Lecture 39 : Benefit Cost Ratio (BCR) and Discounted Payback Period

Hello everybody, welcome to this lecture on the topic of benefit-cost ratio and discounted payback period. These are also measures of profitability and are related to the acceptance or rejection of mining project proposals. Now, the three topics that we will be discussing today are benefit-cost ratio, net benefit-cost ratio, and discounted payback period. Once we have a mining project proposal in hand or ideas about the current market price and the costs, we have the information about the cost of capital, which means the cost of financing.
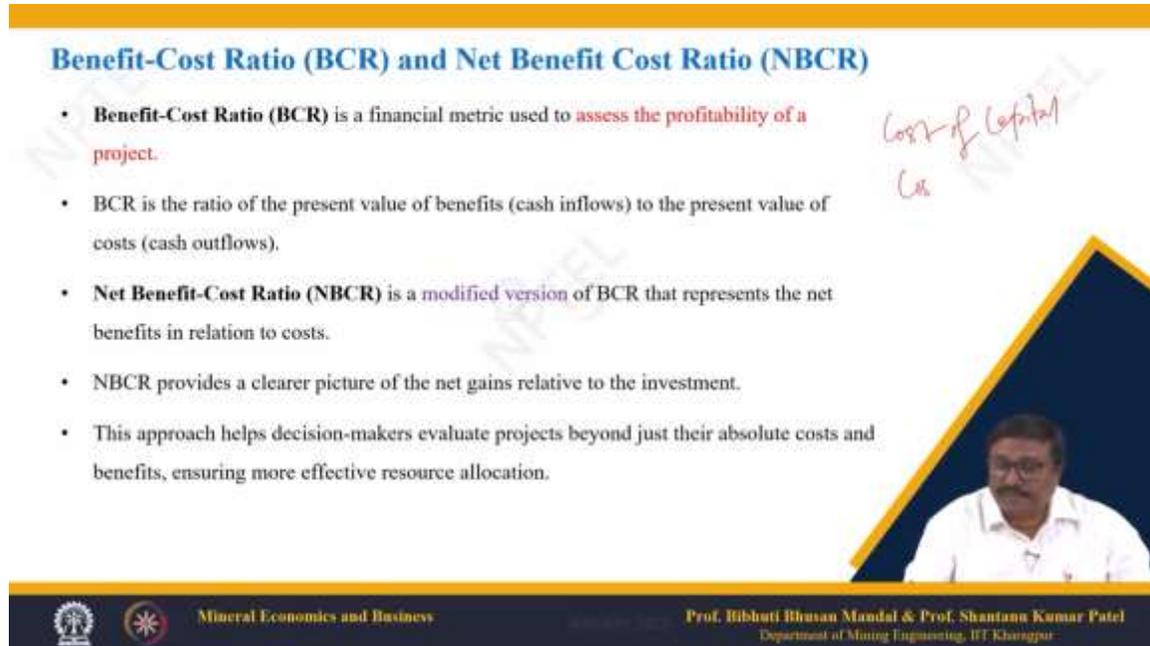

We also know the cost of different processes. For different processes, we also know the sales revenue. So, from there, if you have this knowledge, then utilizing different instruments and processes that we have described so far, we can forecast a series of cash

inflows and outflows. When the project is in the proposal form, and we have ideas about the probable sources of financing, the estimated cost of capital, different expenditures involved in running the mining business, and the sales revenue from selling coal or minerals from the mine, then we can have a complete forecast of the cash inflows and outflows over the entire life of the mine.

There are different measures like NPV, IRR, or MIRR, as we have studied so far, which can give you some idea about profitability. Also, whether we should decide to go ahead with the project. Then, what will be the value addition to the firm, or what will be the percentage rate of return? For different aspects of the decisions we want to take, we have different metrics. In this case, we will be talking about the benefit-cost ratio, or in short, BCR, which is another financial metric used to assess the profitability of a project.

Now, this is the ratio of the present value of all benefits—that means all cash inflows—to the present value of costs, that means cash outflows. And then we have another concept called the net benefit-cost ratio, which is a modified version of the benefit-cost ratio, representing the net benefits in relation to the cost. Now, this NBCR—net benefit-cost ratio—provides a better or clearer picture of the net gains relative to the investment. That we will see. It is a simple modification.

