Lecture- 39
Evaluation of Water Projects: Capital Budgeting Methods (Contd.)

Hi everyone, so we will continue our discussions on the capital budgeting methods, we did discuss the payback period method, discounted payback period method and net present value method in the previous couple of sessions and this session we are going to talk about the another method, which is the internal rate of return.
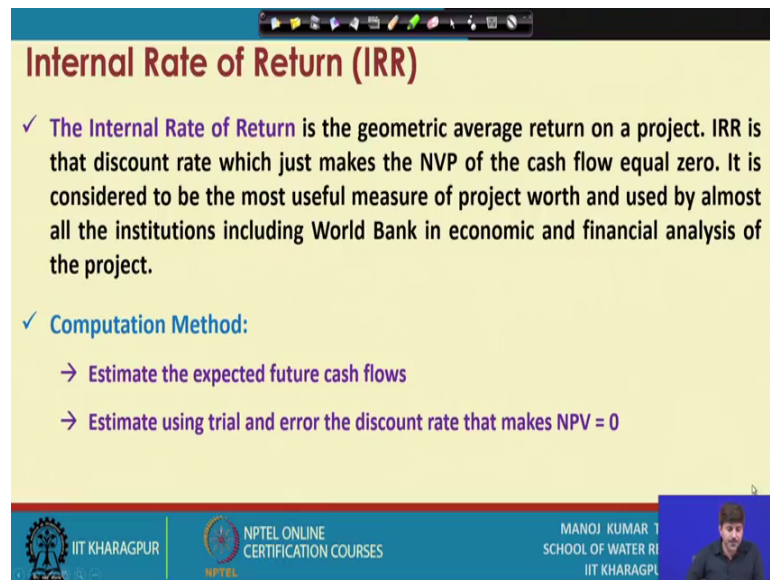
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So, we will begin with that.

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So, the internal rate of return is the geometric average return on a project, the IRR which is typically known and it is a one of the very common term in the banking sector and in the project financing sector. So, IRR is the discount rate, which just makes the net present value of the cash flow equal to 0.

So, it is considered sort of the one of the most useful measures of a project worth and used by almost all in institutions including the World Bank in economic and financial analysis of the project. So, this is one of the very common terminology or common approach which is used on a very large scale. The methods are little difficult if you compare to the earlier methods, it estimates the expected future cash flow and then using trial and error with different discount rate it tries to make the net present value 0. So, for which ever discount rate or whichever return rate the net present value becomes 0 that is selected.

So, since it incorporates trial and error. So, calculation becomes little complicated not that straight forward as we have seen for the earlier methods.

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However, the advantages one of the major advantages is it directly gives the rate of return which is one of the very useful tool and in fact, many the banking sector and financial sector people lock, people like to talk in terms of the return. If I am investing this much of money, how much return I am going to get? So, that kind of information it provides, it provides the information about the how much return on the money will be available in certain time frame, certain time period, so that way this information becomes very helpful. The formula if you see for computation is again derived from the NPV only. So, we discussed in the previous session that what NPV is.

So, NPV is the net discounted cash flow minus the initial outlay or the capital investment. So, by definition when we say that internal rate of return is the rate at which NPV turns 0, so that means, if we make this NPV equal to 0 what we get is the net discounted cash flow will be equal to the initial outlay.
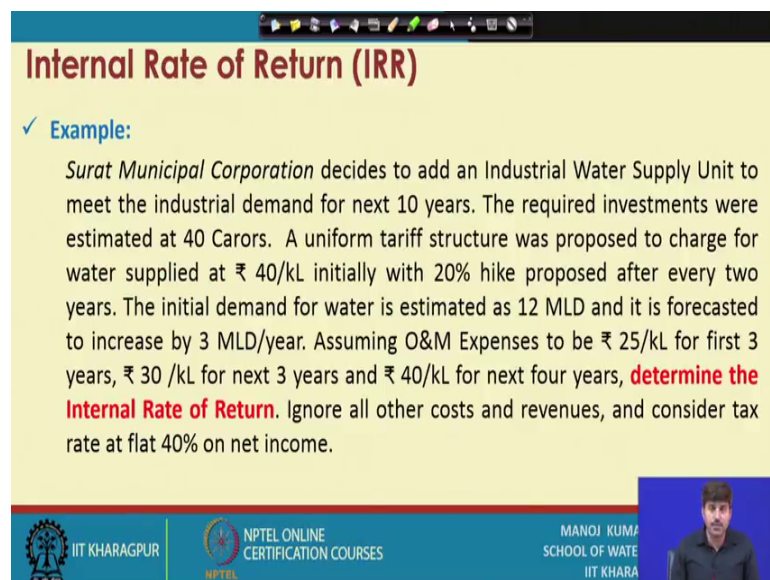
Now, this criteria is satisfied at a particular rate of interest because in this formula if we change the rate of interest, if we change the k value, the value of NPV will change. So, at a given at a particular rate of interest this will actually at equal to the capital outlay. So, when this term becomes equal to the capital outlay at any particular given rate, that rate or that rate of return is mentioned as IRR, which is internal rate of return.

