**Financial Management for Managers**
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Lecture 45
Risk Analysis in Capital Budgeting - Part VI

Welcome all, so in the process of learning about the different techniques of risk analysis in the capital budgeting proposals now we are going to discuss the last technique, 6th technique and this technique is called as the decision tree analysis. Decision tree is a very popular way of analyzing or taking very important decisions in the business. And in the risk analysis of the capital budgeting also we apply this concept here.

So how we talk about the, how we develop the decision tree, if we talk about that concept, so you I will take you directly to this level, for example this is a decision tree we have developed here, so you can say that it starts from here and it moves through this different branches of the tree.

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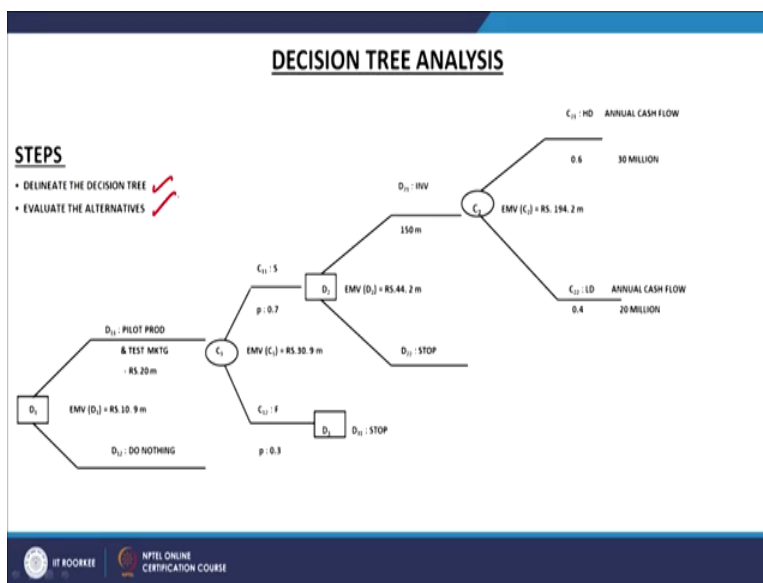
So this is the model of the decision tree but how this tree is developed and what is the background and how it helps in say calculating the NPV of the projects and analyzing the risk in the say capital budgeting proposals that I will discuss with you first. So in the decision tree there are 2 steps involved, right there are 2 steps involved. One step is first step is the, delineate the decision tree first of all you draw the decision tree.

And second step is evaluate the alternatives, these are the 2 steps involved here which is given here also in this structure, we have already written that delineate the decision tree and second thing is evaluate the alternatives and then which alternative is the best alternative on the basis of NPV to be calculated that alternative we are going to select, right.

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So in this case delineate the decision tree means identify the decision points and the chance point. When you develop the tree you try to find out the decision points and the chance point, so to first of all we have to take decision, we do this thing, we do that thing, right. If we do this

thing what are the chances of success? What are the chances of failure? If we do that, what are the chances of success? What are the chances of failure? So you have to take the first of all decision and then try to find out to what extent the decision is going to be a success or is going to be a failure and there we will use the probability estimates, right.

Chances of the success of the decision or chances of the failure of the decision, so first step is delineate the decision tree or draw the decision tree, right. Second is evaluate the alternatives, so it means when you have to evaluate the alternatives read this steps very carefully, right. When you want to draw the tree you can start from here, you can start from the left hand side but when you want to evaluate the alternatives available you have to start from this side and this is called as the right hand side.

So left hand side and right hand side, right so in this case first is start at the right hand end of the tree and calculate the NPV, what is written here, calculate the NPV at various chance points that come first as one proceeds left ward. So it mean what you have to do is, you have to start from here and then you have to calculate the NPV, so these are the chance points. First chance point is C2, right and when you talk about the C2 here so you have got the 2 chances here, C21 and C 22 right.

These two chances are there, so it means C21 is chances are of the high demand which are 60 percent and here are the chances of low demand which are 40 percent so chances there can be two chances and both the chances we have to associate with the probability, right. Similarly given the NPV of the chance points at the step 1 we have to then calculate the NPV. On the basis of the values given here, we will have to calculate the NPVs by applying the say this present value, interest factor for NOT concept.

