Debre Markos University

Institute of Technology

Construction Technology & Management Academic program

Development and Construction Economics

(CoTM 5271)

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CHAPTER-3

Comparison of Alternatives

Method of comparing alternatives

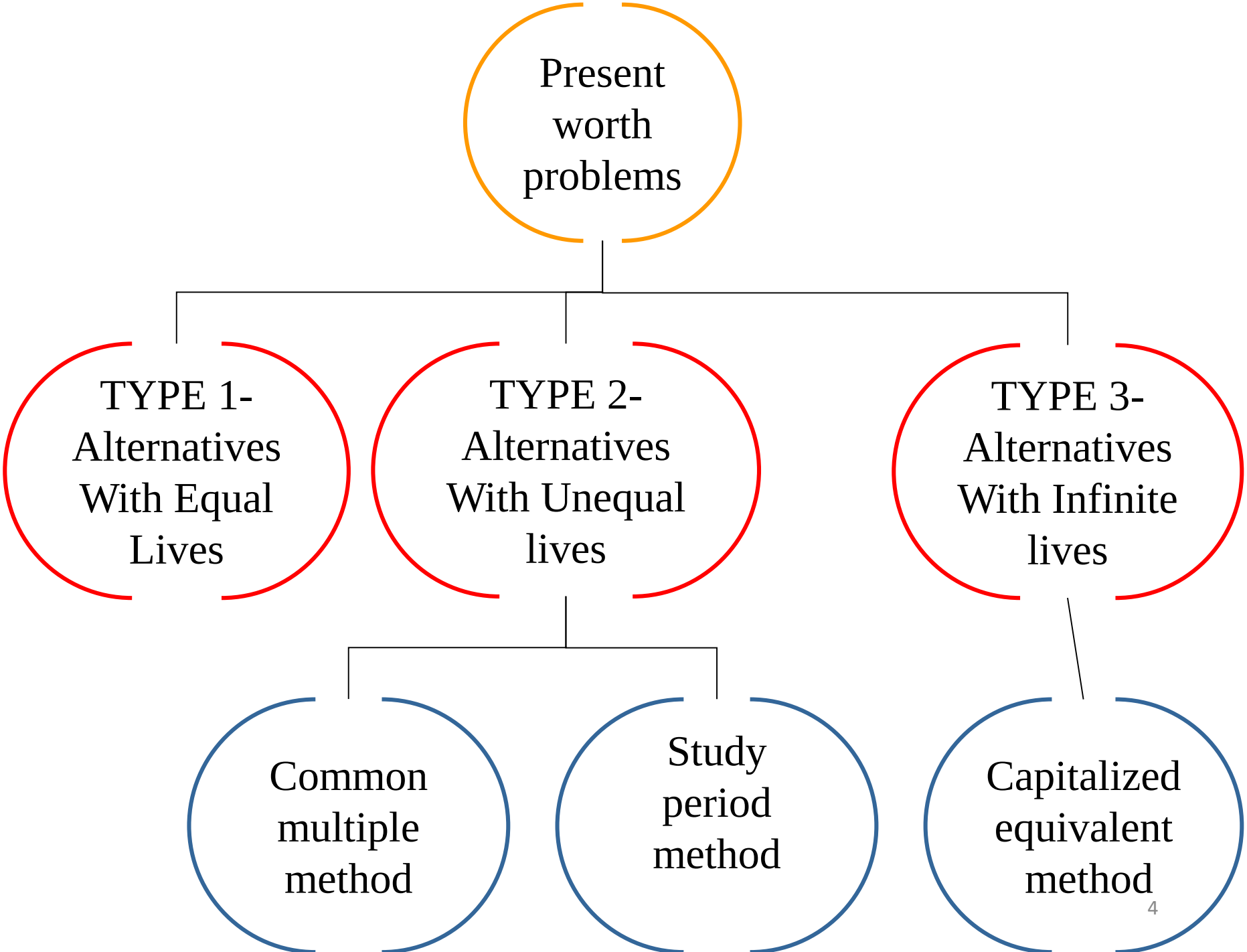
Evaluating Alternatives by Equivalence of

- Present Worth Comparison
- Future Worth Comparison
- Annual Cost and Worth Method
- Rate of Return Method

A) Present Worth Comparison

Assumptions

- Cash flows are known.
- Cash flows do not include effect of inflation.
- The interest rate (discounting rate) is known.
- Comparisons are made with before tax cash flows.
- Comparisons do not include intangible considerations.


Present worth problems
TYPE 1- Alternatives With Equal Lives
TYPE 2- Alternatives With Unequal lives
TYPE 3- Alternatives With Infinite lives
Common multiple method
Study period method
Capitalized equivalent method

1) Alternatives with equal lives

- The competing alternatives have equal lives (life period).
- The alternative with the maximum present worth is the most economical alternative.

- For cost dominated cash flow diagrams the alternative with the lowest present cost is chosen.
  - Select the alternative if its net present worth (Present worth of benefits – Present worth of costs) ≥ 0

- In case of cash flow diagrams involving both costs and revenues the net or difference of present worth of revenues and costs are found.
- This is referred to as net present worth or net present value (NPV).

Cont…,

- The method of comparison of NPV is quite popular for evaluation of alternatives.
- NPV is also used to calculate profitability for an investment alternative.

- Profitability index (PI) is the ratio of NPV and capital cost (CC) for an investment.

In other words, **PI= NPV/CC**

2) Alternatives with unequal lives

- If alternatives do not have an equal life period of service (they are not co-terminus).
- Decision to choose between two batching plants, which may have different service lives

  say 5 years and 10 years.
- Here in one case, there would be a need to replace the plant at the end of five years, and any cost likely to be incurred at that point in time, should be appropriately accounted for in the budgeting at the outset.

- The common multiple method and the study period method are two approaches to solve this class of problems. /Read about it./

3) Alternatives with infinite lives

- when the alternatives involved have long lives, for example the appraisal of different alternatives involving construction of civil engineering structures – dams, power projects, tunnel projects etc., which have a reasonably long life.
- A very popular approach used in such problems is the application of capitalized equivalent method,

Capitalized equivalent (CE) is the present (at time zero) worth of cash inflows and outflows.

CE is a single amount determined at time zero, which at a given rate of interest, will be equivalent to the net difference of receipts and disbursements.

Cont. …

- If the given cash flow pattern is repeated in perpetuity or time with out end (infinite).
- Mathematically,

$$CE = A \times (P/A, i, n=\infty)$$
$$= A \times [((1+i)^{\infty}-1)/\ i(1+i)^{\infty}]$$
$$= A/i$$

- CE analysis is very useful to compare long-term projects.

B) Future Worth Comparison

- In this method, the future worth of each component of cash flow is evaluated and the algebraic sum of such future worth becomes the basis for comparison.

- Although there is no special advantage in using this method over the present worth method

- It is frequently used in cases where the owner expects to sell or liquidate an investment at some future date, and wants an estimate of net worth at that point in time.

C) Annual Cost and Worth Comparison

- In this method, all payments and disbursements are converted into an annualized cost series.

- Annual cost is the cost pattern of each alternative converted into an equivalent uniform series of annual cost at a given interest rate.

- Could be used to compare alternatives with equal and unequal lives.