Now, how we take decision based on the internal rate of return is simple that there is a preset return needed let us say if I am investing certain amount, I will see how much

return it is going to give me, if it is going to give me more than 12 percent of return I can consider otherwise I will not consider, so for such scenarios, when there is a preset interest rate that is seeked or that is desired.

So, if the internal rate of return is exceeding that value, the project is accepted; if IRR estimated is less than that value the project will be discarded and cannot be accepted because it will not meet the desired return criteria in that sense. So, that is how the internal rate of return is taken into the account, let us see a worked out problem for the purpose of seeing how the internal rate of return is estimated.

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We will take the same problem, which we took in the earlier session; again the same problem of the Surat municipal corporation proposing for a industrial water supply unit for meeting the industrial demand in a next 10 years. The tariffs are provided, the O and M expenses are provided, the tariff and O and M expenses per unit of water consumed is provided and then, says that determine the internal rate of return ignoring all other costs and revenues at a flat 40 percent tax rate on net income. So, the inputs to the problem, remains same, which was there in the earlier session.

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Internal Rate of Return (IRR)

✓ **Example: Solution**

Years ->	1	2	3	4	5	6	7	8	9	10
Water Demand (MLD)	12	15	18	21	24	27	30	33	36	39
O&M Rate (₹/kL)	25	25	25	30	30	30	40	40	40	40
Yearly O&M (Cr ₹)	10.95	13.69	16.43	23.00	26.28	29.57	43.80	48.18	52.56	56.94
Tariff Rate (₹/kL)	40	40	48	48	57.6	57.6	69.12	69.12	82.94	82.94
Revenue: Water Charges (Cr ₹)	17.52	21.90	31.54	36.79	50.46	56.76	75.69	83.26	108.98	118.07
Cash Flow (Cr ₹)	6.57	8.21	15.11	13.79	24.18	27.19	31.89	35.08	56.42	61.13
Tax (Cr ₹)	2.628	3.284	6.044	5.516	9.672	10.876	12.756	14.032	22.568	24.452
Cash Flow After Tax (Cr ₹)	*3.942*	*4.926*	*9.066*	*8.274*	*14.508*	*16.314*	*19.134*	*21.048*	*33.852*	*36.678*

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However, the output here we are not seeking the net present value, in the earlier case we were seeking the net present value at 12 percent discount rate, here we are not seeking the net present value, we do not know what is the discount rate or rate of return is. So, the aim of the problem is to find that at what rate of return this the net NPV will turn equal to the capital, net NPV will turn to the 0 in a way that net cash flow after taxes or after depreciation or all factors including will actually be equal to the capital investment. So, the basics of this problem will we have already discussed that how we can use the O and M rate and tariff rate in order to compute the yearly O and M expenses and revenue from water charges.

Then, we can basically take the difference of these 2 in order to get the cash flow; we can apply taxes on to that. So, we will get the finally, we will get the cash flow after the taxes. So, that is one useful information here, that we got the cash flow after the taxes exactly similar to the previous problem that we took in the while discussing the net present value.

So, for net present value once we get the cash flow after the taxes, we apply a rate of return; we apply a rate of return or we apply a discount rate like for previous case with the same data we apply 12 percent rate of return and then, we get a discounted cash flow by using that rate of return and summation of that minus the capital outlay is considered as NPV. For this case, because we do not know at what percentage return is to be applied,

that is what actually we are estimating. So, when we do not know we cannot get the discounted cash flow.

So, from here the steps change, it for a net present value given a rate of return we can estimate the discounted cash flow and take the submission of that. Here, we cannot get the discounted cash flow because we do not know the rate of return. So, what we will do?

