Depreciation, Alternate Investment and Profitability Analysis.
Professor Dr. Bikash Mohanty.
Department of Chemical Engineering.
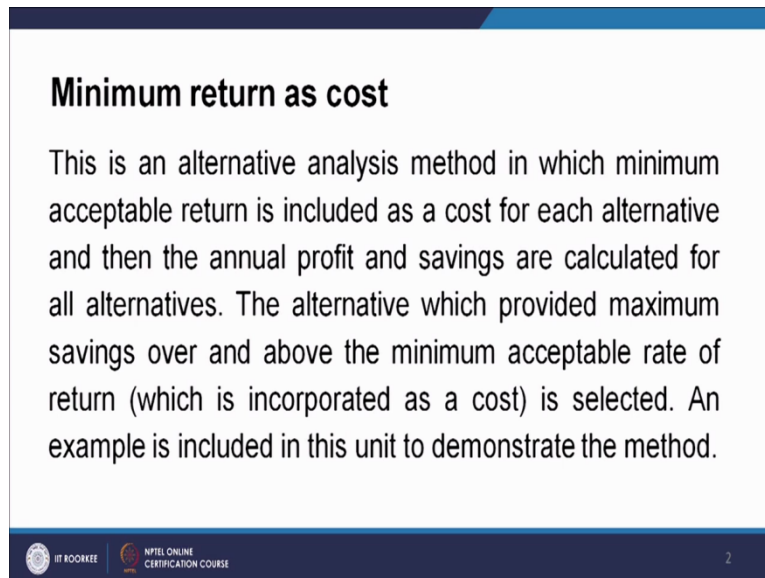**Indian Institute of Technology, Roorkee.**
Lecture-14.
Alternative Investment – Minimum Return as Cost.

Welcome to the course Depreciation, Alternate Investment and Profitability Analysis. We are continuing with module two which is alternative investment. In the present lecture we will take minimum return as a cost method for alternative investment selection, minimum return as a cost this is an alternative analysis method in which minimum acceptable return is included as a cost for each alternative and then the annual profit and savings are calculated for all alternatives.

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Formulae Used

Sinking Fund factor: Multiplies a single amount at N to give the annual rate of a series of N equal amounts	(A/F,i,N)	$\dfrac{i}{(1+i)^N - 1}$	F→A A=F(A/F,i,N)

The Annual cost is calculated based on annuity formula as:

$$A = P\,\frac{i(1+i)^N}{(1+i)^N - 1} \quad \text{Or} \quad A = P\,\frac{i}{1-(1+i)^{-N}}$$

A = Amount of annuity per year
F = future value of sum of all annuities
P = present value of sum of all annuities
i = interest rate per year
N = no. of years the annuities are paid
No. of payments are equal to no. of compounding years

Objective-1: Given the capital investments, estimated life span of capital investments, annual operating costs and annual earnings, MARR compare four different investments based on minimum return as a cost method for the selection of the best investment

The alternative which provides maximum savings over and above the minimum acceptable rate of return which is incorporated as a cost in the formulation is selected. An example is included in this unit to demonstrate the method.

Now this is the formula used where the P is converted into A, that is present value is converted into annuity and this formula will be used in the present lecture. Now the objective giving the capital investments, estimated life span of capital investments, annual operating costs and annual earnings, MARR compare four different investments based on minimum return as a cost method for the selection of the best investment.

Example-1: There are four different plans under consideration for construction of buildings for o commercial purpose to earn rent. A comparison of these plans to be made at the end of the time window of 20 years at that time assume that the resale value is 200% of the original investment. It is estimated that the minimum acceptable rate of return(MARR) as well as interest rate are 10%. The data for the above plan is given in the table shown below

	Plan-A	Plan-B	Plan-C	Plan-D
Original Investment, Rs.	110000	201000	300000	480000
Annual Rent	20000	35000	58000	109000
Annual maintenance	2000	5000	8000	10000
Taxes	1000	1500	1800	2000

This is the first question that is example number one, tells there are four different Plans under consideration for construction of buildings for a commercial purpose to earn rent. A comparison of these Plans to be made at the end of time window of 20 years, at that time assume that the resale value is 200 percent of the original investment. It is estimated that the minimum acceptable rate of return that is MARR as well as interest rates are 10percent. The data for the above Plan is given in the table below.