D) Rate of Return Analysis Comparison

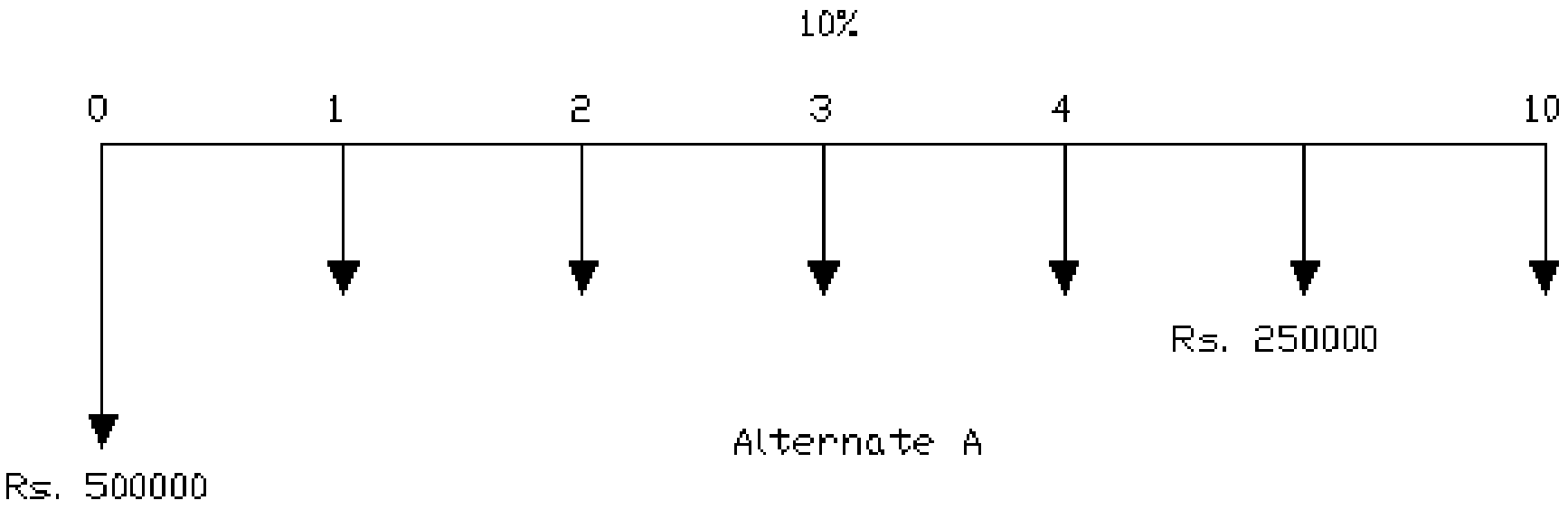
- Single alternative case
- In this method all revenues and costs of the alternative are reduced to a single percentage number
- This percentage number can be compared to other investment returns and interest rates.

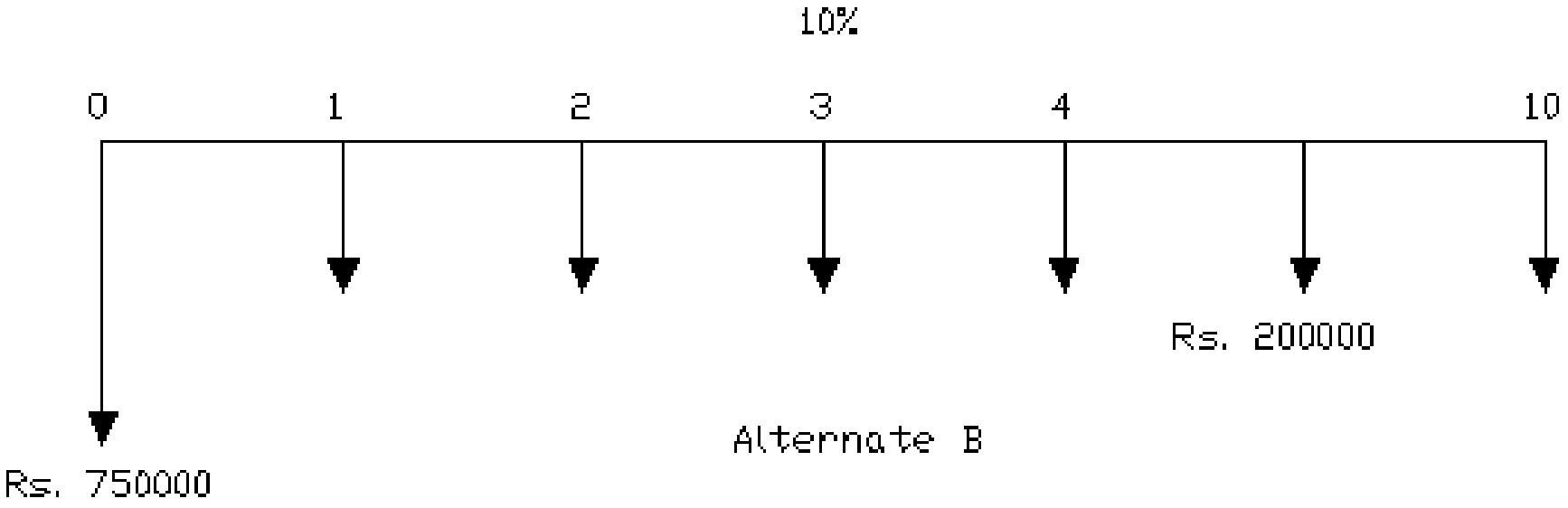
Examples

1- Chose from the two

An alternative, A, costing 500,000 and annual expense of Birr 250,000 for the next 10 years.

Alternative B, on the other hand costs 750,000 and annual expense of Birr 200,000 for the next10 years. Which alternative would you prefer if interest rate were 10%.?


10%
0
1
2
3
4
10
Rs. 250000
Rs. 500000
Alternate A


10%
0
1
2
3
4
10
Rs. 200000
Rs. 750000
Alternate B

Calculation of present worth

- **Present worth of Alternate A**

  = 500000+250000(P/A, 10%, 10yrs)

  = 500000+250000(6.1446)

  = 2,036150.00

- **Present worth of Alternate B**

  = 750000+200000(P/A, 10%, 10yrs)

  = 750000+200000(6.1446)

