = LE565,000
- Now, the infinite series payment formula could be applied for n = ∞:
- Capitalized cost P = A / i = 565,000 / 0.07 = LE8,071,000

2.EQUIVALENT UNIFORM ANNUAL WORTH ANALYSIS

- In this section, the goal is to convert money into an equivalent uniform annual cost or benefits
- The major advantage of this method is that it is not necessary to make the comparison over the same number of years when the alternatives have different lives
- The reason for that, it is an equivalent annual cost over the life of the project

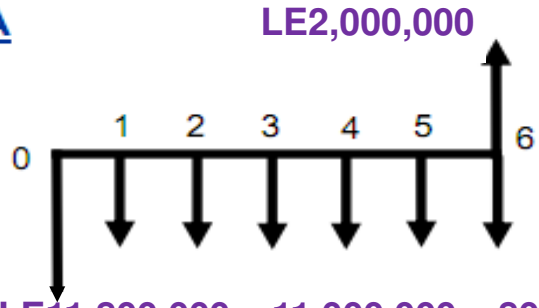
2.EQUIVALENT UNIFORM ANNUAL WORTH ANALYSIS

Example: If the minimum required rate of return is 15% which project should be selected?

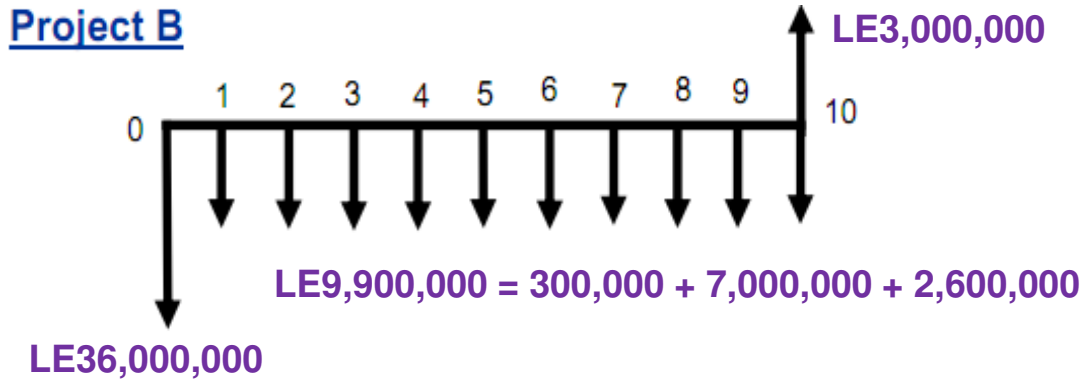
	Project A	Project B
First cost	LE26,000,000	LE36,000,000
Annual maintenance cost	LE800,000	LE300,000
Annual labor cost	LE11,000,000	LE7,000,000
Extra income taxes		LE2,600,000
Salvage value	LE2,000,000	LE3,000,000
Project service life (years)	6	10

2.EQUIVALENT UNIFORM ANNUAL WORTH ANALYSIS

Project A



Project B



2.EQUIVALENT UNIFORM ANNUAL WORTH ANALYSIS

- EUACA = LE26,000,000(A/P, 15%, 6) - LE2,000,000(A/F, 15%, 6) + LE11,800,000 = LE18,442,000
- EUACB = LE36,000,000(A/P, 15%, 10) - LE3,000,000 (A/F, 15%, 10) + EL9,900,000= LE16,925,000
- Project B should be selected since EUACB < EUACA

2.EQUIVALENT UNIFORM ANNUAL WORTH ANALYSIS

An asset depreciates uniformly from a first cost of LE50,000 to zero over a 20-year time frame. If operating costs are initially LE1,500 but increase by LE2,000 per year and revenues are LE20,000 per year but decrease by LE1,000 per year what is the EAW if the machine is replaced every 10 years and the interest rate is 5%.

EAUC = -50,000 (A/P, 5, 10) – 1,500 – 2,000(A/G, 5, 10) + 20,000 – 1,000(A/G, 5, 10)+ 25,000(A/F,5 ,10)

= -25,000(0.1295) – 1,500 – 2,000(4.09909) + 20,000

– 1,000(4.09909) = LE2,965

3.RATE OF RETURN METHOD

- **The objective of the rate of return method is to find the rate of return (i% percentage) for an investment over a specific service life**

- **The rate of return method considers all the cash follows that occur during the life cycle of an investment**

- **There are two methods to find the rate of return:**
  - Present worth
  - Equivalent uniform annual cost

- **Internal Rate of Return (IRR) calculations tell us the exact rate of return we are receiving on an investment**

3.RATE OF RETURN METHOD

- Suppose that you invested in 1970 LE1,650 in a savings account at 6% per year. Then, you could have LE10,648 on Jan., 2002 . What is the meaning of this 6% interest here?