We have to calculate the NPV and once that NPVs calculated given the NPVs of the chance points at step 1, right here at step 1 evaluate the alternatives at the final stage of the decision that out of the decision on the basis of the chances here this chance and this chance these are the 2 outcomes of the chances and probability assigned is 60 percent, 40 percent on the basis of the NVP coming out here we will have to evaluate this decision which is now we are going to say that the 2 possible decisions we can take either we can take the decision 21 or we can take the decision say we can take the decision D21 and or we can take the decision D22.

So if you say go for it so means if you take this decision we go for the investment and if we take this decision we go for stopping, we will not take make investment. But if we go for the investment chance of the high demand are this much, chances of the low demand are this much, right?

So we have to calculate the NPV here and then on the basis of that we have to evaluate this particular decision which we are going to evaluate, so this is the step number 2. At each final stage decision point select the alternative which has the highest NPV and term care the other alternatives, each decision point is assigned a value equal to the NPV of the alternative selected at that decision point, so it means we will have to then follow the step calculate the NPV here and then try to find out that which one is the highest NPV out of the two.

This is going to give you the highest NPV or this is going to give you the highest NPV since this decision is going to stop the project so no question of NPV, NPV can be expected here only so here it will come as the present value of the cash flows and minus this investment of 100 million rupees which we are going to 150 million rupees investment which we are going to make here, so it means whatever the value comes up here that people have to calculate.

Though the value is also given here, expected market value is also given to us which is 194.2 million, how it is calculated I will explain it to you and this is outflow, so this is the present value of the cash inflows and this is the present value of the cash outflows, so 194.2 million minus 150 so the NPV is going to be 44.2 positive NPV, so we are going to take the decision. So this way the whole process has to be followed.

Lastly proceed backwards, means towards left side in the same manner calculating the NPV at chance points so selecting the decision alternatives which has the highest NPV at various decision points terminating the inferior decision alternatives and assigning NPVs to the decision points till the first decision point is reached, right. So you have to means sum of the decision have to be discarded.

But some of the decision which are taken they have to be evaluated on the basis of the chances of the success or failure and after that the decision which is going to give us the highest NPV that has to be identified that has to be means say evaluated and if says that yes NPV is going to be

positive here then certainly we will take the decision or we will means make the investment or will do the needful for making that investment, right.

So this is the these are the 4 steps involved largely first two steps, first of all draw the tree and then evaluate the alternatives. Drawing the tree you have to start from the left hand side but for evaluation of the alternatives you have to start from the right hand side, starting with the chances moving to the decision and then evaluating the first decision, similarly evaluating the second decision and then going to the last one.

The beginning whether we should go for this investment or we should not go for this investment, so this is a nutshell you can say the decision tree analysis and how we can apply the technique of the decision tree analysis.

Now to understand this technique well and how this tree has been drawn here and how these values have been calculated we will do it ourselves here and then we will try to find out that by using the concept of decision tree how we can say analyze the risk associated with the project and take the decision whether to go for this investment or not to go for this investment, right.
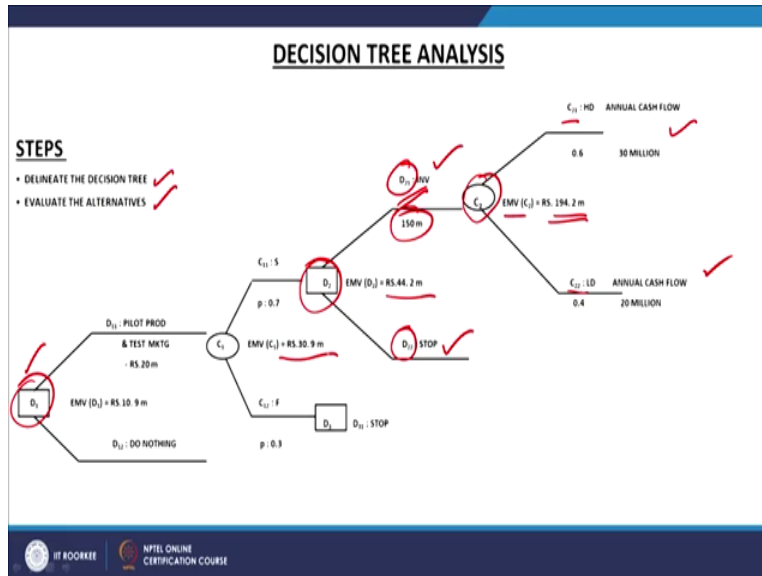
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Decision Tree Problem

Alpha Ltd. has come up with an electric moped. The firm is ready for pilot production and test marketing. This will cost ₹ 20 million and take six months. Management believes that there is a 70 percent chance that the pilot production and test marketing will be successful. In case of success, Alpha can build a plant costing ₹ 150 millions. The plant will generate an annual cash inflow of ₹ 30million for 20 years if the demand is high or an annual cash inflow of ₹ 20 million if the demand is moderate. High demand has a probability of .06; moderate demand has a probability of 0.4. The discount rate is 12 percent.