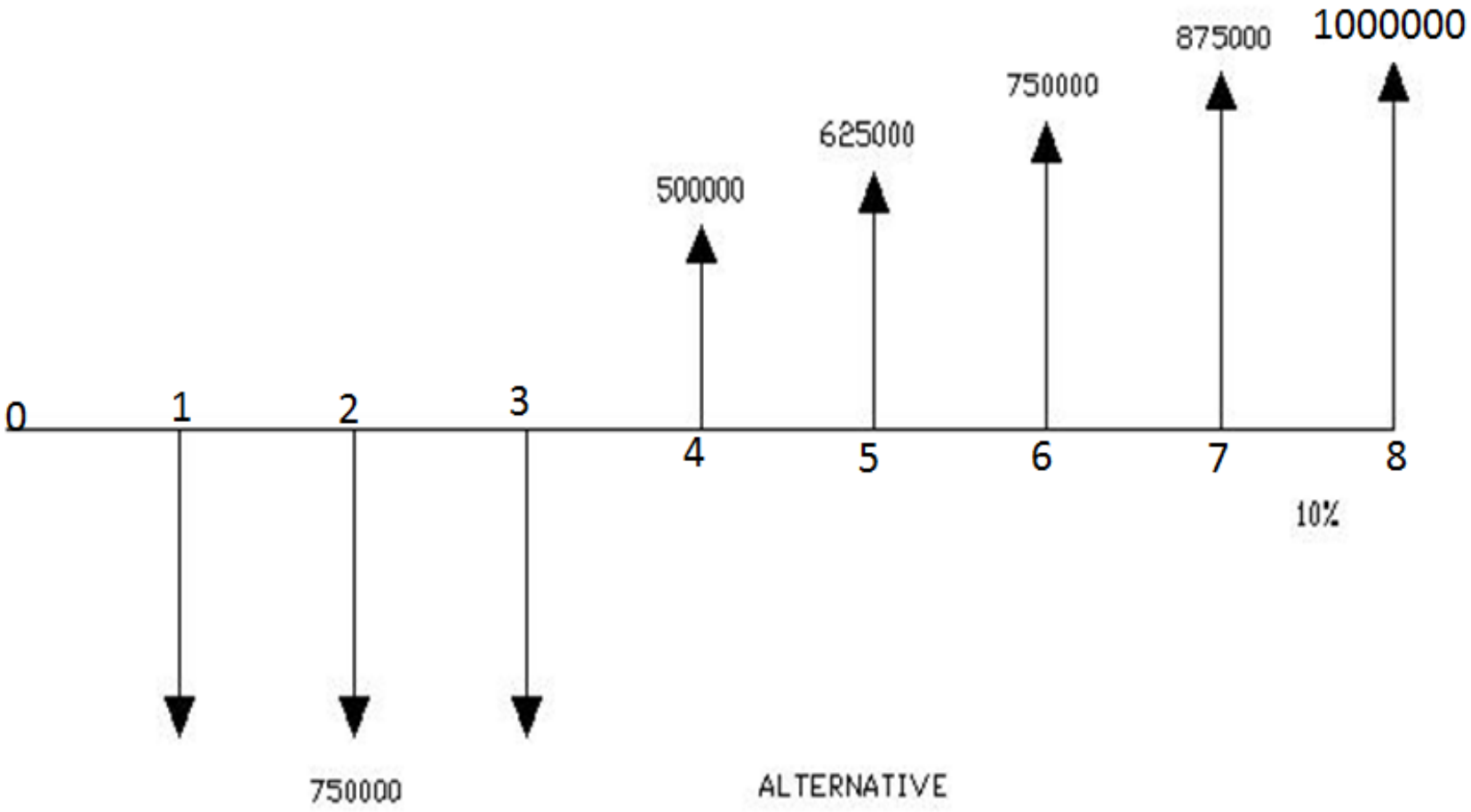
  =1,978920.00

Decision: In this case, since the present worth of cost for alternative B is less than that of alternative A, It is preferable to choose alternative B.

Cont…,

2-An investor can make three end of year payments of 750,000 which are expected to generate receipts of 500,000 at the end of year 4 that will increase annually by 125,000 for the following four years. If the investor can earn a rate of return of 10% on other 8 year investments, is this alternative attractive?

Cash flow diagram



- Net Present worth = Total benefits – total costs
- Present worth of alternative 1 = $500000/(1+i)^4+625000/(1+i)^5+750000/(1+i)^6+875000/(1+i)^7+1000000(1+i)^8-750000/(1+i)^1 - 750000/(1+i)^2 –750000/(1+i)^3$

= **203,320.00 (+ ve)**

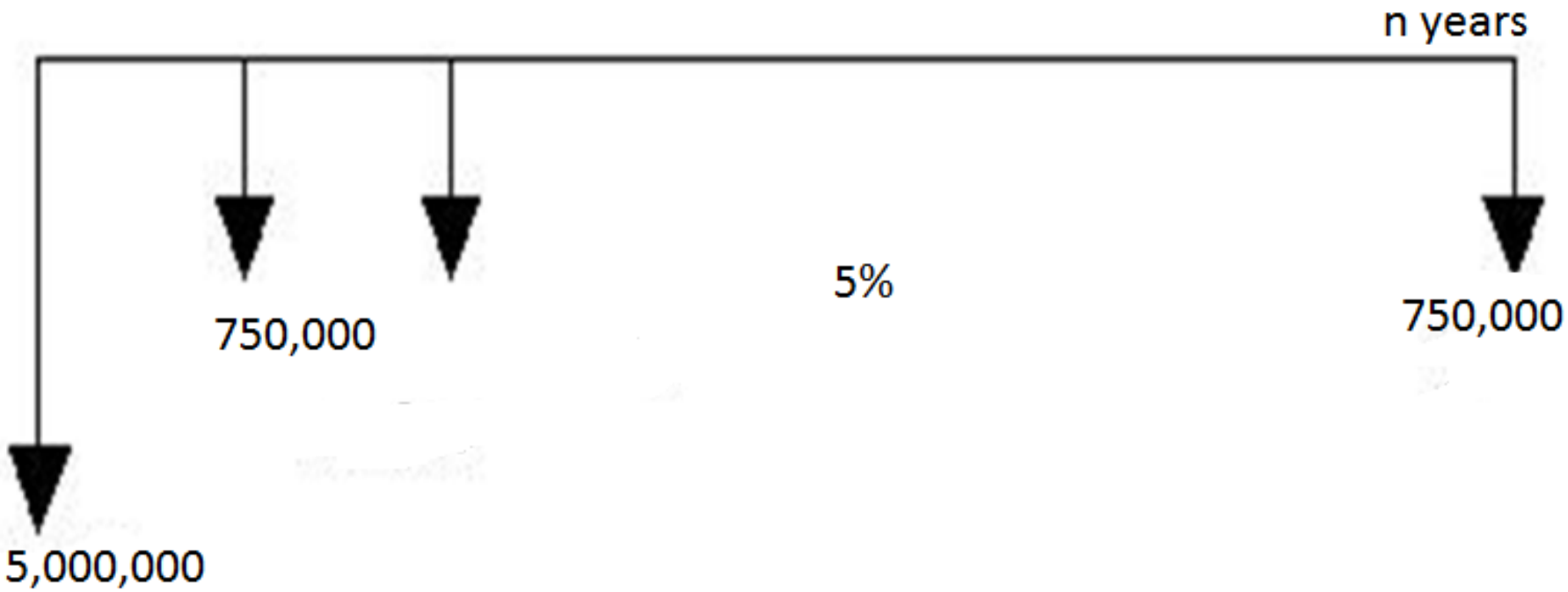
- Therefore this alternative is attractive.

Cont…,

3- A small check dam A costing 5Milion to construct will cost 750,000 a year to operate and maintain.