And this approach also helps decision-makers evaluate projects beyond just their absolute cost or benefits. It ensures more effective resource allocation by seeing the ratio, looking at the ratio. Now, for definition purposes, the BCR—which is also known as the profitability index—helps assess whether a project is financially viable or not. It can be calculated in two ways. One is the typical formula: BCR is the present value of benefits, which are actually cash inflows, and we transform these into terms of present values because we have, say, a series of cash flows. Out of this, the cash inflow part is transformed to the present value, or the cash inflow part is taken to the present value.

Then we add the entire present value of all the benefits—all the cash inflows—and we have in the denominator the initial investment. So:

$$BCR = \frac{PYB}{I}$$

Where,

- PVB = present value of benefit (cash inflow)

- I = Initial Investment

So, what are the inflows divided by the initial investment? So, that will give us the benefit-cost ratio. Whereas, NBCR is a simple modification.

$$NBCR = \frac{PYB - I}{I} = BCR - 1$$

Now, the BCR once you find out in terms of percentage also, then if it is a simple ratio. Or greater than 1 or NBCR, which is if it is 1 then NBCR becomes 0. So, when either BCR is greater than 1 or N BCR is greater than 0, we accept the project because of the profitability. But if it is 1, that means all the inflows are equal to the present values of all the inflows equals to the initial investment. In that case, BCR will be 1 and NBCR will be 0.

Decision rule of BCR or NBCR

Condition	Decision
BCR > 1 or NBCR > 0	Accept the project
BCR = 1 or NBCR = 0	Indifferent
BCR < 1 or NBCR < 0	Reject the project

- If BCR is greater than 1, it means the project's benefits exceed its costs, making it a profitable investment.
- When BCR is exactly 1, the present value of benefits is equal to the investment, meaning the project neither gains nor loses value.
- If BCR is less than 1, the project's benefits are not enough to recover the costs, making it financially unviable.

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So, we have an indifferent attitude toward the project. We need to think about other things or we have to relook at the costing that we have done so far. If the BCR is less than 1 and NBCR accordingly is less than 0, then we reject the project. So, what we actually say is that if BCR is greater than 1, it means that The project's benefits, the inflows as I said, exceed its costs, making it a profitable investment.

So, the benefits are above all the costs and exceed all the costs involved. So, naturally this year shows that the investment is profitable. When BCR is exactly 1, that means the present value of all the benefits is equal to the investment; the project neither gives us gain nor loss. So, decision-making is pending. If BCR is less than 1, then the project's benefits are not enough to recover the investment that we have done, making it financially not viable.

Financially not viable. So, it is just a simplistic ratio, but still it gives you a quick idea about whether to go for this or not without doing too much calculation. Now, this is very useful as it measures the net present value per unit of investment. You can see the PVB by I, which means this is the investment. So, all the present values of the cash inflows divided by I, the initial investment, show per unit of investment how much you are getting.

So, this helps to compare large and small projects, but it has, of course, some limitations, like giving the same results as NPV when you have done the NPV. If you do the benefit-cost ratio, the results are the same when there is no constraint. So, if there is no budget restriction, the BCR and NPV will give the same project selection outcome. But it also has a limited capital budget use when funds are limited; then BCR can help rank projects efficiently, but it does not allow combining small projects to compete with larger ones. That is not the issue; it is a ratio and does not talk about absolute values. Now, the cash outflows in future periods, BCR is less reliable if the project has significant future costs, making it an unsuitable selection tool.

So, while BCR is helpful in ranking projects, it should not be the single factor in decision-making. Let us take an example to understand how it is calculated. For example, the cost of capital is 12 percent. An initial investment is 100,000. The expected

benefits—that means, cash inflows—are 25,000, 40,000, 40,000, and 50,000, as we have shown the outlay here from year 1 to year 4.

Example:

Cash flows are given below:

Details	Values
Cost of Capital	12%
Initial Investment (I)	₹1,00,000
Expected Benefits	
Year 1	₹25,000
Year 2	₹40,000
Year 3	₹40,000
Year 4	₹50,000

Find benefit cost ratio and net benefit cost ratio and whether the project should be accepted or not ?