So Plan A, Plan B, Plan C and Plan D. Original investment is equal to 110000 one lakh ten thousand, this is 201000, that is 300000 and this is 480000. Annual rent is 20000 that is 35000 this is 58000 and this one 109000, annual maintenance 2000, 5000, 8000 and this is

10000, taxes 1000, 1500, 1800, 2000. As after 20 years the investment will fetch double the amount and will result a profit of hundred percent.

This amount which is a future worth of profit, should be distributed as a annuity throughout the 20 years period and should be treated as earning. So it tells that now the investment which will be done here at t equal to 0 after 20 years this value will double and hence I will get my profit here that 100 percent profit here and this profit which is a future value has to be distributed as annuity.

So for that the original investment needs to be recovered through an annuity and should be treated as expenditure. So a let us start analyzing it. Annual profit due to 200 percent enhancement of cost Plan A, so, the profit will be 110000, this price which is 110,000 rupees will be double here after 20 years so my profit is 110,000 rupees.

So this is a future value which has to be converted into annuity using the formula. So this is the formula one + i to the power 20 - one, so this comes out to be rupees 1920.56. So here the profit for A Plan is 110,000 rupees, for the B Plan will be it will be 201,000, for the C Plan it will be 300000 and for the D Plan this will be 480000.

Now the same thing for Plan B annual profit due to enhancement of cost for Plan B this will be 201000 into the same factor 0.1 divided by 1 + 0.1, 20 - 1 is equal to rupees 3509.38. Now for Plan C, same thing for Plan C will be equal to 3 lakh into 0.1 divided by 1 + 0.1, 20 - 1 and this comes out to be rupees 5237.88.

So now for D Plan for Plan D this when calculated comes out to be rupees 8380.62. Now this is the profit which has been converted into annuity and so this is the receipt. Now the same thing can be done for this investment original investment, the original investment which is a value has to be converted into annuities. So this is this is basically a present value here we are converting the future value and when will be converting the original investment as it is a present value, it will be converted to annuity with some other formula than what we have used here.

Now when we are converting it to annuity basically the investment is here, for Plan A this investment is 110000 rupees for Plan A. So this is a present value which has to be converted into annuities so, annual cost of capital recovery this is for Plan A, this will be equal to the value 110000 into 0.1 divided by 1 - 1 + 0.1 to the power - 20 because my time window is 20 years.

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Example No. 1

	Plan A	Plan B	Plan C	Plan D
...ment	1,10,000	2,01,000	3,00,000	4,80,000
	20,000	35,000	58,000	1,09,000
...nce	2000	5000	8000	10000
	1000	1500	1800	2000

Annual cost of capital recovery (for Plan A)

$$= 1,10,000 \times \frac{0.1}{1-(1+0.1)^{-20}} = Rs\ 12920.56$$

(for Plan B)
$$= 2,01,000 \times \frac{0.1}{1-(1+0.1)^{-20}} = Rs\ 23609.$$

(for Plan C)
$$= 3,00,000 \times \frac{0.1}{1-(1+0.1)^{-20}} = Rs\ 35237$$

Plan D
$$= Rs\ 5638$$

Example No. 1

	Plan A	Plan B	Plan C	Plan D
...fit	1920.56	3509.38	5237.88	8380.62
...ry	12920.55	23609.4	35237.88	56380.61
...al profit	6000	8399.78	18200	49000

$$= 1920.56 + 20,000 - 12920.56 - 2000 - 1000 = Rs\ 6000$$

Example No. 1

	Plan A	Plan B	Plan C	Plan D
An...	1920.56	3509.38	5237.88	8380.62
	12920.55	23609.4	35237.88	56380.61
...profit	6000	8399.78	18200	49000
	(5.45%)	(4.199%)	(6.07%)	(10.20%)
...after				1000
...n 20 g	-5000	-11700	-11860	

$$= 6000 - 0.1 \times 1,10,000 = -5000$$

This comes out to be rupees 1292056, similarly the annual cost of capital recovery for Plan B is equal to the cost of the which is 201000 rupees into the same factor is 0.1 - 20. This comes out to be rupees 23609.38. Similarly we can find out for Plan for Plan C, this is 300000 into same factor 0.1 1 -, - twenty is equal to rupees 35237 thirty five thousand two thirty seven point eight eight and the same thing for Plan D comes out to be, Plan D comes out to be rupees 56000 56380.62.