Required:

Conduct he decision tree analysis and advise Alpha Ltd. accordingly about the production of the moped.

DECISION TREE ANALYSIS

So now let us see this problem and then we will do the required analysis, what is the problem here? Alpha Ltd has come up with an electric moped, new electric moped they have developed, this is the product which they have developed is electric moped, this is the name of the company, this is Alpha Ltd. The firm is ready for pilot production and test marketing right. Means all test have been done and now the marketing, test marketing can be done, pilot production can be done and test marketing cab be done.

When you want to go for the pilot production and test marketing that will cost us how much? 20 million rupees and it will take a time of how much? 6 months, right and on the basis of the results of the say your pilot production and test marketing if the results are encouraging we will go for the commercial production otherwise we will lose 20 million rupees and we will abandon the project.

Management believes that there is a 70 percent, now this is a chance there is a 70 percent chance that the pilot production and the test marketing will be successful. In case of success alpha can build a plant costing rupees how much? 150 million, total investment requirement is 150 million and for the test marketing and pilot production the investment requirements are quite low which is 20 million rupees. Plant manager generates, plant will generate an annual cash inflow of 30 million rupees for 20 years.

If the demand is high or an annual cash flow of the 20 million if the demand is moderate, high demand is the probability of has a probability of 60 percent and low demand has a this is basically 0.6 percent so this is the probability of 60 percent and this has the probability of 40 percent, 0.4 and what is the total investment? The cash inflow will be coming up as 20 million and the time period is 20 years.

The discount rate is 12 percent, in this case now evaluating this whole information this is the electric moped we want to say start manufacturing but final commercial production will start only after the results of the test marketing and the pilot production and the test marketing becomes encouraging or positive and the investment required for the test marketing as well as pilot production is 20 million but if the results are quite encouraging then the commercial production will start.

And for staring this commercial production will have to make a proper investment of 150 million rupees in the plant and the sales expected are say annual sales expected from this plant of this investment will be 30 million rupees for a period of 20 years. In case of the high demand and minimum is 20 million in case of the moderate demand. Probability of high demand is 60 percent and probability of low demand is 40 percent and discount factor we will use for calculating NPV is the 12 percent.

So what is required here, conduct the decision tree analysis and advice Alpha accordingly about the production of the moped. So now we have to go for the conduct the decision tree analysis we have o conduct the decision tree analysis and advice Alpha Limited accordingly about the production of the or about the commercial production of the moped. So now we have taken this decision here and for taking this decision if you see we have found out here is that is say here you are given the total in case of the high demand we are given the 30 million of the say sales.

In case of the moderate demand sales will be annual sales will be the 20 million or cash flow I would say not sales, cash flow will be 20 million probability is 60 and 40 so we have to calculate the NPV of these values or with the help of this investment proposal or these investment requirements let us now evaluate it, so now we have to calculate the say we have to develop the decision tree here and we should look at this decision tree.

We started with this D1 right, what decision was here? First step is delineate the decision tree, draw the decision tree, second is evaluate the alternatives, let us discuss how it has been drawn. We have first started with the D1 and then we said that pilot production and test marketing is requiring how much? 20 million rupees and do nothing is no investment is required if you want to not to go for the investment or do not want to even test the product in the market.

Now if you go for this chances of success that is C11 are going to be 70 percent and chances of the say you can call it as failure, it is S mean success and F is a failure, chances of the failure, failure of the test marketing will be 30 percent and if we go for means if we become successful, if we become say as per the 70 percent chances if we become successful then we will go for the commercial production where the decision 2 will be taken and investment of 150 million will be required.