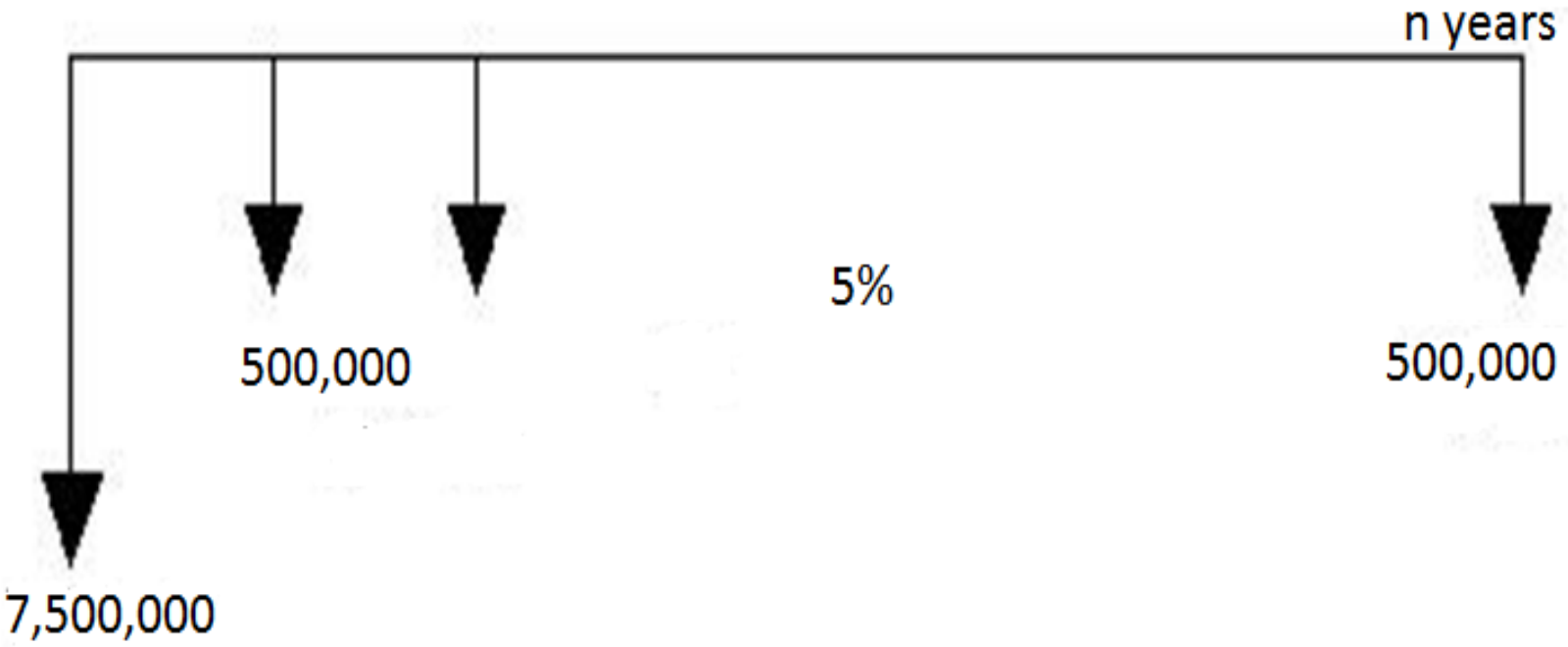
Another design B costing 7.5Milion to build will cost 500,000 a year to operate and maintain. Both installations are felt to be permanent. The minimum required rate of return is 5%. Which alternative should be preferred?

Dam A cash flow diagram



- NPV = 5,000,000+750,000/0.05
  = 20,000,000.

Dam B cash flow diagram



- NPV = 7,500,000 + 500,000/0.05
  = 17,500,000.

The NPV of dam B is less so Construct Dam B.

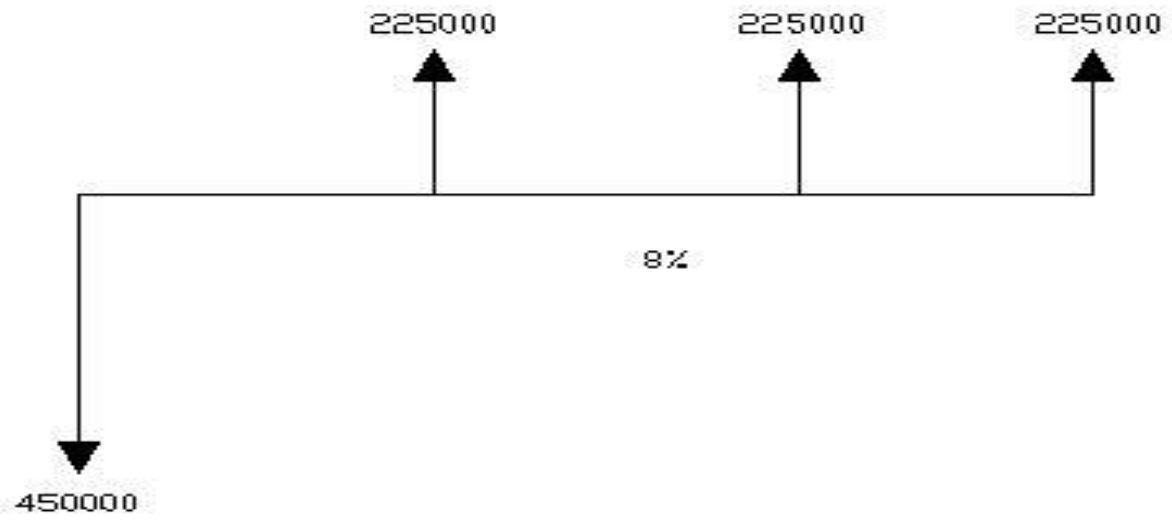
Cont…,

4-Two equipments A and B are available to perform a construction activity for 3 years. The initial cost for each equipment at time 0 and subsequent annual savings (positives), both in birr are shown in the following table. The required interest rate is 8%. Which equipment is preferred?

Table data

Years	0	1	2	3
Equipment A	- 450,000	225,000	225,000	225,000
Equipment B	- 725,000	300,000	300,000	400,000

EQUIPMENT A



NPW = P worth of benefits – P worth of cost

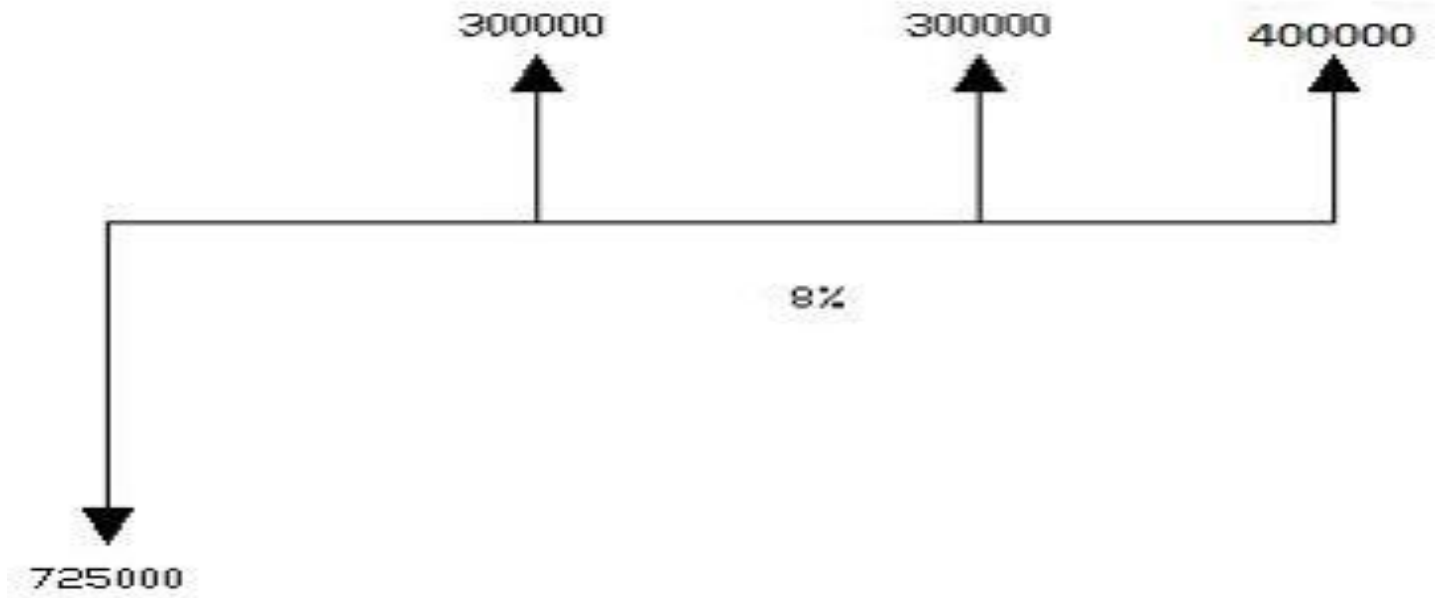
= 225000(P/A 8% 3) – 450000

=225000(2.5771)-450000

= 579847.50-450000

= 129,847.50

EQUIPMENT B



NPW = P worth of benefits – P worth of cost

= 300000(P/A 8% 2)+ 400000(P/F 8% 3) – 7250000

= 300000(1.7833)+400000(.7938)-725000

= 534990+317532-725000

= 127,522

“Equipment A is preferred.”