  - This is your opportunity cost if putting money in savings account was the best you can do at that time!

  - So, as long as you earn more than 6% interest in another investment, you will take that investment

  - Therefore, that 6% is viewed as a Minimum Attractive Rate of Return or required rate of return (MARR)

3.RATE OF RETURN METHOD

- If projects being assessed then any project with an IRR greater than the MARR should be accepted

- IRR is defined as the investment rate that makes the PV of all expenditures equals the PV of all income(NPV =0)

- Or, Rate of return (ROR) or Internal Rate of Return (IRR) is defined as the interest rate earned on the unpaid balance of an installment loan

3.RATE OF RETURN METHOD

Example, we might invest LE5000 in a machine with a five-year useful life and annual revenue of LE1252.

What rate of return would we receive on this investment?

The least IRR is the one that makes the NPV of all payments equal to zero

The five payments of LE1252 are equivalent to a present sum of LE5000 when interest rate is 8%. Then, IRR =8%

3.RATE OF RETURN METHOD

Year	Cash flow	Unrecovered investment at beginning of year	8% return on unrecovered investment	Investment repayment at end of year	Unrecovered investment at end of year
0	-LE5000				
1	+1252	5000	400	852	4148
2	+1252	4148	331	921	3227
3	+1252	3227	258	994	2233
4	+1252	2233	178	1074	1159
5	+1252	1159	93	1159	0
			1260	5000	

3.RATE OF RETURN METHOD

IRR for one Alternative

- **When deciding on one alternative, then it is acceptable if it brings a positive IRR or an IRR greater than the MARR**
- **Rate of return calculation by the present worth method:**
- **The calculations are done in three steps:**
  - Draw a cash flow diagram
  - Set up the rate of return equation in the form

    $0 = \pm P + \Sigma\, nj = 1\ F\ (P/F, i\%, n) \pm A\ (P/A, i\%, n)$
  - Select values of i by trial and error until the equation is balanced to zero

3.RATE OF RETURN METHOD

IRR for one Alternative

- **Rate of Return Calculation by the EUAC Method:**
- **The calculations are done in three steps:**
  - Draw a cash flow diagram
  - Set up the rate of return equation in the form

    $0 = \pm P\,(A/P, i\%, n) \pm A$
  - Select values of i by trial and error until the equation is balanced to zero

3.RATE OF RETURN METHOD

IRR for one Alternative

- **Example: An investment resulted in the following cash flow. Compute the rate of return.**

Year	0	1	2	3	4
Cash flow (LE)	-700	+100	+175	+250	+325

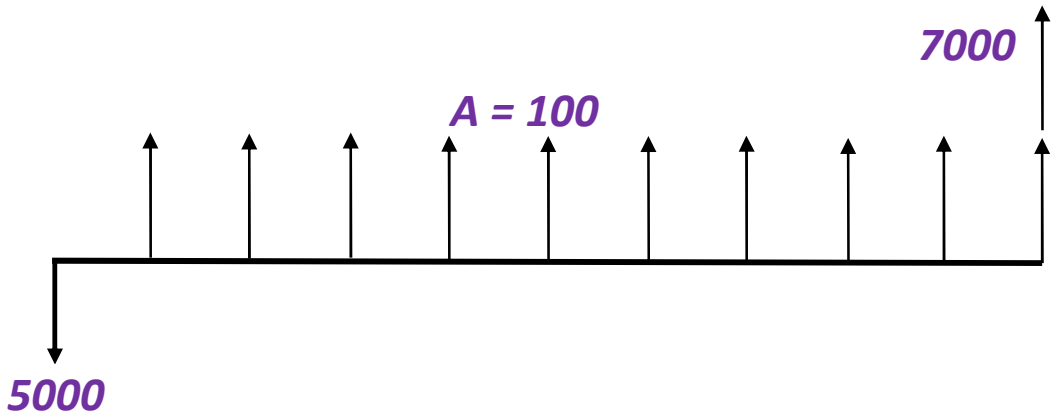
- EUAB – EUAC = 0
- 100 + 75(A/G, i, 4) – 700(A/P, i, 4) = 0;
- try i = 5%
- 100 + 75(A/G, 5, 4) – 700(A/P, 5, 4) = +LE11
- try i = 8%
- 100 + 75(A/G, 8, 4) – 700(A/P, 8, 4) = -LE6
- by interpolation, then i = 7%.