So this is not earning, this is a investment, we should remember it. The annuity of profit is 1920.56 this is 3509.38, this is 525237.88, this is 8380.62. Now annual cost, cost of capital recovery is 12,920.55, this is 23609.4, that is 350237.88, this is 560380.61. Now net annual profit, net annual profit is equal to 1920 for Plan A, for Plan A this is 920.56 + 20000 - 12920.56 - 2000 -1000, it comes out to be rupees 6000.

Now if I see the numerical this 1920.56 has come from here because this is a receipt and then annual rent for Plan A is 20,000 so this annual rent for Plan A. Then this is the annual cost of recovery and so this is a negative quantity because this is the spending, so this is my negative and then annual maintenance is 2000, so it's a negative quantity and taxes is 1000 so this is negative quantity. So, these are two receipts and this we have to giv,e this is a expenditure from year to year is expenditure this is recipient, so profit is six thousand.

So similarly for all the Plans I can calculate the net annual profit, so this is 6000 this is 8399.98 this is 18200 this is 49000. Now annual savings after adding MARR as cost, if I calculate return this comes out to be a 5.45 percent this is 4.179 percent. This is 6.07 percent, this is 10.20 percent.

Now here if I calculate annual savings after adding MARR as a cost, this will be equal to 6000 which is my net profit - 0.1, because 10 percent is MARR. So ten percent of the cost original cost of the equipment for the Plan this is 110000 so 10 percent cost of this is reduced from here then it gives us - 5000.

Let us check it, this is correct, so I get - 5000. So, if I make a column like this annual savings after adding MARR as a cost, this becomes - 5000 this becomes. That means this quantity which shows - signs. So, that these Plans will not generate a profit of 10 percent, while Plan D will generate a profit of more than 10 percent and if we compare the returns we find that this 5.45 percent which is less than 10, this is 4.179 this is less than 10 and this is also less than then and this the only Plan which generate profit more than 10 percent.

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So my conclusion is the annual savings after adding MARR as a cost is maximum for Plan D, hence it is selected for investment. The annual savings after adding MARR as a cost for Plan A, B, C shows a negate value indicating that it offers a return which is lower than MARR and hence these Plans cannot be consider.

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	Pipe-A	Pipe-B	Pipe-C	Pipe-D
Diameter of pipe, mm	150mm	300mm	457mm	610mm
Investment in pipeline, Rs.	110000	135000	165000	256000
No. of pumping station required	7	4	2	1
Cost of a single pumping station, Rs.	25000	45000	95000	164000
Total Fixed investment, Rs.	285000	315000	355000	420000
Taxes ,insurance, inspection, etc. Rs. per year	20000	25000	30000	39000
Maintenance of pipeline, Rs. per year	25,000	20,000	20,000	15000
Attendant cost, Rs. per year	30,000	30,000	10,000	16000
Electricity bills, Rs. per year	20,000	16,000	15500	14000
Total annual cost, Rs.	95000	91000	75500	84000
Annual earnings due to pumping, Rs. (earning are same as same amount of crude is pumped)	130000	130000	130000	130000

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Now let us take an example, example two, example two shows the there is proposal to pump crude oil using a pipeline. For this process three pipeline diameters 150mm, 200mm, 457mm and 610 mm have been selected. It is a known fact that if one selects higher diameter pipeline, its fix cost will be more, however it's pumping cost will be less. The problem thus turns out to be the selection of most economic diameter. If the service life of pumping station and pipeline is 18 years with some salvage value that is 10 percent of fixed cost can be consider, salvage value is 10percent of the fixed cost of the pipeline and minimum acceptable rate of return MARR is 10 percent.

Then we have to select the best pipeline diameter. These table shows you the complete data of the all the four diameter of the pipelines. And distribution of data is also given like a total fixed cost is distributed amount, the investment in pipeline, number of pumping stations

required cost of a single pumping station, all these add together gives you the total fix cost. Similarly taxes insurance inspection maintenance of pipeline attendant cost, electricity bills will give you total annual cost.