Rate of Return Method

- Evaluation of different competing alternatives, especially in the area of investments.
- In general, rate of return may be regarded as an index of profitability.

The following terms are commonly encountered.

- MARR (minimum attractive rate of return-given by the company),
- IRR (internal rate of return),
- IRoR (Incremental rate of return), and
- ERR (external rate of return)

(IRR)

- Internal rate of return, sometimes represented by the symbol i* or the acronym ROR, is defined as the interest rate which reduces the present worth of given cash flow to zero.
- Computation of IRR
  - IRR determined by equating the net present worth of the cash flow to zero, i.e, setting the difference of the benefits and cost of the present worth to zero, as shown below:

$$(PW)_{benefits} - (PW)_{cost} = 0$$

Steps For computing IRR

- **Step 1** Assume a trial rate of return (i*).

- **Step 2** Counting the cost as negative and income as positive, find the equivalent net worth of all costs and incomes.

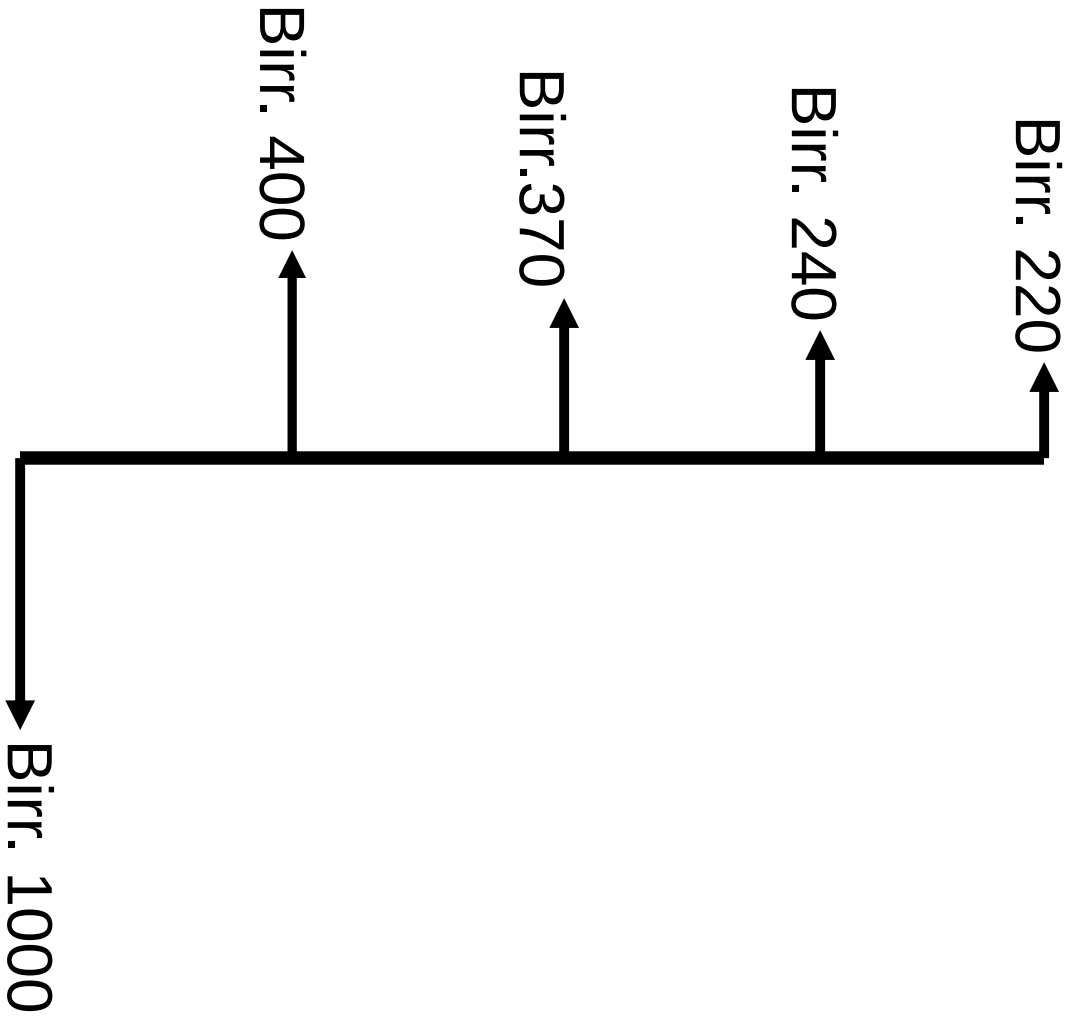
- **Step 3** If the equivalent net worth is positive then the income from the investment is more than the cost of investment and the actual percentage of return is higher than the trial rate, and vice versa

Cont,..

- **Step 4** Adjust the estimate of the trial rate of return and go to step 2 again until one value of i is found that results in a positive equivalent net worth and another higher value of i is found with negative equivalent net worth.

- **Step 5** Solve for the applicable value of i* by interpolation.

Eg1Calculate IRR The Cash flow Shown



Computation of IRR

$(PW)_{benefits} - (PW)_{cost} = 0$

Let IRR be i*

NPW = -1000 + 400 (P/F, i*,1) + 370 (P/F, i*,2) + 240 (P/F, i*,3) + 220 (P/F, i*,4)=0

Assuming trial i* = 10%

NPW = -1000 + 400 x 0.9090 + 370 x0.8264 + 240 x 0.7513 + 220 x 0.6830 = 0

We find that i*= 10% in the above example is a special interest rate which has reduced the net present worth of given cash flow to zero. Thus i*=10% is the Internal rate of return for this example.

Cont,..

- It represents the percentage or rate of interest earned on the unrecovered balance of an investment, at any point of time and further the earned recovered balance is reduced to zero at the end of the project.
- An illustrative computation showing how a part of the cash flow at the end of a year goes towards payment of interest due on the outstanding (unrecovered) balance of investment, and, the remainder liquidates the outstanding investment
- In this example, at the end of the proposal's life (4 years) the entire investment has just been recovered, and the applicable rate of interest (10%) is a special and unique rate called the IRR!

Illustration of IRR

End of year t	Cash flow at EOY, t	Unrecovered balance at the beginning of year t	Interest earned on the unrecovered balance during the year	Unrecovered balance at the beginning of the year (t+1)
0	-1000	-	-	-1000
1	400	-1000	-100	-700
2	370	-700	-70	-400
3	240	-400	-40	-200
4	220	-200	-20	0
10% is the IRR				

Important point

- It is not possible to calculate the rate of return for the cash flows involving cost alone or revenue alone as can be observed from above equation.

