Water Economics and Governance
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Lecture - 37
Evaluation of Water Projects:
Capital Budgeting Methods

Hello everyone, continuing our discussion from the previous session we will be talking about the capital budgeting methods for the economic evaluation of water project or

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Financial evaluation of a water project depending on whatever input we are taking to begin with the major capital budgeting methods include the payback period and discounted payback period then there is a net present value internal rate of return or average rate of return which is also known as accounting rate of return or average accounting return and profitability index or benefit cost ratio.

These are the major capital budgeting methods which are typically used for evaluation the feasibility economic feasibility or financial feasibility depending on the inputs of a project they can also be used in a water sector because as we were talking in the previous session that the water sector projects are generally hugely capital intensive and their economic feasibility can be evaluated based on these methods therefore.

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We will start with the very basic payback period method which is one of the most one of the most basic and one of the most simple method for feasibility evaluation of projects in terms of economic or financial feasibility the method is very simple the payback period is actually the period or the length of time let us say how many years or number of years after which the initial investment is recovered from future incremental cash flow.

If let us say I am investing a capital of 100 rupees today and I am going to recover let us say some 10 rupees next year or 25 rupees next year or then 50 rupees then again forty rupees then 20 rupees 70 rupees that way let us say I am going to recover some amount or some money in the subsequent year. Those becomes my net cash flow and the payback period is a very simple method which will tell that in how many years or what length of time.

If it could not necessarily always be in years it could be in the months also, but since we are talking about capital intensive projects where these are there is a huge amount of capital is invested in the beginning. Generally, payback period remains little larger, but eventually the concept is that in any given time frame in whatever given time frame the initial investment is recovered from the future cash flows is known as the payback period.

The computation is fairly simple one needs to estimate the cash flow and then subtract cash flow from the initial cost until the investment has been recovered.when the

investment is completely recovered that point of time will be the payback peri od for the project the decision for evaluating feasibility of the project whether to accept project or not accept project is based on the payback period of course, the shorter the payback period the proposal or the project is better.

Because if I have a 2 proposals one is giving me payback in let us say 5 year another is giving me payback in 3 years so; that means, whatever I am investing today I am getting recovered in 3 years by one project or for one proposal. While for another proposal I am in I am actually getting back my investment in 5 years the same investment; of course, getting back the investments as soon as is better.

The shorter payback period are always considered better and for acceptance purpose I can accept a proposal; if the payback period is less than some preset limit. I let us say see I will invest in this project only if whatever I am investing today I am able to recover that amount and I am or I am able to recover all my investment within say 5 years. That becomes my preset limit for acceptance criteria now if I received 3 different proposals I evaluate one is giving me payback period of for say 3.5 years another is giving me payback period for of let us say 4.8 years, while the third one is giving me payback period of 6 years.

Now, I have a preset limit of 5 years I know that a method c is giving me a payback period of 6 years. I will out rightly discard that because it is taking longer for returning my investment then what I want because preset is limit is what actually I want.

If I want to recover my investment in 5 years and some project is proposing to investment to recover my investment in 6 years of course, I am not going to consider that. Project c gets cancelled now project a and project b both are able to invest both are able to recover my investment in less than 5 year one is in 3-point 5 year another in is let us say 4.8 here.

Of course, I will consider the one which is giving the shorter payback period because that is recovering my investment is just 3.5 year although on my criteria both proposals can be accepted, but I see that proposal a appears to be better because of the shorter payback period. That is how the decisions are make for a payback analysis now if we see.

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Payback Period (PP or PBP)

✓ **Example:**

A company decides to build a CETP (Common Effluent Treatment Plant) in the industrial belt at SIDKUL, Haridwar. The initial investment was estimated as ₹ 25 Carors. The CETP was expected to generate returns as under. Estimate the payback period.

Years ->	0	1	2	3	4	5	6	7	8
Capital Investments (Cr ₹)	25								
O&M Investments (Cr ₹)	--	--	1.2	1.4	1.5	1.5	1.5	1.8	2.0
Returns Expected (Cr ₹)	--	--	4.2	6.5	7.5	7.5	9.0	9.0	12.0

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If we take an example which will make it more clear how the payback period is analyzed. Consider there is a company in sidkul haridwar which wants to build a CETP CETP is basically common effluent treatment plant which sort of deals which sort of treats the effluent received from various different factories and industries.