3.RATE OF RETURN METHOD

IRR for one Alternative

- **Example: If LE5,000 is invested now, this is expected to yield LE100 per year for 10 years and LE7,000 at the end of 10 years, what is the rate of return?**

Cash flow diagram:



3.RATE OF RETURN METHOD

IRR for one Alternative

Using the equation:

$$0 = \pm P + \Sigma nj = 1\ F\ (P/F, i\%, n) \pm A\ (P/A, i\%, n)$$

$$0 = -5{,}000 + 100\ (P/A, i\%, 10) + 7{,}000\ (P/F, i\%, 10)$$

Try i = 5%:

$$0 = -5{,}000 + 100\ (P/A, 5\%, 10) + 7{,}000\ (P/F, 5\%, 10) = +\ LE69.46$$

Try i = 6%:

$$0 = -5{,}000 + 100\ (P/A, 6\%, 10) + 7{,}000\ (P/F, 6\%, 10) = -\ LE355.19$$

By interpolation i = 5.16%

3.RATE OF RETURN METHOD

Comparing Two Alternative Using the IRR

- When two alternatives are compared, the IRR for each one is calculate and each alternative should first satisfies the MARR
- Alternative with the highest IRR not necessary being the best
- If the cash flows for one or all alternatives contain expenditures only, in this case we couldn't compute the IRR and accordingly we couldn't compare these alternatives using the IRR
- In this case, the incremental rate of return (ΔIRR) is computed on the difference between the alternatives

3.RATE OF RETURN METHOD

Comparing Two Alternative Using the IRR

- The cash flow for the difference between the alternatives is computed by taking the higher initial cost alternative minus the lower initial cost alternative
- If the ΔIRR is ≥ MARR then choose the higher cost alternative
- Thus means that the additional invested to obtain the higher alternative is superior to invest it elsewhere at the MARR
- If the ΔIRR is ≤ MARR then choose the lower cost alternative

3.RATE OF RETURN METHOD

Comparing Two Alternative Using the IRR

Example: You are given the choice of selecting one of two alternatives. The cash flows of the alternatives as shown in the following table. If the MARR is 6%, which one you select?

Year	Alternative 1	Alternative 2
0	-10	-20
1	+15	+28

3.RATE OF RETURN METHOD

Comparing Two Alternative Using the IRR

Normally, we select the lesser-cost alternatives (alternative 1), unless we find the additional cost of alternative 2 produces sufficient additional benefits that we would prefer. So, we will evaluate the difference project.

Year	Alternative 1	Alternative 2	Alt. 2 – Alt. 1
0	-LE10	-LE20	-20 – (-10) = -10
1	+15	+28	28 – 15 = +13

3.RATE OF RETURN METHOD

Comparing Two Alternative Using the IRR

- PWcost = PWbenefit
- 10 = 13(P/F, i%, 1)
- (P/F, i%, 1) = 10/13 = 0.7692; then i = 30
- Then, choose alternative 2
- Thus means that the additional LE10 invested to obtain alternative 2 is better than invest the LE10 elsewhere at 6% (MARR)

3.RATE OF RETURN METHOD

Comparing Two Alternative Using the IRR

Explaining the previous example:

Year	Alternative 1	Alternative 2
0	-LE10	-LE20
1	+15	+28
IRR	50%	40%
NPW	LE4.15	LE6.42

Expenditure only

3.RATE OF RETURN METHOD
Comparing Two Alternative Using the IRR

- Based on the NPW analysis, choose Option 2
- This agrees with the rate of return analysis on the difference between the two alternatives
- Based on the rate of return, Option 1 has higher rate of return
- Our analysis is to maximize the return not the rate of return
- Option 1 has a 50% rate of return (return =0.5 x 10= LE5), while option 2 has a 40% rate of return on a larger investment (return = 0.4x20= LE8)

3.RATE OF RETURN METHOD

Comparing >Two Alternative Using the IRR

- List the projects in order of increasing capital
- Check that the first project has an IRR greater than the MARR
- If yes, it becomes the defender, if not reject it and try remaining projects in order until one is greater than the MARR
- Subtract the defender's values (first cost, annual cost, annual revenues) from the challenger and calculate the IRR of the remainder
- If the IRR is greater than the MARR accept the challenger as the new defender, if not reject it and compare the next alternative
- Continue until all alternatives have been considered

3.RATE OF RETURN METHOD

Comparing >Two Alternative Using the IRR

Example: The following information showing the cash flows for two alternatives. If the MARR is 15%, which one is preferred?