So here I will only write the total fixed investments and total annual cost and the distribution of all these costs are given in this table. So pipe A,this is example two, pipe A which is 150 mm diameter, pipe B which is 300 mm diameter, this is D equal to, diameter equal to this, pipe C this is 457 mm diameter and pipe D which is 610 mm diameter. Now total fixed investment in rupees is 2,85,000 this is 3,15,000, this is 355000, this is 4,20,000 and total annual cost which is a summation cost including taxes, maintenance of pipeline, attendant cost, electricity bill etc is 95,000, 91,000 and 84000.

Now we have to use the minimum cost as a return method to select which pipeline I should go for. So, depreciation of the pipeline using straight line method is equal to this is for pipe A is equal to 285000, 1 - 0.1 divided by 18, which comes out to be 14250. Now how this has come, basically this depreciated amount will be this - this salvage value. So if I open up this, this is nothing but 2,85,000 - 0.1 into 285000. Now this gives me the salvage value this is my original cost a divided by this is my service life.

So obviously this will give rise to the depreciation the value of a depreciation is 14250 rupees. Now annual savings after including MARR as a cost is equal to, now if you see the annual earnings here, these annual earnings is 130000, this is 130000, this is 130000, this 130000, this is same because all the pipelines will do the same job, so they will be rewarded same.

So this is equal to 130000 this my earning, then my expenditures, expenditures will be the depreciation 14250.00 -, this is my annual cost 95,000 - 0.1 into 285000. This is what, this is MARR and this is my fixed cost original cost so what I have done I have presumed that at least the pipeline should earn 10 percent of the fixed cost as a return.
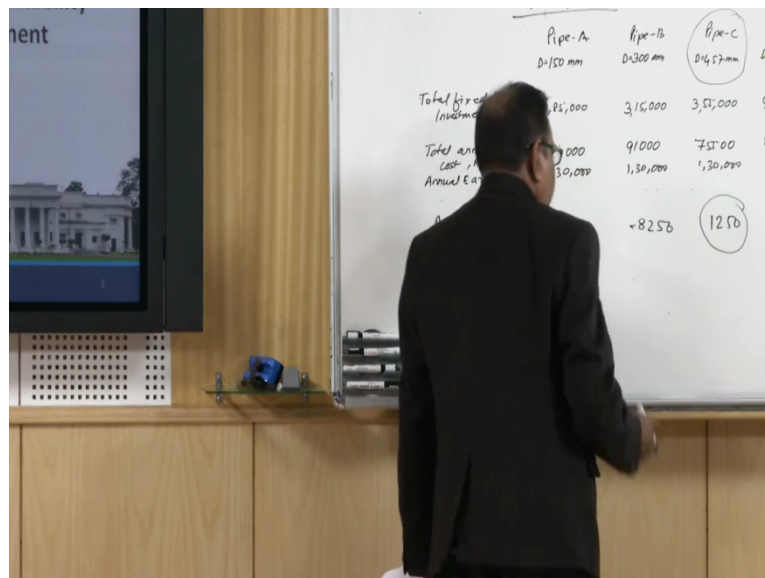
So this return I am subtracting from here and when I subtracted I found this is - 7750. That means, this pipeline is not going to give me 10 percent return. Even if this value become zero I will get a 10 percent return, as this value is - I am not going to get to 10 percent return and hence the this is rejected.

Similarly if I compute for others, now depreciation cost for pipeline B will be equal to 3,15,000 into 1 - 0.1 divided by 18 comes for 15750.0 and annual saving including MARR as cost, this is 1,30,000 - 15750.0 - 91,000 - 0.1, 315000 and this comes out to be - 8.50. Again the pipeline B is not giving me a return of 10 percent. This is MARR, as a cost this has been included, so even if I get zero value here, my return will be 10 percent. As I am getting a negative value this pipeline will also not able to give a return of 10 percent.

So if I calculate for the rest two pipelines this result, so this is the table whcih shows me the complete results. So annual savings, annual savings this is - 7750, this is 8250, this is 1250, this - 17000, so except pipe C all are giving negative that means they are not giving me 10 percent return.

So as pipe C is giving more than 10 percent return this would be selected for the job. So to summarize this, in this lecture we saw the minimum return as a cost method and how to apply this method for selection of alternative exclusive alternates, and we have seen that this is very simple method and can solve complicated problems. Thank you.