Generally, in industrial cluster because industry may not all industry may not independently want to treat their wastes. They said their affluent or they send their waste to a common effluent treatment plant and this common effluent treatment plant treats their waste and sort of to the effluent discharge limits and then discharges it the for the treatment of the waste received from different industries it charges to different industries. If I am having a CETP let us say and I am receiving effluent from 50 different industries I will charge those 50 industries based on the how much volume they are sending.

If someone is sending let us say one million liters per day I may charge him one lakh rupees a month if other is sending me 2 million litres per day I will charge him 2 lakh rupees a month. That way the charging is dependent on to the volume send anyway that is beyond the context of this problem.

For this particular problem let us consider there is a CETP company wants to build a CETP in a industrial belt at sidkul haridwar yes, the company has estimated that there would be a requirement of initial investment of rupees 25 crore and the X they are expected to generate returns based on their table which is given as under. Now they want

to estimate the payback period of the project. In how much years they will be able to recover their investment.

That is what payback period is now you see that there is a capital investment and probably there is no return in year one. Let us say consider that the plant construction takes an year or couple of year. You will not see any return in probably in year one from year 2 onwards there are some O and M investment because a company has to operate that treatment facility.

There are some O and M expenses and there are returns in terms of charges from the industries that are sending the effluent. The O and M expenses and return expected onto the operation of the plant is provided in the table. Now we have to calculate the payback period for this problem.

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If we tend to solve this problem it is fairly straightforward these 3 points are given to us. We are given the capital investment we have been given the operation and maintenance investment and the return expected. Now, if we evaluate the net cash flow because that is what one needs to evaluate for such methods.

Net cash flow if you see in year 0 because we have invested 25 crores at these beginning. At the time period 0. My net cash flow is minus 25 at the beginning in year 0 or in at the

conception of the project at the start of the project there is a investment of 20 crore is done now there is no O and M expenditure and no return in year one.

For year one net cash flow is 0 no cash inflow or no cash outflow for year 2 there is an O and M investment of 1.2 crore and return expected is 4.2 crore. There is a net gain of plus 3 crore. That is my net cash flow for this particular year now in year 3 if you see again the O and M expenses are 1.4 and the return expected is 6.5. The plus 5.1 or net 5.1 is the net cash flow from the system similarly year 47.5 minus 1.5 is 6 year 5 is 6 year 6 is 7 year 7 is 7.2 and year 8 the 10 crore.

This is what is the net cash flow which is obtained by deducting the invest O and M investment needed in a year from the return expected in that particular year. Now, if you see the cumulative cash flow. Of course, at the beginning there is minus 25 there is no cash flow here. It is it will still remain minus 25 in year 2 there is a net cash flow of 3 into the system.

This minus 25 and plus 3 will become minus 22 because 3 has been recovered 3 has been flowed into the system in form of positive cash. That way the cumulative cash flow becomes minus 22. Similarly, in year third when 5.1 is further coming it is becoming 16.9 then in year 4 when 6 is further coming into the system it is becoming minus 10.9 further 6 inflow will make it minus 4.9 and then in year 6 when 7.5 is further flowing into the system. That will cover up for the net debt of minus 4.9 and the cash flow will turn positive from here onwards that 2.6 crore plus.

Now, if you see in the absolute term the company by the 6th end of 6th year has recovered this investment of 25 and all the O and M investments done so far and has reached into a net cash flow of 2.6 into the system or positive cash flow further in year 7th till it is generating 7.2. That will raise to 9.8 and in the year 8 again it will turn to 19.8 this way one can see that how the cumulative cash flow is increasing into the system. Now if we want to analyze the payback period for this proposal.

We can see that up till year 5 this is outright negative net cash flow is negative and in year 6 it is turning positive. The cash flow the pay the payback period for the proposal is going to be something between year 5 and year 6 up to your end of year 5 it is negative. It is certainly going to be greater than 5 years and it is in the year 6 it is going for positive so; that means, it is less than 6 years. We can estimate the payback period as 5

years plus because there is a fraction of year that is needed in the 6th year there is a net flow of 7 point 5; however, it needs to meet the debt of only 4.9. 4.9 is the debt that needs to be met and 7.9 is the net inflow into the system.

If we distribute the 7.5 across the year we can basically take a ratio of this which is coming out to be 0.65. 5 plus 0.65 will be total 5.65 years which is the payback period for this proposal. It has to be distinctly clear that by the time the cumulative cash flow is negative it is not it has not met it is payback period. The payback period is exactly when your cumulative cash flow becomes 0.