	Alternative 1	Alternative 2
Initial cost	LE8000	LE13000
Annual costs	3500	1600
Salvage value	-	2000
Useful life	10	5

3.RATE OF RETURN METHOD

Comparing >Two Alternative Using the IRR

The cash flow of the incremental project

Year	Alternative 1	Alternative 2	Alt. 2 – Alt. 1
0	-8000	-13000	-5000
1-5	-3500	-1600	1900
5	-	+2000 -13000	-11000
6-10	-3500	-1600	1900
10	-	+2000	2000

$NPV_{2-1} = 0 =$ -5000 + 1900(P/A, i%, 10) - 11000(P/F, i%, 5)

+ 2000(P/F, i%, 10); then **$IRR_{2-1} = 12.65\%$**

IRR_{2-1} is less than MARR, then choose Alternative 1

3.RATE OF RETURN METHOD

Comparing >Two Alternative Using the IRR

Example: A small company is looking at expanding its business by purchasing a small new store that will operate for 10 years before being sold and replaced with a newer larger store. Three sites have been recommended to the owner each with different costs and expected revenues based on its location. The company operates with a MARR of 15% before taxes. Rate the alternatives based on:

a) PW comparison and

b) IRR comparison

3.RATE OF RETURN METHOD
Comparing >Two Alternative Using the IRR

	SITE 1	SITE 2	SITE 3
Land Purchase Price	100,000	150,000	160,000
Renovations	40,000	40,000	60,000
Resale	125,000	155,000	175,000
Expected Revenue	125,000	195,000	300,000
Annual Power Costs	35,000	55,000	75,000
Annual O & M cost	66,000	109,000	184,000

3.RATE OF RETURN METHOD

Comparing >Two Alternative Using the IRR

First, determine total initial cost, net revenues and rank the sites in order of first cost

	SITE 1	SITE 2	SITE 3
Initial costs	140,000	190,000	220,000
Resale	125,000	155,000	175,000
Net Revenues/year	24,000	31,000	41,000

3.RATE OF RETURN METHOD

Comparing >Two Alternative Using the IRR

- Present Worth Comparison where i =15%
- Site 1: PW =-140000+125000(P/F,15,10)+ 24000(P/A, 15, 10)

  = -140,000 + 30,898 + 120,450 = LE11,348
- Site 2: PW =-190000 +155000(P/F,15,10) + 31000(P/A, 15, 10)

  = -190,000 + 38,313 + 155,582 = LE3,895
- Site 3: PW =-220000 +175000(P/F,15,10) + 41000(P/A, 15, 10)

  = -220,000 + 43,257 + 205,770 = LE29,027
- Therefore select Site 3 then Site 1 and then Site 2

3.RATE OF RETURN METHOD

Comparing >Two Alternative Using the IRR

- IRR Comparison
- Site 1: -140,000 + 125,000(P/F, i, 10) + 24,000(P/A, i, 10) = 0
- By trial and error i= 16.66%, Select Site 1 since IRR > MARR
- Incremental site 2- site 1
- -50,000 + 30,000(P/F, i, 10) + 7,000(P/A, i, 10) = 0
- By trial and error i= 11.69%
- Select Site 1 since ΔIRR < MARR
- Incremental site 3- site 1
- -80,000 + 50,000(P/F, i, 10) + 17,000(P/A, i, 10) = 0
- By trial and error i= 19.79%
- Select Site 3 since ΔIRR > MARR

4.BENEFIT/COST RATIO METHOD

- The Benefit/Cost (B/C) method is based on the ratio of the annual benefits to the annual costs for a particular project
- Benefits are advantages, expressed in terms of a monetary value to the owner (i.e. dollars, etc.)
- Disbenefits are disadvantages, expressed in terms of a monetary value to the owner (i.e. dollars, etc.)
- B/C = (Benefits – Disbenefits) / Costs

4.BENEFIT/COST RATIO METHOD

$$B/C\ ratio = \frac{Equivalent\ annual\ total\ benefits}{Equivalent\ annual\ total\ cost}$$

$$B/C\ ratio = \frac{Present\ worth\ of\ total\ benefits}{Present\ worth\ of\ total\ cost}$$

4.BENEFIT/COST RATIO METHOD

Example (3)

The construction of a sewerage system is estimated to be $30,000,000.