So, these are the expected benefits over the next 4 years. So, we have to find the benefit-cost ratio—that means, BCR and NBCR—this we have to calculate. And, of course, based on that, can we take a decision that the project proposal should be accepted or rejected? Let us calculate. On the right, you see the same data for reference, and on the left side, you see the solution. So, the discounted benefits equal the PV of all the inflows.

So, that means the present value of all the inflows has been discounted to the present value—all the inflows are discounted to the present value. So, you see the first here is 25,000, and then 40,000, then 40,000, and 50,000. So, accordingly, we have discounted and found the present values here. Now, the total present value is coming to 114,500. So, BCR is the PVB divided by the initial investment. The initial investment is given here, and we have used the 12 percent cost of capital here.

So, now the BCR will be 114500 whole divided by 100000. and N BCR will be BCR minus 1 that is 0.145. So, BCR is 1.145 or N BCR is 0.145. So, since the BCR is greater than 1 and NBCR is greater than 0, so the project should be acceptable. project should be acceptable.

You do not know really from here that what is the degree of your confidence, but as we see from the calculation it has, we have a positive view a positive vision towards the acceptance of the proposal initially. Other than this, there are more simplistic, criterias where, many people would like to say that if I am giving you 100 crores, then for how many years my money will be held up? After how many years I am going to get the money back first? First thing is that after that, whatever will be there, that will be my profit. That is fine.

Solution:

Discounted benefits = PV of all the inflows

$$PV = \frac{25,000}{(1+0.12)^1} + \frac{40,000}{(1+0.12)^2} + \frac{40,000}{(1+0.12)^3} + \frac{50,000}{(1+0.12)^4}$$

$$PV = 114,500$$

$$BCR = \frac{PYB}{I}$$

$$BCR = \frac{114,500}{100,000}$$

$$NBCR = BCR - 1 = 1.145 - 1 = 0.145$$

$$BCR = 1.145 \text{ or } NBCR = 0.145$$

Since BCR > 1, the project should be acceptable.

Details	Values
Cost of Capital	12%
Initial Investment (I)	₹1,00,000
Expected Benefits	
Year 1	₹25,000
Year 2	₹40,000
Year 3	₹40,000
Year 4	₹50,000

But for how many years I should give you money? and then ah then you develop the mine and then start productions sale in the market ah pay all those taxes royalties etcetera and then when I am getting the money back. So, it is called a simple calculation of payback period payback period. So, it is also ah ah measure of our our our attitude towards investment we want to know that how quickly we can get the money back. So, it can be formally written as the length of time required to recover the initial cash outlay on the project.

So, the shorter the period, the more desirable is the project. If I am getting it in 5 years, fine. If I am getting it 10 years, I have to think twice about it. So, as a widely used investment criterion, This seems to offer the following advantages.

But it is simple both in concept and application to conceptualize, okay, for this many, so many years, I am going to keep my money held up in the business and then I am getting the actual profits. And application of these things also is very simple. It is a rough and ready method for dealing with the risk of financing a project. Since it emphasizes earlier cash inflows, it may be a sensible criterion when the firm is having problems of liquidity. That means when we say, , we do not have enough, , the facility of liquidity.

Payback Period

This is the length of time required to recover the initial cash outlay on the project. Accordingly, **the shorter the period, the more desirable the project**. As a widely used investment criterion, this seems to offer the following advantages:

(i) It is simple both in concept and application.

(ii) It is a rough and ready method for dealing with risk.

(iii) Since it emphasizes earlier cash inflows, it may be a sensible criterion when the firm is having problems of liquidity.

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That means you do not transform your assets easily to cash for investment somewhere else. Then, what happens you cannot venture into a proposal another   project expansion project, where your investment would be held up for long time. If you get the money quickly back, then the problems of liquidity will be solved that means, you do not have to bother much about that. So, we will go for those projects where the Where the earlier cash inflows are ensured.

So this makes sense in calculating the payback period to understand when I am going to get the investment back. How soon we are getting the investment back. ah Before I show the problems and solution, let me talk something about the   limitations. It fails to consider time value of money in simplest form. The cash inflows are just added up every year say from fifth year or so, I am fourth year or so, I am getting this this amount back after selling the minerals.

in the market and after few years I am showing that I am getting the payback. I am getting back the investment that I did in the beginning. So, they are simply added without suitable discounting in the simple calculation of payback period. It ignores cash flows beyond the payback period. So, the total viability and the prospect of the project, the value addition that we do in the project over the entire life of the mine is all ignored.