- IRR method should not be used for ranking of projects

Incremental rate of return (IROR)

- If an alternative requires a higher initial investment than the other.
- Evaluation of the rate of return on the increment of initial investment,
- The return yielded on this extra investment is called the incremental rate of return (IROR).
- The incremental analysis is based on the principle that every investment is as good as the other.

Incremental rate of return (IROR)

Steps involved in the incremental analysis

- **Step1:-** List out all the alternatives in ascending order of their first cost or initial investment. It may be pointed out at this stage that in most cases alternatives with the lowest investment are likely to turn out to be the 'do nothing' alternative.
- **Step2:-** Compare the rate of return of all alternatives with the assumed MARR, and check if the rate of return is at least equal to the MARR. If not, the alternative is dropped and not considered in the further analysis.

Step 3:-

- Prepare the cash flow diagram on incremental basis between the alternatives which is being examined & the current alternative (to begin with we have taken the alternative with the lowest initial investment).

Step 4:-

- When an alternative which has just been examined is acceptable (rate of return is more than the MARR) it becomes the current best replacing the earlier one. The new best is examined with the next higher investment alternative.

Step 5:-

- In case rate of return is less than MARR, the alternative under examination is ruled out and the current alternatives remain the lucrative (profitable) one. The current best is compared to the next higher investment.

Step 6:-

- The process mentioned through steps 1 to 5 is repeated till all the alternatives have been looked into and the best alternative is selected.

Selection criteria

Consider project x_1 and x_2;

If you "prefer Project x_2 over x_1"

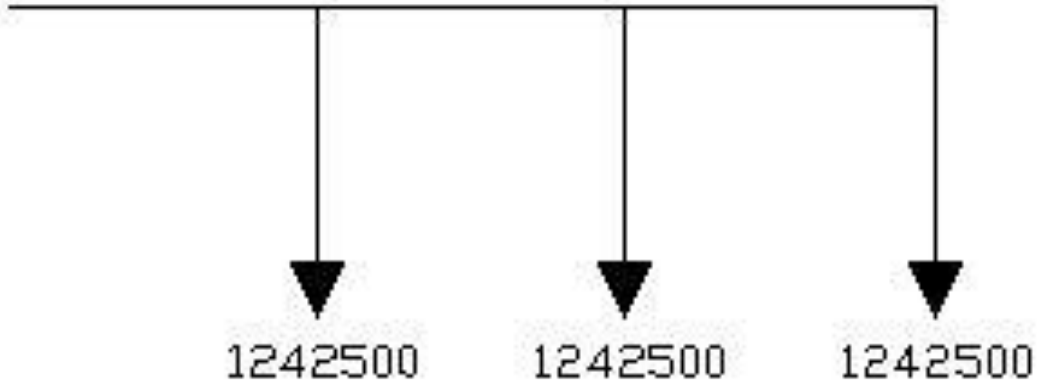
$$IRR_{x_2-x_1} > MARR \quad select \; x_2$$

$$IRR_{x_2-x_1} < MARR \quad " \quad x_1$$

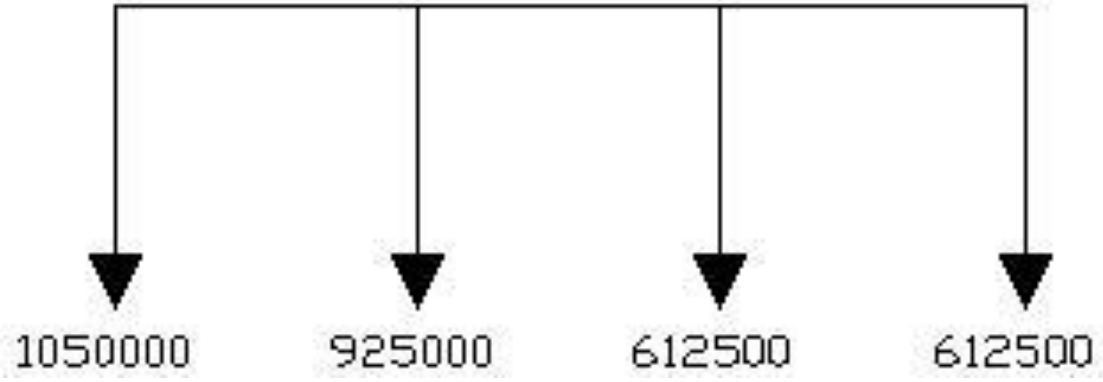
$$IRR_{x_2-x_1} = " \quad selecte \; either \; one.$$

Eg 3 Illustration

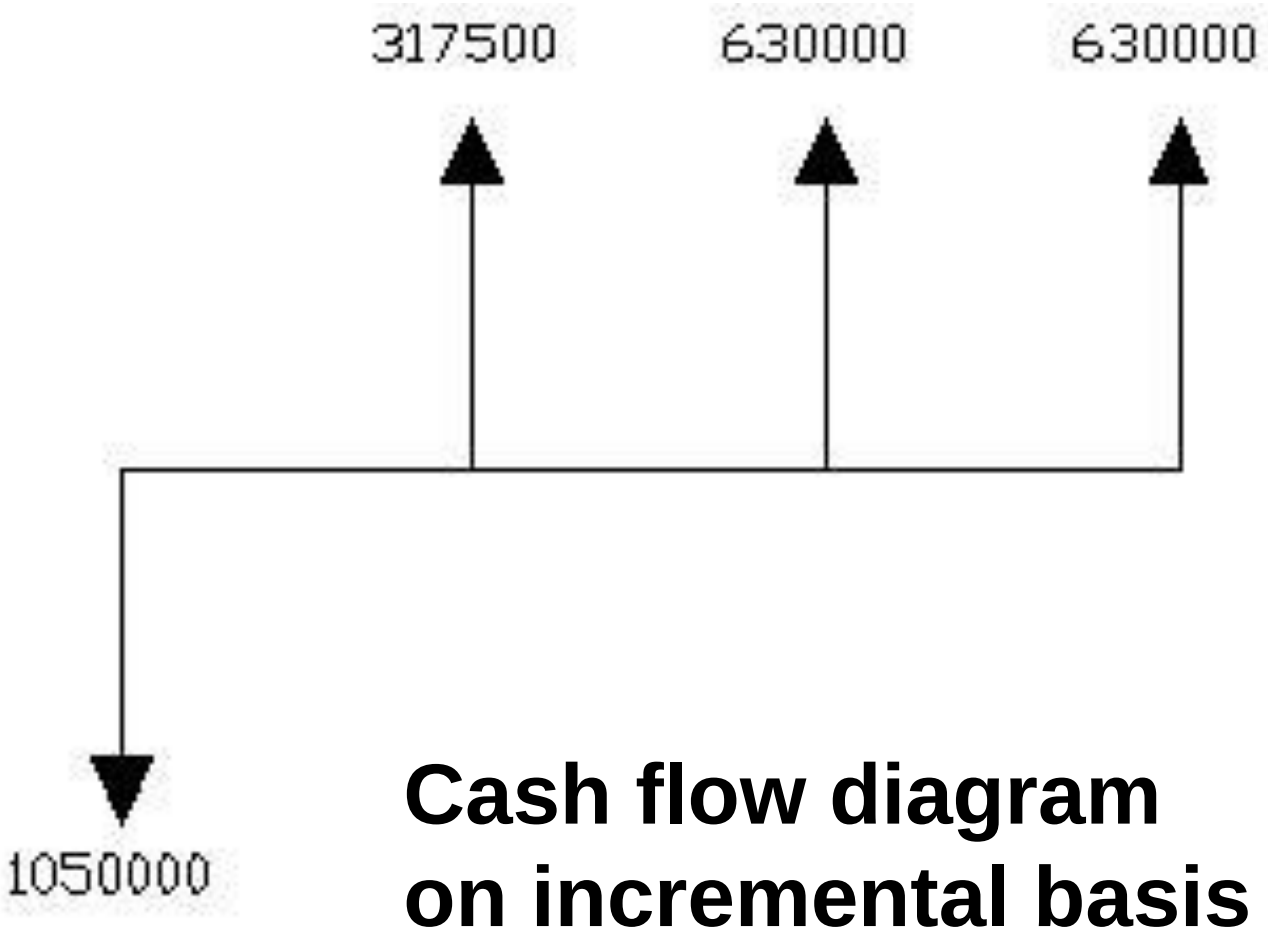
- A Construction Company is purchasing Aluminum Doors at Rs. 3550 per piece from a vendor.
- The annual demand for the doors is 350 pieces.
- In order to develop the in-house capabilities for production of Aluminum Doors the company requires investment in equipment to produce Aluminum Doors at an initial cost of Rs. 1050,000 initially, Rs. 925,000 at the end of first year and Rs. 612,500 each year at the end of year 2 and 3.
- The equipment will have no salvage value at the end of year 3.
- Should the company develop in-house capabilities or continue to buy Aluminum Doors from its vendors?