Cumulative cash flow is 0.4 0.9 here at the end of 5 year and 2.6 here at the end of 6 year. If we linearly interpolate this one years duration we will get 0.65 years fractional value and that is going to be my net cash net payback period. If I add 5 to this value the 5.65 will be my payback period for this. Now based on any criteria any preset criteria that I fix up let us say I fix up that I will accept this project only if my payback period is 5 years. On that criteria it is not meeting the payback period desired payback period and this is likely to be rejected.

However, if the company is saying that I will accept the project I will I will accept the proposal if the payback period is let us say 10 years or 7 years then it is within that preset payback period time and the pro the proposal will appear attractive to the company because as opposed to 7 year it is getting payback in 5.65 years and the company can certainly accept the proposal based on the payback analysis. That is what is the basic payback method one of the most simple and.

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One of the most used method primarily used method there are certain Pros and Cons. The advantages it is very easy to understand and it is little biased towards the liquidity the cash itself while there are Cons that it ignores the time value of money that is one of the major demerits or one of the major disadvantages of the basic payback period. That it is ignoring the time value of money if you see the previous example over here.

It has considered this whatever the return in the 4th year or return in the return in the 4th year 6th fifth year let us say 6 crore return as a net 6 crore value, but investment is being made today and down the line 5 year or 6 years this 6 crore is not equal to the 6 crore in today's term. I am investing today.

My the cash flows also has to be probably in today's financial terms todays monetary terms; however, it does not account for that and that is one of the major disadvantages of this it uses an arbitrary cutoff point where there is the cumulative cash flow is becoming 0 that becomes the our cutoff point and it further ignores the cash flow beyond the cutoff rate.

Like in previous example you see that if for a payback period method if I say that this 5.65 is my payback period for the proposal. Whatever revenue is being generated outside that payback period it does not incorporate that it is biased against long term projects such as R and D and new projects because there the returns are expected at a much later stage whereas, investments are done today only. The payback period is going to be very

large because if you are investing let us say certain amount in R and D project today you may not actually get any return for the next 4 5 years when the when if I am investing in R and D if I am let us say trying to develop a new approach of waste treatment wastewater treatment.

Now, that new approach will take time to develop if I have spent 5 years in developing a new approach and then it is going on to the field scale installations or commissioning. Eventually, the payback might be coming might start at to or any return on to that investment might start at to come after let us say 6 7 8 10 years. For that period the there is a idle period.

Where there is no inflow revenue and that way the payback period are going to be very large for such project or any new project. For example, the previous project that we had we have taken you see there was no cash inflow in the first year or the 0 year. When there is no cash inflow immediately. The pure payback period is likely to be prolonged that way. That is one of the another disadvantages of this payback period.

However, the major disadvantages which was we were saying is the it ignores the time value of money was considered in discounted payback period which is a modified version of payback period which is known as discounted payback period.

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This discounted payback period is the number of years or the time for the cumulative discounted cashflow to recover the initial investment. It is conceptually the identical to the payback period there also we were measuring the cumulative cash flow and see.

Whenever it is becoming 0 that is my payback period; however, in discounted payback period we in order to incorporate the time value of money. We discount the net cash flows of the future with appropriate discount rates. That is the only additional step over here which is followed rest remains the same computation method is same we estimate the cash flow here also.

But we discount these cash flows at a pre-specified discount rate. Whatever is the discount rate we will use that discount rate to discount these cash inflows and then subtract the future cash flows from the initial cost until investment has been recovered the decision rules again remain the exactly identical the shorter the discounted payback period. It is better we will accept the discounted payback period is less than some preset limit. Whatever the limit is pre-specified and let us consider the earlier example.

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For a discounted payback period case where we consider 10 percent discount rate 10 percent annual discount rate. For the same problem for the same investment for the same O and M expenses and same return expected what will be the payback period. If we consider a 10 percent discount rate.

That means, we need to adjust the time value of money with this 10 percent discount rate.

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Let us see, how this will fair in such a scenario up to this. We have discussed in earlier problem that the net cash flow how we estimated for different years starting from year 2 to year 8 a now with this down these cash flow in order to consider the time value of money. That is where you see an additional row in terms of discounted cash flow now what this discounted cash flow is doing if you see.

The discount rate given in the problem is 10 percent. 10 percent discount rate means 1 plus 10 by 100 and to the power n or to the power t whatever we take is going to be the discount rate applicable at that particular year nth year. If because 10 percent discount rate is again not going to be the uniformly distributed means 10 percent discount rate is not going to be applicable means each value will not be just discounted by 10 percent 10 percent in first year.