We are interested only to that period when my money when the investment is generated already given back as cash inflows. So, there we do not know much about the entire prospect of the project. So, if this substantial cash flows are still cash inflows are in the later years, the payback period will not talk about all those things. It is a measure of projects capital recovery, not profitability. When you are recovering the capital, that is the measure.

In 4 years, 5 years, that is the only thing that we are talking. But the attractiveness of the application of this method is there. There is a person who wants to invest in the mining project and knows that how many years this will be held up. Then they will think whether we should go for this or we should think about, , So, short term investment in case of short term investment this is important, but in case of very long term investment where the capital after the capital recovering what is the prospect of the project in that case this method may not be so suitable for application or taking a decision.

To counter this these disadvantages or the limitations as we have said in the previous slide I talked about. We can introduce the discounted payback period to take care of the time value of money which was not there in the simple payback period that I have just now discussed. This is a capital budgeting method. that calculates the time required for an investment to recover its initial cost considering the time value of money. Now, we have introduced this thing in the payback period calculation.

Discounted payback period

- The **Discounted Payback Period (DPP)** is a capital budgeting method that calculates the time required for an investment to recover its initial cost, considering the **time value of money**.

- Unlike the regular payback period, which simply sums up cash flows, DPP discounts each cash inflow using a given discount rate (typically the cost of capital) before calculating the recovery time.

- DPP = Year before full recovery + $\dfrac{\text{Discounted cash flow in the next year}}{\text{Remaining unrecovered amount}}$

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So, previously we were just adding simply summing up only going adding the cash inflows and then we found the ratio of PVB divided by I. Now, so the in comparison to the regular payback period which simply sums up the cash flows the discounted payback period will do a discounting of each cash inflow using a given cash given a discount rate typically the cost of capital before calculating the payback period or the recovery time. So, the discounted payback period DPP. to the year before full recovery actually we are going to a little bit more precise here that is why we have given we have taken two terms one is the year before full recovery plus may be the fraction of part fraction part. So, if if if the exact figure comes that 4 years or 5 years or 6 years then the calculation ends here, but if there is a smaller part remaining then what we do discounted cash flow in the next year, divided by the remaining unrecovered amount. This ratio will give you the fractional part of the discounted payback period in much more detail or more precisely

rather. We will see how we can implement this through the problems and solution soon. What are the advantages that we have? As you said we have already taken care of the time value of money which was not done in the in the payback period calculation in the beginning.

Here we have added this. So, what we can say that unlike the simple payback period DPP accounts for the decreasing value of money that means the time value of money by discounting the cash flows. which is a standard procedure and which makes sense because you see now we are allowing the time value of money to make it more precise, more reasonable calculation. So, overall it improves decision making process. Since it considers the risk by discounting the future cash flows, it provides a more realistic measure of the investment recovery.

So, now is just not a rudimentary or quick calculation, we are taking care of the discounting method. So, that our projection of the payback period is much more realistic than by simply calculating the payback period as we have demonstrated in the beginning. Now to choose projects with quick recovery in this respect the discounted payback period helps in identifying projects that recover the initial investment quickly while considering the cost of capital. So it is much more precise in the sense. What are the disadvantages?

So, it ignores, as usual, anything after the payback period; it does not talk about anything. Once the initial investment is recovered—that means the discounted payback period is known—the discounted payback period calculation does not talk about the future cash inflows after the payback is done. Which may lead to poor investment decisions. As I said earlier, it can be so that once the payback is done—fully recovered—the prospect may increase considerably, which is never reflected in the discounted payback period or payback period, nowhere. This part is neglected.

Example:

For a project, ABC limited needs Initial Investment of ₹50,000 and Discount Rate (Cost of Capital) for this project is 12%. Cashflows are as follows:

Annual Cash Flows	Amount
Year 1	₹12,000
Year 2	₹15,000
Year 3	₹18,000
Year 4	₹20,000
Year 5	₹22,000
Year 6	₹25,000

Calculate discounted payback period for this project

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This is just to see how many years my investment will be recovered; that is all. Let us take an example here. For a project, ABC Limited, which needs an initial investment of, say, 50,000. The discount rate—the cost of capital for this project—is estimated to be 12 percent, and the cash flows are listed here. Year 1 is 12,000; year 2, 15,000; year 3, 18,000; year 4, 20,000; and then year 5 is 22,000.