Cash flow diagram for vendor option



Cash flow diagram for in-house option



Cash flow diagram on incremental basis

Solution

- Assuming i = 20%

N.P.W. = - 1050,000 + 317500 * (P/F,20%,1) + 630000 * (P/F,20%,2) + 630000 * (P/F,20%,3)

N.P.W. = 16660.48

- Now, assuming i = 21%

N.P.W. = - 1050,000 + 317500 * (P/F,21%,1) + 630000 * (P/F,21%,2) + 630000 * (P/F,21%,3)

N.P.W. = - 1677.13

(P/F,20%,1) = 0.8333,
(P/F,20%,2) =0.6944,
(P/F,20%,3) = 0.57870

(P/F,21%,1) = 0.8265,
(P/F,21%,2) = 0.6830,
(P/F,21%,3) = 0.5645

- Thus, the exact value of i lies somewhere between 20% and 21% which can be found out by interpolation, as

i = 20 + (21 – 20)* 16660.48/(16660.48– (

1677.13))

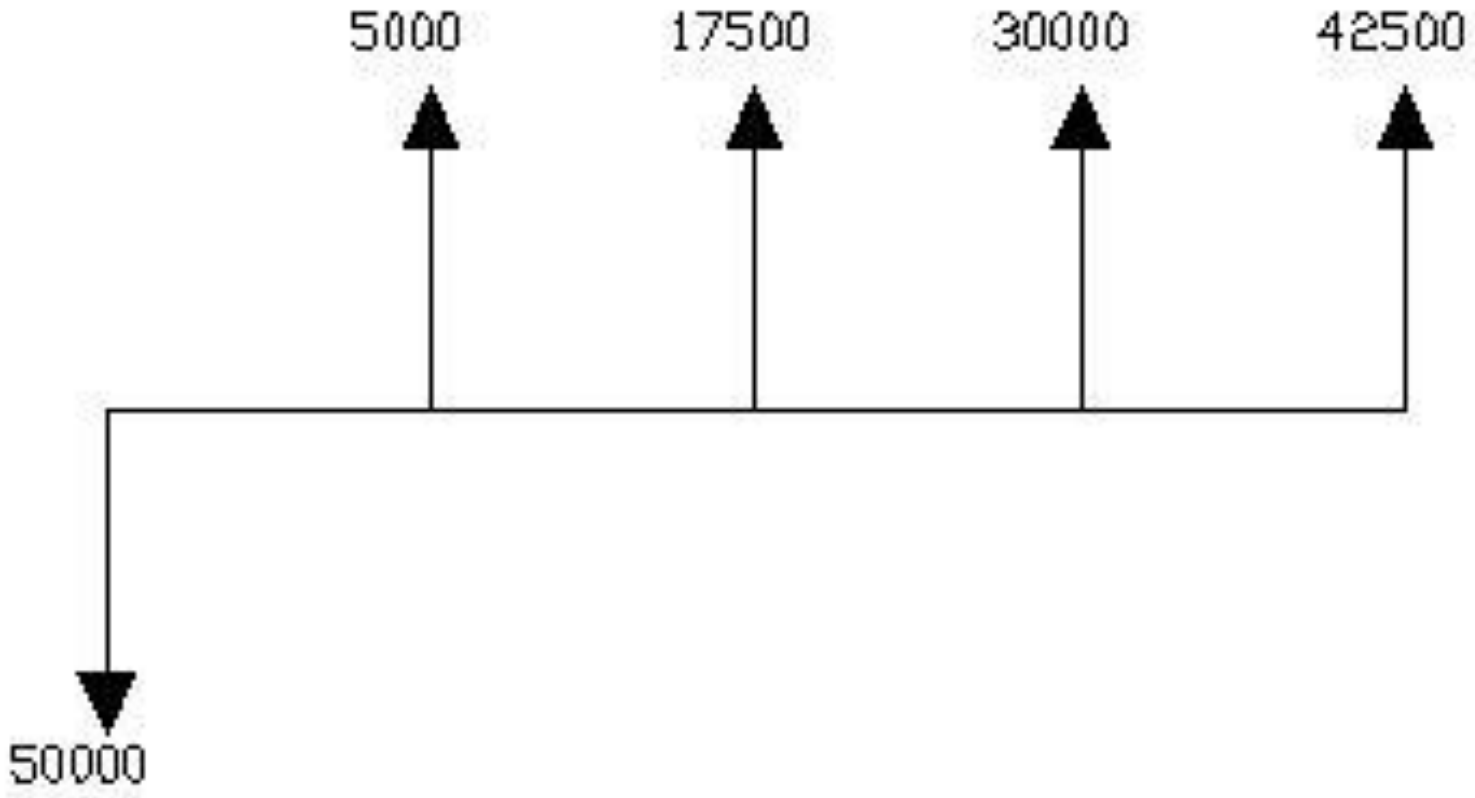
i = 20.908%,

Therefore prefer in-house option if the IRoR (20.908%) is greater than provided MARR.