The annual operation, maintenance and repair (OMR) is $1,000,000/year.

The annual income (benefit) from users is $3,500,000/year.

The life of the system is 30 years and the discount rate is 5%.

- Annual cost of = -1,951,500 – 1,000,000 = -2,951,500/year.

Solution:

B/C = 3,500,000 / 2,951,500 = 1.186

B/C = 53,803,400 / 45,372,400 = 1.186

If B/C is greater than 1, the project is worth

If B/C equals , the project is called break-even

4.BENEFIT/COST RATIO METHOD

- **If the B/C ratio is ≥ 1.0, this means that the extra benefit(s) of the higher cost alternative justify the higher cost**
- **If the B/C ratio is < 1.0, this means that the extra cost is not justified and the lower cost alternative is selected**
- **An alternative method that can be used to compare between projects, is to subtract the costs from the benefits that is (B – C)**
  - If (B – C) is ≥ 0, this means that the project is acceptable
  - If (B – C) ratio is < 0, this means that the project is rejected

4.BENEFIT/COST RATIO METHOD

- Rather than solving problems using present worth or annual cash flows analysis, we can base the calculations on the benefit-cost ratio, B/C
- The B/C is the ration of benefits to costs, or:
- B/C = PW of benefit / PW of costs = EUAB / EUAC ≥ 1

4.BENEFIT/COST RATIO METHOD

Example: Two routes are considered for a new highway, Road A, costing LE4,000,000 to build, will provide annual benefits of LE750,000 to local businesses. Road B would cost LE6,000,000 but will provide EL700,000 in benefits. The annual cost of maintenance is LE300,000 for Road A and LE320,000 for Road B. If the service life of Road A is 20 years, and for Road B is 30 years, which alternative should be selected if the interest rate is 8%?

4.BENEFIT/COST RATIO METHOD

B/C = (Benefits – Disbenefits) / Costs

Given Data	Road A	Road B
Initial Cost	LE4,000,000	LE 6,000,000
Annual Benefits	LE 750,000	LE 700,000
Annual Maintenance Cost	LE 300,000	LE 320,000
Service Life	20 years	30 years

4.BENEFIT/COST RATIO METHOD

- EUAC for Road A = 4,000,000 (A/P, 8%, 20) + 300,000

  = 4,000,000 (0.10185) + 300,000 = LE707,000

- EUAC for Road B = 6,000,000 (A/P, 8%, 30) + 320,000

  = 6,000,000 (0.08883) + 320,000 = LE552,980

- B/C for Road A = 750,000 / 707,000 = 1.06
- B/C for Road B = 700,000 / 552,980 = 1.26
- Choose Road B

4.BENEFIT/COST RATIO METHOD

- In case of comparing more than two alternatives, follow the same procedure for the IRR.
- List the projects in order of increasing capital.
- Calculate B/C for the first alternative.
- If B/C is greater than one, thus means that this alternative is acceptable and can be compared with other alternatives.
- If B/C is less than one, then continue with other alternative until you reach an alternative with B/C greater than 1.
- Compare the selected alternative from the previous step with the next alternative.

4.BENEFIT/COST RATIO METHOD

- Subtract B/C for the selected one with the next alternative (difference project).
- If B/C for the difference project is greater than 1, then select the project with highest cost.
- Continue until all alternatives have been considered

4.BENEFIT/COST RATIO METHOD

Example: Two machines are being considered for purchase. If the interest rate is 10%, which machine should be bought?