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We will again make trial and errors, we will consider the different rate of returns and try to get the discounted cash flow and see if that discounted cash flow; some of that discounted cash flow is actually getting close to the initial investment. When it is equal to the initial investment that particular discount rate will provide the solution in form of the IRR.

So, for this problem, this cash flow after tax is we estimated and we will take this forward from this point onwards. So, this is the cash flow after investment and we have added another column NPV. So, what NPV essentially is for any case is like of course, we got a NPV, if you recall the previous session for this problem we got a NPV as some close to thirty 36 or so that many [Fl] at 12 percent discount rate, so that is a very high value. So that means, we can use higher rate of return, so that the NPV becomes less and less, so that is a very high positive value.

So, let us start with at a 20 percent rate of return, just we have to basically make an arbitrary guess based on the knowledge or based on the information and our time saving in terms of the calculations will actually be how accurate guess we can make to begin with.

So, let us start at a 20 percent rate of return and get the, what you are seeing here at 20 percent rate of return. So, these values are essentially; all these values are essentially the discounted; all these values are actually the discounted rate of discounted cash flow. So, all these values are discounted cash flow. So, when we take the 20 percent rate of return, the discounted cash flow will actually like for example this, this year 1. So, 20 percent means 1.2 to the power 1 that will be equal to this.

Similarly, for let us here this divided by 1.2 to the power 5 that will make this value. So, that we will calculate the all the discounted cash flow at a 20 percent rate of return and then the sum of this; this sum of this minus our initial outlay which is 40 will be equal to the net present value.

So, what we see that at 12 percent discount rate earlier we got a net present value of around 36 [FL], here at 20 percent discount rate still we are getting net present value close to 10 [FL], so that means, we will have to further go higher. So, let us increase the discount rate and consider at what happens at 25 percent discount rate. Now, for 25 percent discount rate, again let us say if we want to estimate this. So, it will be this number divided by 1.25 to the power this is 3rd year, so 3. Similarly, 21 divided by 1.25 to the power 8 will give this number. So, 21.048 divided by 1.25 to the power 8, will give this number.

So, that way we will calculate the discounted cash flow at 25 percent rate. Now, what we see that when we sum this number what we get is that the total sum minus 40 is equal to 0 minus 0.607. So, that is very crucial information that the net cash flow or the net present value has turned negative. So, net present value has turned negative means you are not going to get 25 percent of return. So, your return is likely to be less than 25 percent. So, we took the 2, first 2 iterations, we took the 20 percent and 25 percent, we figure out that net present value is positive at 20 percent. So, the IRR has to be greater than 20 percent, while net present value is negative at 25 percent. So, IRR has to be less than 25 percent.

Now, it is just slightly negative. So, it is going to be close to 25 percent only, not anywhere near 20 percent because that is still giving the 10 [FL] of close to 10 [FL] of net present value which is a huge number rather compared to 25 which is just minus 0.06. So, sorry minus 0.6, so very close over there.

So, since it is close, so let us try at 24 percent rate of return, the discounted flow. Similarly, instead of 1.25 we will use 1.24. So, all these numbers will be divided by say 1.24 to the power n where n is the year respectively. So, that way we will compute this and when we get the sum of this and subtract 40. So, sum of this minus 40 what we get is 1.236 still positive, so that means, it is going to be higher than 24.

So, the internal rate of return is going to be higher than 24, but less than 25. So, it is somewhere in between 24 and 25, we are actually closing in towards the correct value. So, since we are closing in towards the correct value let us take another guess, again see how do we make guesses? So, this is negative side 0.6, positive side 1.2. So, positive side number is much larger, net present value, so we will have to shift larger from positive side and go towards close to the negative side. So, from 24 to 25 let us try at 24.7 as a trial. So, when we do at 24.7 means we divide all these values by 1.247 to the power n, where n represents the year or t that way.

So, when we divide all these values we get these discounted cash flow and sum of these discounted cash flow is equal to minus 0.066, again very; we are very close now, it has actually reached 0.066. So, we roughly we can take in fact, even 24.7 also. So, we can take 24.7 as internal rate of return because this is very little number. So, NPV is very close to 0.

However, still if you want to or if one wants to go more fine. So, then he can give another shot. So, let us try at 24.6 percent another close to now this is negative, so that means, this IRR is higher and at this rate of return is higher and actual rate of return is going to be slightly less than this.