Or if we are means accepting this where the chances are quite bleak 30 percent we will not go ahead, we will not go for any kind of commercial production. For example, as per the 70 percent probability of success we go ahead and we take decision 2 where the first thing comes up is that we will make a investment of 150 million rupees in the plant, second decision may be not to go ahead. But we are going to decide because chances of success are quite high so we are going to make this investment of 150 million.

So two decision you might take, either you take D21 or you take decision D22, if you take 2 1 it means this investment will be made, if you take D 2 2 no investment will be made. Once the investment is made, now we go to the C2 level. C2 level says that chances of the high demand are 60 percent and chances of the low demand are 40 percent and if there is a high demand annual cash flow will be of 30 million and if there is a moderate demand then the annual cash flow will be of 20 million, right.

So first this tree has been delineated or drawn has been means given the shape. Once this tree has been given the shape now the second thin we have to do is evaluate the alternatives though the values are also (kept) given here after the evaluation but how these values have been worked out partly the information is given to us in the case and partly like this value we have worked out, this value we have worked out.

So these values we have to work out on the basis of the present value analysis of the cash flows, cash inflows and then same concept of the NPV we have to apply where we will subtract the say the amount of the cash outflows from the amount or the present value of the cash inflows and try to find out the NPV. If the NPV is positive we will take the decision, if NPV is negative we will abandon the decision. So now second step in this decision tree that is for the evaluation of the alternatives we are going to learn how to take that decision, right. So for taking that decision what we have to do is.

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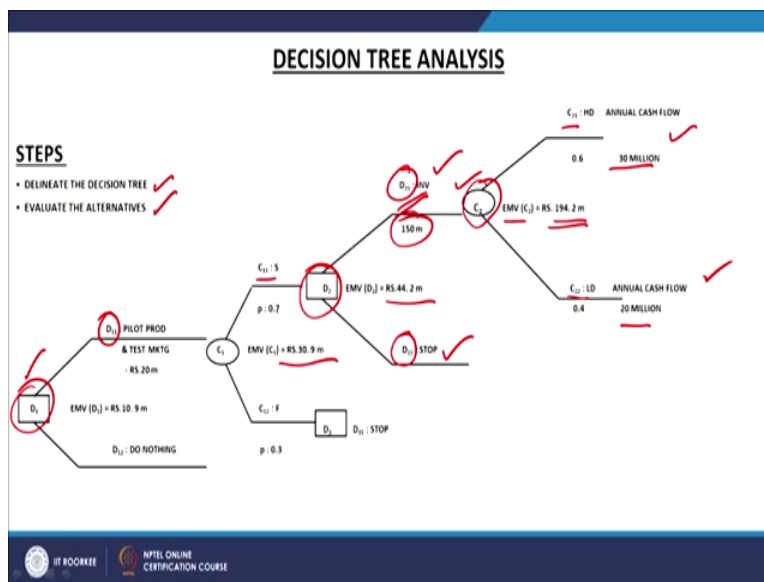
Now we have to calculate the say NPV at the different chance points and first step is to calculate the NPV at what chance point? That is C2, we are starting from the right hand side, right, I am starting from the right hand side and this is C2 so these are the 2 outcomes of the C2.

We are going to calculate the present value of these cash flows, 30 million and 20 million, so let us calculate the present value of these cash flows, so NPV at C2 is going to be how much? The first one is what is the probability? 60 percent and how much is going to be the cash flow? 30 millions and you are going to multiply it with something that is present value interest factor and that is for NOT because this cash flow of 30 millions will be available for a period of how many? 20 years, right?

So means we are going to calculate it for 20 years and discount rate is given to us 12 percent, so we are going to evaluate this part, 60 percent is the probability that your cash flow will be 30 millions plus 40 percent is the probability we are writing here plus 40 percent is the probability of the sales or the cash flow of how much? 20 millions PVIFA and again how many years? 20 years and the discount factor is 12 percent close the bracket.

If you solve this you will come out with that the cash flows is going to be how much, rupees 194.2 millions, 194.2 millions is going to be the cash flow of this particular, so this is not the say yeah one correction I will like to make here, this is not the NPV actually, this is going to be the we have to call it as the in the book also it is written as NPV but this is not NPV this is basically the present value, this is the present value of the cash flows.

So present value of the cash flows is going to be 194.2 millions, right this is the step number 1, so first of all what is the cash flows given to you as per the chance 1 and the chance 2, chance of success 1 and chance of success 2 and their respective probability multiplying by the probability you calculate the present value of the cash flow and if you calculate the present value of the cash flows then you will be able to take the decision.