	Machine X	Machine Y
Initial cost	LE200	LE700
Annual benefits	95	120
Salvage value	50	150
Useful life, years	6	12

4.BENEFIT/COST RATIO METHOD

- **Machine X:**
  - EUAC = 200(A/P, 10%, 6) - 50(A/F, 10%, 6) = LE40
  - EUAB = LE95
  - B/C = 95/40 = 2.37
- **Machine Y:**
  - EUAC = 700(A/P, 10%, 12) - 150(A/F, 10%, 12) = LE96
  - EUAB = LE120
  - B/C = 120/96 = 1.25
- **Calculate the incremental benefit cost ratio, ΔB/ΔC (machine Y – machine X)**
  - ΔB/ΔC = (120-95) / (96-40) = 0.45
- **Since the incremental B/C is less than 1, it represents an undesirable increment of investment.**
- **Therefore choose the lower cost alternative – machine X**

4.BENEFIT/COST RATIO METHOD

Example: A company has decided to build a factory on a particular site. There are two mutually exclusive proposals that have been developed for the main factory. There are also three secondary proposals for the main project. The present worth of the benefits and costs are shown below. Which combinations of projects are best if the company can only spend LE400,000?

4.BENEFIT/COST RATIO METHOD

Main Proposals

Project	Benefits	Costs	B/C
A	300,000	150,000	2.0
B	450,000	250,000	1.8

Secondary Proposals

Project	Benefits	Costs
1	75,000	50,000
2	140,000	100,000
3	300,000	150,000

4.BENEFIT/COST RATIO METHOD

All the possible combinations with cost less that LE400,000 are ranked in order in the following table:

Combination	Benefits	Costs	B-C	B/C
I (A, 1, 2)	515,000	300,000	215,000	1.72
II (A, 3)	600,000	300,000	300,000	2.0
III (A, 1, 3)	675,000	350,000	325,000	1.93
IV(A, 2, 3)	740,000	400,000	340,000	1.85
V (B, 1, 2)	665,000	400,000	265,000	1.66
VI (B, 3)	750,000	400,000	350,000	1.87

4.BENEFIT/COST RATIO METHOD

- Since all B/C ratios are greater than one, then we will compare all alternatives
- Since alternatives I and II have the same costs while benefits of alternative II is greater, then choose II
- III-II: $\Delta B/\Delta C$ =(675,000–600,000)/(350,000–300,000) = 1.333
- Accept III
- IV-III: $\Delta B/\Delta C$ =(740,000– 675,000)/(400,000 – 350,000) = 1.3
- Accept IV

4.BENEFIT/COST RATIO METHOD

- Since alternatives V and IV have the same costs while benefits of alternative IV is greater, then choose IV
- VI-IV
- Since both alternatives VI and IV have the same costs while benefit of alternative VI is greater, the
- Accept VI

5.PAYBACK PERIOD METHOD

- Payback period is defined as "the period of time required for the profit or other benefits from an investment to equal the cost of the investment"
- The criterion in all situations is to minimize the payback period
- This method concerns with determining the number of years or months (the time) required to recover all the invested money
- When comparing between alternatives using this method, the alternative with the least payback period is selected

5.PAYBACK PERIOD METHOD

Example: A company has decided to buy new equipment for a project with 4-year duration. There are two different equipment can be used for this project. The cash flows of those types are shown in the table below. What is the payback period for each equipment and which one should be selected?

Year	Cash flows	
	Equipment A	Equipment B
0	-LE35,000	-LE35,000
1	20,000	10,000
2	15,000	10,000
3	10,000	15,000
4	10,000	20,000

5.PAYBACK PERIOD METHOD

To find the payback period, find the time at which the cumulative cash flows equal zero

Year	Cumulative cash flows	
	Equipment A	Equipment B
0	-LE35,000	-LE35,000
1	-15,000	-25,000
2	**0**	-15,000
3	10,000	**0**
4	20,000	20,000

The payback period for equipment A is 2 years, while it is 3 years for equipment B. Accordingly, Equipment A will be selected

5.PAYBACK PERIOD METHOD

Advantages:

- Easy to use
- Uses all the available cash flow
- Reduce the possibility of risk on projects as it selects the project with the least payback period
- Well known economic evaluation method

Concerns on using the payback period method:

- It is an approximate economic analysis method
- It does not consider the time-value of money
- Economic consequences beyond the payback period are ignored
- It is not suitable for long-life projects as the actual cash flows may differ than that was expected at the time of analysis

5.PAYBACK PERIOD METHOD

- One of the disadvantages of the payback period is that it ignores the time value of money. This drawback could be overcome by considering the time value of money, by determining the PW of both the costs and the revenues and equating them to find the payback period

5.PAYBACK PERIOD METHOD

Example: Calculate the payback period for the following two alternatives shown in the next table if the investment rate is 15%. Which one do you recommend?

Let's assume that the payback period is n years. So, it is required to find n where the PW of cost equals the PW of benefits.