Year 6 is 25,000; these are the cash flows. Now, we have to calculate the discounted payback period for this project—discounted payback period—that means the time value of money will be considered for calculation. Let us see: to find DPP, we need to discount each year's cash flow—each year's cash flow—each year's cash flow to present time. So, it is a simple discounted cash flow technique: Ct divided by (1 + r) raised to the power t, and we have the cash flows once again listed here, as I was telling in the previous slide,

as I have shown there. So, if we use this formula for every year, then the discounted cash flows become this one.

The 12000 becomes 10704, 15000 will become 11958 like that you go on calculating and you find out these values. now in the first year once the discounted cash flow is 10714 say the cumulative discounted cash flow is 10714 next year we are getting 11958 which we are adding and then we are getting this one we go on accumulating go on accumulating and you come here like say 73342 is the total cumulative discounted cash flow total cumulative discounted cash flow. Now, the cumulative discounted cash flow reach 48194 by year 4. So, if you see the cumulative amount that is already   recovered which is 48194, then what is happening?

Solution:

To find DPP, we need to discount each years cash flow to present time.

Discounted cash flow $= \dfrac{c_i}{(1+r)^i}$

Year	Cash Flow (₹)	Discounted Cash Flow (₹)	Cumulative DCF (₹)
1	12,000	10,714.29	10,714.29
2	15,000	11,958.00	22,672.29
3	18,000	12,812.40	35,484.69
4	20,000	12,710.00	48,194.69
5	22,000	12,482.80	60,677.49
6	25,000	12,665.00	73,342.49

The remaining part, the remaining amount in the next year after the year 4 is 1805 of only a fractional part. So, 1805 rupees is spending after 4 year. So, in year 5 the discounted cash flow is 12482, but we need to recover only 1805 rupees. So, in the whole year it has the capacity to give you 12482 rupees, whereas you need only to recover 1805 rupees to complete the payback, discounted payback.

So, you just take a ratio to find out the fraction of the year required to recover the remaining amount, so that it becomes a full recovery. So, it gives you a figure 0.14. You add this 4 years before what we have found up to this and then we add 4 plus 0.14, it becomes 4.14 years, approximately 4 years and say about 2 months, 4 years and 2

months. The whole money is recovered. The initial investment is recovered in 4 years and 2 months.

- The cumulative discounted cash flows reach ₹48,194.69 by year 4.
- The remaining amount to recover: 50,000 − 48,194.69 = 1,805.31
- In year 5, the discounted cash flow is ₹12,482.80, which is more than the required ₹1,805.31.
- The fraction of year required to recover the remaining amount:

$$\frac{1805.31}{12482.80} = 0.14 \text{ years}$$

The **Discounted Payback Period (DPP)** = 4 + 0.14 = **4.14 years** (approximately 4 years and 1.7 months)

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One more example here. So, this is a for example, a mining project that requires an initial investment of rupees 250 crores and it generates cash inflows as below for over 7 years for 7 years. Now, the discount rate here is 10 percent. As you can see that year wise cash inflows are 50, 70, 90, 100, 110, 20 and 130 crores. These are the cash flows projected.

We have to find out all these not only discounted payback period, but BCR, NBCR and discounted payback all this matrix active found out. If you want to see it holistically, you it is better to find out certain aspects. So, you need to have different financial matrix and if you see to want to see it holistically look at the ah the prospects through BCR or say NBCR or discounted payback period or NPV IRR all these things you can calculate and see what these are saying towards our   ah acceptance or rejection or the   future prospect of the project.

To calculate the BCR and NBCR simply we have already shown it and the discounted payback period we need the present or discounted values of cash inflows in future. So, for discounted payback period we also need cumulative cash inflow. using the formula P B equals to C T by 1 plus R into T for where T is the year. So, for every year we will be

doing this. So, we make a schedule, we make a complete schedule where we know the year wise cash inflows in rupees crores and here are the discounted cash flows

Example:

A mining project requires an **initial investment of ₹250 crores**, and it generates cash inflows as shown below over **7 years**. The discount rate is **10%**.