So it means now to go to the step number 2, if you go to the step number 2 now what you have to do is that you have to now calculate the NPV at the say D2, what is the decision here? we have to now say evaluate it so if you look it at the say whatever the total information is given to us here

on the basis of that we will have to say try to find out that because we wanted to take this decision D21.

So we have to take this decision on the basis of the chances of the high demand and low demand so it means you have to evaluate now the say decision alternative D2 and for that what you have to do is, you have to follow the step here, so put here as the alternatives, we write here alternatives and put here as the NPV, right. Now it will be NPV this is the cash flow present value of the cash flow and now we are going to calculate the NPV.

So what is the decision here? D21 and how much investment is required? Initial investment required is 150 millions, right and how much is going to be the cash flow available or NVP available? NVP is going to be rupees 194.2 minus 150, so NPV is going to be how much? 44.2 millions rupees, 44.2 millions is going to be the NPV, so this is the decision in favor of D21 and in case of the (D2) D22 what it says?

It says stop, no investment is required to be made, so there is no question of calculating the NPV here, so we have to go for calculating the present value of the cash flows as per the chances of the success and less success and then to evaluate the decision on the basis of the chances of success or failure and on the basis of that we have done this, so once you have done it so we are going to select how which decision, decision D21 because NPV of this decision is more than D22.

So you can all it as NPV of D21 is greater than the NPV of D2, so it means we are going to say take the decision in favor of D1, so decision 21 is going to be the final decision which we are going to accept and we are going to means make the investment of 150 millions because the present value of the cash flows available is going to be 194.2 millions, so this is a first step half of the decision we have taken here.

And now we will have to go for the next level and then we have to calculate now the NPV at C1 and what is the C1? C1 is this, C1 is about making the investment about the say this one D1, test marketing, right. So test marketing is requiring the investment of how much? 20 millions and 70 percent chances are of success the test marketing will be successful whereas 30 percent chances are of the failure.

So now we are going to evaluate the decision which is called as D1 or D11, on the basis of chances C11, right. So for this we will have to calculate now the NPV. So nest thing is step number, this is the step number 3 and this is a step number 4, so you can call it as present value at C1, we have to calculate the present value at C1 not NPV but the present value at C1, so what is the probability of chances of success? 70 percent, so it is 0.7 into how much is the cash flow expected?

44.2 right, then plus it is how much? 30 percent chances are how much of the failure? Where the cash flow is expected to be because if there is a failure there is no cash flow at all, we are not considering, we are not calculating the cash flow. So it means in this case we are going to find out that the total this cash inflow si going to be 0 because if there is a failure, there is no cash inflow so if you calculate this, so you are going to find out that present value of the cash flow is something like rupees 30.9 million.

44.2 is going to be the say the total cash flow available and if you calculate the present value of that cash flow so you can say that finally the total amount which is going to be this is going to be the expected value, at this decision C2 44.2 so it means if you say look it at the 44.2 if you see the 70 percent of the probability of having this cash flow and 30 percent is of not having any cash flow, 0 cash flow, so present value at the C1 is how much?

That is 30.9 million, rupees 30.9 millions, so like this now at this 5 we will evaluate now like this alternatives and then we calculate the NPV, alternative and then we calculate the NPV, so what is the decision here? The decision here is D11 we are going to take the decision that is your D11, so means on the basis of these chances we are going to evaluate the decision D11 and D11 is saying go for the pilot production.

And if you go take this decision, go for the pilot production, so how much is going to be the investment here? 20 millions is the outflow minus how much is the NPV available 30.9 million, so NPV is going to be how much? 10 point, rupees 10.9 million is going to be the NPV of the project and we should go ahead with this investment or not we will have to take the decision now on the basis of these estimates.

So it means this is 10.9 million, right so we have taken the means we have evaluated it an if you go further this D2, decision number D12 so it means in this case what you are going to say? Do nothing, it says do nothing so if you do this so NPV is going to be 0, so it means the D11 which is more important for us. If you talk about the decision here, D11 is more important for us and if you take this decision D11 then we are going to have this NPV of the 10.9 million rupees, right.

So it means finally what can you say is your decision should be once you have to write the decision, what you have to write here is based on the above calculations you should write like this, based on the above calculation we find that the optimal decisions strategy is as follows, it will depend upon what? All these calculations are available now with us, will depend upon the following things.