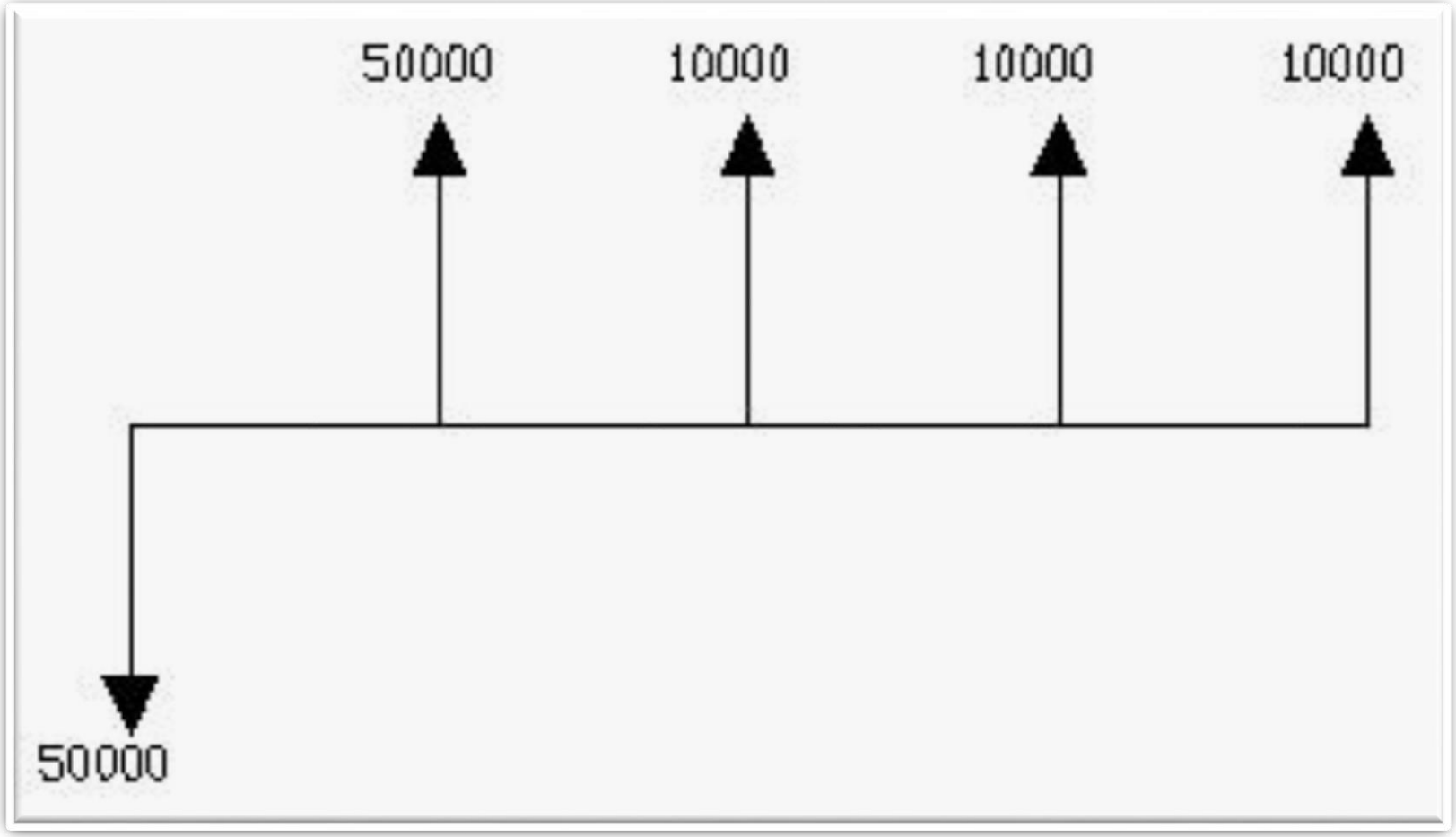
Example

- Which project is preferred using incremental rate of return method. The minimum attractive rate of return is 10%.

EOY ⟶	0	1	2	3	4
Project X	-50,000	5000	17,500	30,000	42,500
Project Y	-50,000	50,000	10,000	10,000	10,000

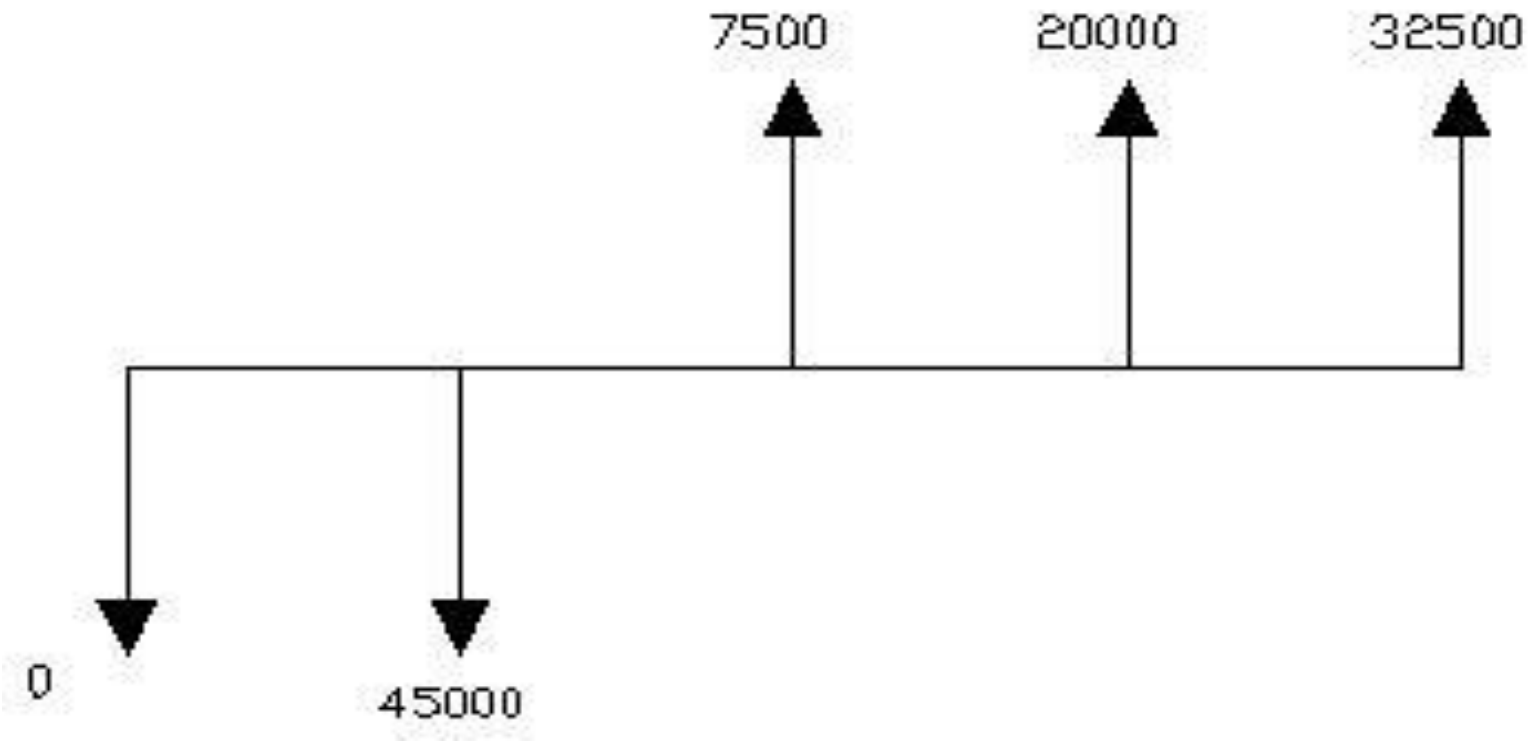


Cash flow diagram for X



Cash flow diagram for Y

Incremental Rate of Return Method



Cash flow diagram on incremental basis while preferring X over Y

- Assume i = 10% (P/F i% , n)

  N.P.W. = $-45000 + 7500/(1+0.1) + 20000/(1+0.1)^2 + 32500/(1+0.1)^3$

  = 2764.85

- Assume i = 15%

  N.P.W. = $-45000 + 7500/(1+0.15) + 20000/(1+0.15)^2 + 32500/(1+0.15)^3$

  = -1986

- By interpolation, i = 12.9%
- Since 12.9% (Exact value of i) > 10% (MARR), Prefer X over Y.