Year	Cash Inflows (₹ Crores)
1	50
2	70
3	90
4	100
5	110
6	120
7	130

Find BCR, NBCR and discounted payback period

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50 becomes 45.45 using this formula, and where the 10 percent discounting rate is applicable. As I have shown before, we go on making this schedule cumulative, and we come up to the seventh year, which means 441.84. Now, the total cash inflow is 441.84 crore. So, the formula for BCR and NBCR will be very simple: BCR will be PVB divided by I, which is 441.84 divided by 250. So, it becomes 1.76.

Whereas, NBCR will be 1.76 minus 1. It gives us 0.76. The initial investment is 150 crores. So, you can see from the table that by the end of year 4, the cumulative discounted inflows are 239 crores, which means not fully recovered. In year 5, the cumulative inflows become 307.47 crores, which exceeds 250 crores.

So, here I will correct it—just a minute—yes, this is actually 250 crores. So, you see at the end of year 4. At the end of year 4, the cumulative discounted inflows are 239, which is less than 250 crores. Again, if you go to the next year, year 5, the cumulative inflows become 307.47, which exceeds 250 crores, our initial investment. So, at the end of year 4, the recovery was not enough; there was a shortfall.

Whereas, in year 5, the cumulative inflows will exceed the initial 250 crores. So, what we do is the amount to be recovered in year 5 is 250 minus the recovery up to the fourth year, which is 239. So, the remaining part is 10.84 crores. So, the fraction of the year required to recover the remaining amount will be 10.84 divided by 68.31. That gives us 0.16 years.

So, now, if we add this to the previous 4 years, it gives us a precise 4.16 years. We can also convert this into months. From the BCR, what we see is that it is 1.76, which means it is greater than 1. The BCR is 0.76, which is greater than 0. Greater than 0, and also, for the payback period, the discounted payback period, we see that in 4 years or 4 years and a few months, 1 or 2 months, you get the entire 250 crores back. What we see is that, based on the BCR and NBCR, the project is acceptable.

We are not talking about value addition and all those things because that is not included in the calculation of BCR and NBCR. And if somebody is happy with a 4 to 5-year investment and payback period, then they should immediately go for it. And then, of course, they can think about the future cash inflows after the payback period is over, how many years it will continue to give cash inflows, and what the total amount will be. From there, we can also find out the net present value of the company. In that case, what is happening is that apart from the calculation of BCR, NBCR, or this payback period—

Total cash inflow = 441.84 cr,

Formula for BCR and NBCR:

$$BCR = \frac{PVB}{I} = \frac{441.84}{250} = 1.76$$

$$NBCR = \frac{PVB - I}{I} = BCR - 1 = 1.76 - 1 = 0.76$$

The initial investment is ₹150 crores.

By the end of **Year 4**, the cumulative discounted inflows are **₹239.16 crores** (not fully recovered).

In **Year 5**, the cumulative inflows become **₹307.47 crores, which exceeds ₹250 crores**.

Amount to be recovered in year 5: 250 − 239.16 = ₹10.84 crores

The fraction of year required to recover the remaining amount:

$$\frac{10.84}{68.31} = 0.16 \text{ years}$$

The **Discounted Payback Period (DPP)** = 4 + 0.16 = **4.16 years**

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simplistic calculation so far—we can also take care of the net present value, which we can calculate.

And also, we can find out the modified internal rate of return to give you a more realistic rate of return on investment. With this, we come to the end of the project valuation series. If you want to learn more, you can go through many books or text materials available, but these two books are good enough to give you the ideas you require for this course. And what I want to say in the concluding remarks is that in the last four lectures, we have tried to give you the ideas of project valuations. The net present value, the internal rate of return, the modified internal rate of return, Then we talked about the payback period and the discounted payback period.

REFERENCES

- *Financial Management* by P C Chandra. McGraw Hill Publishers. Chennai, India
- *Mineral Project Valuation* by O Jones, E Lilford and F Chan

These things are only to know whether the project is viable and how attractive the project is. After that, we can go for detailed scheduling, further details, and other planning, or a detailed project report can be prepared. But these things will give you the initial idea about the attractiveness of the project. Thank you very much.