For the next year it is going to be further lower for the next year it is going to be further lower that way. If my net cash flow is for example see let us say this is my net cash flow if I want to discount it this is for year n consider this value for year n if I want to discount that. I will have to divide this number by 1 plus 10 upon 100 to the power n where 10 is actually the interest rate or discount rate. 10 percent discount rate means 0.1 you divide 10 by 100 it becomes 0.1 eventually it will be c n upon 1 plus 0.1 which is equal to 1.1

divided by n if my discount rate is for example, 8 percent. Then this is going to be c n divided by 0.08 to the power n where n is the this number of years.

For n is equal to 0 this value will be one and your net cash flow is going to remain your net cash flow. No change for the n is equal to 0 when your n is equal to 0 here since there is no cash generated anyway. The discounted value is also going to be 0. Now here the cash inflow generated is 3 and if you see the discounted cash flow is going to be lesser than that because this 3 is generated 2 years later.

There is going to be the effect of this and this 3 will eventually be 3 divided by 1.1 to the power 2. Because, we are into the second year that will be 2.5 similarly here similarly here for example, this one will be 6 divided by 1.1 to the power 4 and this will be 6 divided by 1.1 to the power 5. You see although this value is same the net cash flow in year 4 and year 5 is same, but net cash flow in year, but discounted cash flow in year 4 and 5 are different, because the rate of discount is changed.

6 crore earned in the 4th year is not equal to the 6-crore earned in the fifth year also 6 crore earned in the 4th year is probably equal to 4.1 crore in today's term and 6 crore earned in the fifth year is equal to 3.7 crores in today's term. With that analysis like for last year it is going to be 10 divided by 1.1 to the power 8 which is the time frame. That way we will get the discounted cash flow and instead of using the net cash flow. We will use this discounted cash flow in or cumulative cash flow analysis or you can call that cumulative discounted cash flow analysis as well.

This 25 is going to remain 25 this will remain 25 and here instead of earlier we subtracted 3. Now, we are going to subtract 2.5. It is going to be 22.5. Similarly, earlier we subtracted 5.1 now we are going to subtract 3.8 and that way if you see. Up till year 7 our cumulative cash flow is 2.9 in negative while in year 8 it is turning positive. Up till year 7 it is negative and your payback period has not been achieved your payback period is achieved somewhere in the 8th year. Because, at the end of 8 year you are getting positive cumulative cash flow.

Your payback period is somewhere between year 7 and year 8 and again we can use this same concept as earlier the payback period will be 7 year plus in the 8h year we need to account for 2.9 crore and our net discounted cash flow came for 4.7 crore. 2.9 divided by

4.7 makes it 0.62. 7 plus 0.62 will be 7.62 years is going to be my payback period or discounted payback period.

You can call this actually discounted payback period. This way a time value of money can be incorporated in a payback period as well. The basic payback period has been modified for a discounted payback period where time value of money has been incorporated and one can see that for the same net inflow of cash. If we take this example only.

We solve this we solved this example using the basic payback period and discounted payback period method. The basic payback period or the standard payback period was achieved in 5.65 years while this is achieved in 7.62 years. A net 2 year more time it took for getting the discounted payback period. If we consider the time value of money this is how the payback period can be can sift ahead can sift further.

I will the recovery which was earlier being done in 5.65 years is now when we consider the time value of money is now actually the investments are being recovered in 7.62 year and that is being my payback. If my earlier payback criteria was of let us say 7. Then the by the means of discounted payback period this project should not be accepted while by the means of payback period this project can be accepted if my payback period is higher. Let us say 10 I will be happily accept the discounted payback period as well. That is how the discounted payback period can be estimated.

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This also has certain Pros and Cons. The advantages it that it considers the time value of money it is easy to grasp it is not that difficult then again biased towards the liquidity the Cons or the disadvantages are if the discount value is con being considered.

Then we might want to use the more advanced methods because then the discounted payback is not that easy to analyze and terminologies of like the NPV or IRR are more better methods when we will discuss those that will be seen. That is again then the arbitrary cut off point or ignored the cash flow of the later periods is associated here also for research project and this kind of stuff again this is also going to be or very time consuming or highly capital int intensive projects.

This is also going to be basically create a issue, because, the payback period will be much longer and longer for such projects. Those traditional dis disadvantages are attached with this payback period as well. We did talk about the basic payback period which is just called payback period and discounted payback period in this session we will take some other methods of capital budgeting in the next sessions.

Thank you.