Chose D11, right chose D11 because the outcomes seems to be positive here that is 10.9 million NPV is expected to be 10.9 million so chose D11, make investment of 20 million and go for pilot production and test marketing and wait for the outcome at the point C1 here right, so if the outcome at the C1 is success, outcome at the point C1 is the success which we had calculated here as at the probability of which is 70 percent.

It means because we go for the decision of D11, so as per that decision what we are going to do, we are expecting NPV is 10.9 million positive NPV is there, it means we will go for D11 and we will make investment of 20 million rupees, we will start the pilot production and will go for the test marketing and if the decision is where the C1 is C11 which is the you call it as the decision is success, if the decision is success here, so it means C11 is the success there the chances are the 70 percent then you make the investment of 150 millions.

Then you make the on the basis of this investment, on the basis of this outcome of success invest 150 millions and go for the commercial production, but if we go for the decision not C11 our chances which are at the C12 which is of the 30 percent or these 30 percent chances are of the failure, 70 percent chances are of the success, 30 percent chances are of the failure if the decision C11 is upheld then go for the making investment of 150 millions go for the commercial production and this project is viable, what if the C12 chances 1 2 are say held means you call it as viable or acceptable or finally is going to be the outcome which is a failure and the chances are only 30 percent but still are there then its better not to go for making this investment.

So it means this analysis tells us that NPV are both the decision reliable, so D1 and D2 level based upon the chances of success and failure is positive. In the first case, in case of the pilot production NPV is going to be 10.9 million which is quite a positive NPV and at the second stage once you make the investment of 150 millions and go for the commercial production NPV is expected to be again very high 44.2 millions and that is again positive, right.

So since at both the levels NPV is expected to be positive so I think we should go for making the decision in favor of making this investment initially at the smaller level as a pilot project and test marketing by simply investing 20 million rupees, once the say outcome is success C11 is upheld decisions of C11 is upheld where the chances are 70 percent then we take the final decision, invest 150 million rupees.

So it means the risk analysis can be done in a way that rather than straightway investing 150 million and losing the entire amount in case of the failure of the project is always better to spread the lesser amount, to shell out the lesser amount of money lesser amount of investment as in this case it is only 20 million for the pilot production and test marketing.

If the outcome is positive go for the commercial production otherwise not go, so how it helps in lessening the risk or minimizing the risk or analyzing the risk is in terms of dividing the total investment of this 150 million into 2 stages. One stage is making the smaller investment where we have made a proper analysis and chances of the test marketing are also of the success, but in any case if the second alternative proves good or say holds good and the project becomes a failure then you can say the remaining amount of the 150 millions.

So 2 step investment when we are doing though the results are expected to be positive but still we have to cautious in making the investment and it has to be made one after the another, so if we are successful it is a win-win situation but because of some reason if the project fails even in that case we not going to lose the entire amount only the amount which is invested for the pilot production that we are going to lose.

So this is the entire way or the process how the decision tree has a analytical tool in the risk management or the risk analysis of the capital budgeting proposals or the new investment

proposals can be used, right. So these are the 6 techniques, first 3 are the most popular techniques, sensitivity analysis, scenario analysis and the breakeven analysis.

Other techniques are used in some cases or in many cases provided the investment is quite large, so there we use the multiple techniques. So sensitivity analysis is always used like payback period and other techniques we have a choice either we can go for the stimulation or we can go for the decision tree or we can use the say you can call it as the 2-3 techniques together and try to evaluate the risk or analyze the risk associated with the project from different angles.

So regarding the different techniques of the risk analysis and the capital budgeting proposals I could discuss these proposals with you to some extent or may be mean say means the sensitivity analysis we did in detail, scenario analysis also we try to understand in detail only two techniques that is the Hillers model and stimulation model I discuss with you in abstract and decision tree also we discuss in detail.

And for the further reference if you want to learn further more about these techniques then you can again refer to any good book on financial management. The book which I am also referring here in this discussion or which is a very good book again I am saying it is the book Financial Management by Prasanna Chandra. So detailed discussion about all these 6 techniques is available in that book, or in any other book of the financial management. For the moment I will stop here and some other important concepts with regard to the say risk analysis in the capital budgeting proposals I will discuss with you in the next class, till then thank you very much.