PWcost = PWbenefits

	Alternate 1	Alternate 2
Initial cost	LE12000	LE8000
Annual benefits	3000	1500
Useful life, years	7	15

5.PAYBACK PERIOD METHOD

- **Alternative 1:**
  - 12000 = 3000(P/A, 15, n1)
  - Then, (P/A, 15, n1) = 4
  - From the interest table, n1 lie between year 6 and year 7.
  - By interpolation n1 = 6.6 years
- **Alternative 2:**
  - 8000 = 1500(P/A, 15, n2)
  - Then, (P/A, 15, n2) = 5.33
  - From the interest table, n2 lie between year 11 and year 12
  - By interpolation n2 = 11.5 years
- **Based on these results, alternative 1 will be selected as it has a shorter payback period**

5.PAYBACK PERIOD METHOD

- Analyzing this example:
- There is no return for the investment (IRR = 0) in alternative 1. While the IRR for alternative 2 will be greater than zero as there is still some returns after the payback period
- To overcome this problem, we may compare the payback period over the useful life of each alternative and select the smaller ratio. Applying this for the previous example:
- n1/useful life 1 = 6.6/7 = 0.94
- n2/useful life 2 = 11.5/15 = 0.77
- Based on this comparison, select alternative 2

INFLATION

- Inflation is an important concept in any economic analysis because the purchasing power of money rarely stays constant.
- Over time, the amount of goods and services that can be purchased with a fixed amount of money tends to change (always decline).
- When prices inflate, we can buy less with the same amount of money
- So, it is important to incorporate the effect of inflation in analysis of alternatives
- When the purchasing power of money increase, this is named deflation. Deflation has an opposite effect to inflation.

INFLATION

- **Inflation rate (f):** The inflation rate captures the decrease in the purchasing power of the currency

- **Interest rate (i):** This is the interest rate measuring the real growth of money without the effect of inflation

- **Market interest rate (i'):** The combined interest rate that combines both the real money growth and inflation.
  …… This is named as the **inflated interest rate**

INFLATION

- When calculating the investment of a given some of money, it is multiplied by (1 + i)

- Considering the inflation effect, it is multiplied also by (1 + f) Or, this sum of money is multiplied by (1 + i') which combines both the effect of interest and inflation.

- Accordingly, the relation could be derived as follows:
- (1 + i') = (1 + i)(1 + f) = 1 + i + f + if
- Then, i' = i + f + if

INFLATION

- **Example**: What is the amount of money a company should save now to buy a new equipment costs LE65,000 after three years from now. The interest rate is 13% and the inflation rate is 7%.
- $i' = i + f + if = 0.13 + 0.07 + (0.13 \times 0.07) = 0.2091 = 20.91\%$
- $P = F / (1 + i')^n = 65000 / (1 + 0.2091)^3$

  $= LE36,773$

INFLATION

- **Example: Which of the following revenues is preferred, if the interest rate is 12% and the inflation rate is 11%?**
- **LE60,000 now.**
- **LE16,000 annually starting one year from now for a period of 12 years.**
- **LE50,000 after three years from now and LE80,000 after 5 years from now.**

INFLATION

- $i' = i + f + if = 0.12 + 0.11 + 0.12 \times 0.11 = 0.243 = 24.3\%$
- Pa = LE60,000
- $Pb = A[((1 + i')^n - 1)) / (i'(1 + i')^n)]$

  $= 16000 [(1.24312 - 1) / 0.243(1.24312)] =$ LE61,003
- $Pc = 50000 / (1.243)^3 + 80000 / (1.243)^5 =$ LE52,996
- Then, option b is preferred

$F = P(1+i)^n$	$P = F/(1+i)^n$
$F = A\left[\frac{(1+i)^n - 1}{i}\right]$	$A = F\left[\frac{i}{(1+i)^n - 1}\right]$
$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$	$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$
$F = \frac{G}{i}\left[\frac{(1+i)^n - 1}{i} - n\right]$	
$P = G\left[\frac{(1+i)^n - in - 1}{i^2(1+i)^n}\right]$	
$A = G\left[\frac{1}{i} - \frac{n}{(1+i)^n - 1}\right]$	

DR. AHMED ELYAMANY

EMAIL: DRAHMEDELYAMANY@YAHOO.COM

WEB PAGE: HTTP://DRAHMEDELYAMANY.WEEBLY.COM/

QUESTIONS