So, reduced by 0.1 percent and see what is happening? So, again by doing this when we take this sum of the new discounted cash flows, when we discount all of them by 1.246 to the power n, what we see here is that the net NPV is 0.116. So, 0.116 again turn to the positive side and in fact, if you compare this the negative side number is little lower. So, if you have to pick any one of the 2, 24.7 percent would be better estimate because that is

just 0.06 lower, while the other one is close to 0 double of that, that is 0.12 higher. So, actual number would be going to somewhere in between these again because one is negative and one is positive. So, the more precise estimate can be obtained if one takes a number between these 2.

So, let us try one last at 24.66 close to this number and see what we are getting. So, at 24.66 if we discount all these numbers again it will be divided by all the number will be divided by 1.2466 to the power n. So, all this cash flows that is seen here will actually be divided by this number and that will eventually give us the discounted cash flow at 24.66 percent rate of return and if we see the sum of this is going to be 40.007 and minus 40 is our initial outlay, so that will lead to the net cash flow or net present value of 0.007. So, which is actually more than double digit, first double digits we are getting 0 only.

So, that way we can now consider that NPV is close to 0 or almost 0 over at this rate of return. So, this 24.66 percent rate of return becomes our IRR, so our net INR from for this from this trial and error exercise, we can come out to a value like this and then for this particular problem 24.66 percent is our internal rate of return. So, for that particular firm we can say that if it is investing it is going to get a healthy 24.66 percent rate of return in a 10 year lifespan, because we have considered this calculation for 10 years. So, the project duration becomes 10 year and in a 10 year lifespan the firm is likely to earn a 24.66 percent rate of return.

So, of course, this is a reasonably high number and the project can be accepted, which was eventually seen when we were using the NPV approach as well, because for the same problem even the NPV value was very high, NPV value also we got around 36 [FL] and that is also reflected from the internal rate of return which is close to 25 percent. So, this way the internal rate of return is estimated and is used for evaluating the economic feasibility or financial feasibility of the projects or of the proposed project.

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Now, the method internal rate of return method is has an advantages in terms of that the first thing as we were saying earlier also that managers like to hear in terms of return. So, knowing a return is intuitively appealing and that works in the favour of this approach, it is a simple way to communicate the value of a project to someone who does not know all the estimation details, all the essential details who does not know if you tell this is going to be the values or how the value is estimated or how it is calculated or so all other methods, the benefit cost ratio or this kind of approach is also which will what we will talk in the further sessions, they are not that clear cut in the dissipation of information as internal rate of return because you tell that you invest this much and you are going to get this much of return, that is very crystal clear and that helps in taking the instantaneous or taking the decisions about the whether to go for a project or not.

If the rate of return is high enough, one may not need to estimate a required return which often is a very difficult task that way because for example, in this case only in the earlier practice when we just took 20 percent and we saw that with the 20 percent also we are getting a healthy around 10 [FL] of net present value.

So, we were sure that it is higher than 20 percent. So, even the information this, this information that not just giving the in internal rate of return, but giving this information that the return on this project is going to be higher than 20 percent, even that is a significant statement for helping in the decision making. One may not exactly estimate

how much return it will give, but even if just say that return will be let say greater than 20 percent or greater than 22 percent, even that information or greater than 24 percent that information could be of help.

So, that could actually save from doing the several trial and errors and working out a specific rate of return. Many times it may lead to unrealistic assumption of reinvestment which is one of the disadvantages of the method because when we estimate and presume and say that this is going to be the rate of return and people may consider certain unrealistic assumptions of basically if from this activity my rate of return is this, I will be reinvest in this and so that my rate of like I will again be getting a similar rate of return, but the reinvestment scenario should be accessed on a different bases because one need to again evaluate the basic concepts of the; one need to again evaluate, that what are likely profit on to the reinvestment, which could be very different at times from the first case scenario and again it is not good for comparing 2 mutually exclusive investment at times because the other aspects of the project assessment gets ignored if we just look at IRR for the mutually exclusive projects.

So, those are couple of the limitations of the method and overall this is also a very widely used approach along with NPV and these 2 are the general the NPV and IRR are the probably the most popular approaches of capital budgeting. So, we will end this session here and discuss the few other methods of capital budgeting in the next session.

Thank you.