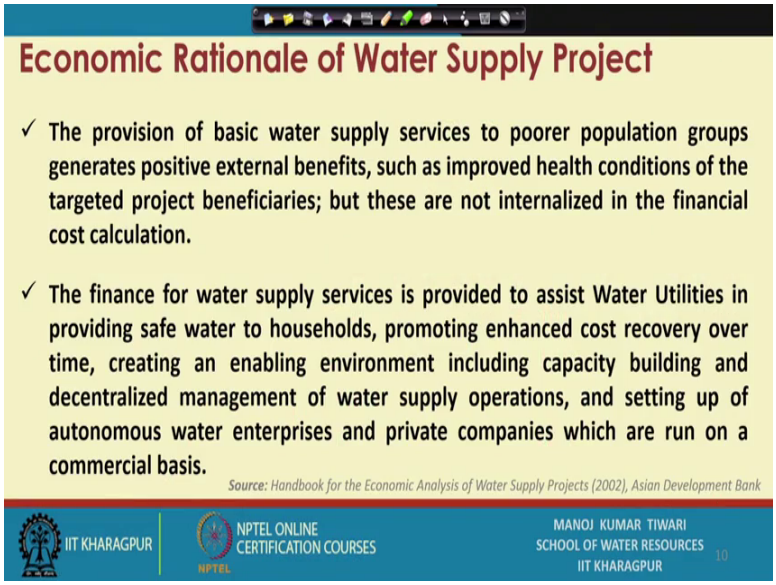
Water Economics and Governance
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology, Kharagpur

Lecture – 32
Economics of Water Projects: Economic Analysis

Hi everyone, in the previous session, we were talking about the economic aspects of water project what is the basic importance of economic analysis of water project and in this session we are going to continue that discussion further.

(Refer Slide Time: 00:31)



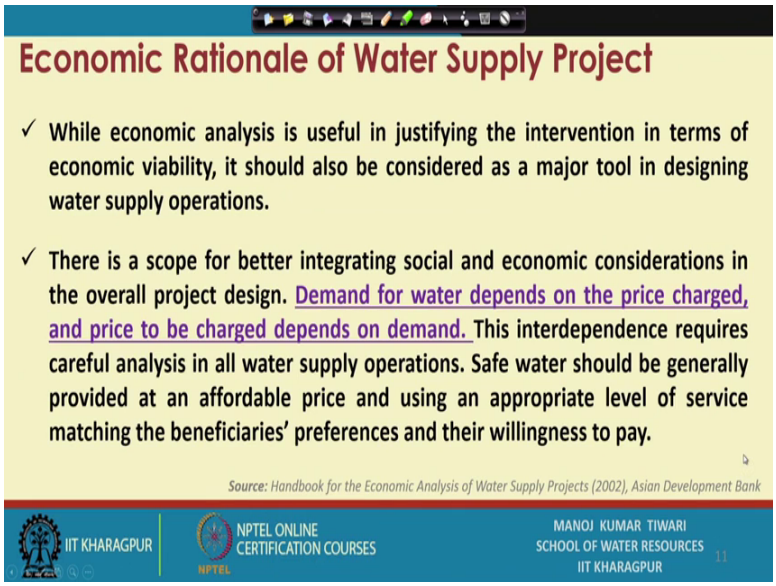
So, economic rationale of water supply project, we see the, but particularly like if we consider water supply project as a 1 of the project dealing with water services or any other any other typical water project we can take instead as well, the basics remain same, but for a for example, the water supply project the provision of basic water supply to poorer population groups sort of generates positive external benefits, such as improved health conditions of the target project beneficiaries, but these are not internalized in the financial cost calculation because how you will incorporate the positive health benefits. Of course, there are ways to quantify that as well, but it is not that easy.

So, for example, you get a idea of water borne diseases in the community, how frequently the such waterborne diseases are getting outbreak in the community and then what is the associated cost of sort of treatment, then cost of loss of man hours, loss of 4

children, they will not be able to go to school, so what is the loss of school hours, then other larger implications.

So, these kind of intangible benefits or cost at times are very difficult to calculate; the finance of water supply services is provided to assist water utilities providing safe water to household, promoting enhance cost recovery over time, so creating an enabling environment that include capacity building and decentralized management of water supply operation. So, such system sets up of autonomous water enterprises and private companies which are run on a commercial basis. So, based on their commercial losses, commercial gains, their advantages they operate such systems.

(Refer Slide Time: 02:51)



Now, you see while economic analysis could be useful in justifying the interventions in terms of economic viability it should also be considered as a major tool in designing the basic operations. So, it is not just about the infrastructure, economics is not just about the development of an infrastructure or calculation of the net cost and net benefits, economics or the economic analysis could also be handful in sort of designing the various operations.

The 1 very good example of this is that you see when we end up pricing water; we have discussed the different pricing structure in the previous week. So, what happens, that if let us say you are pricing water sending a signal towards the demand management, towards the reduction of the demand, like in the increasing block tariffs primarily where

higher blocks are charged with the penalized rate. So, that sends a very strong signal for water conservation or against the wasteful uses of water.

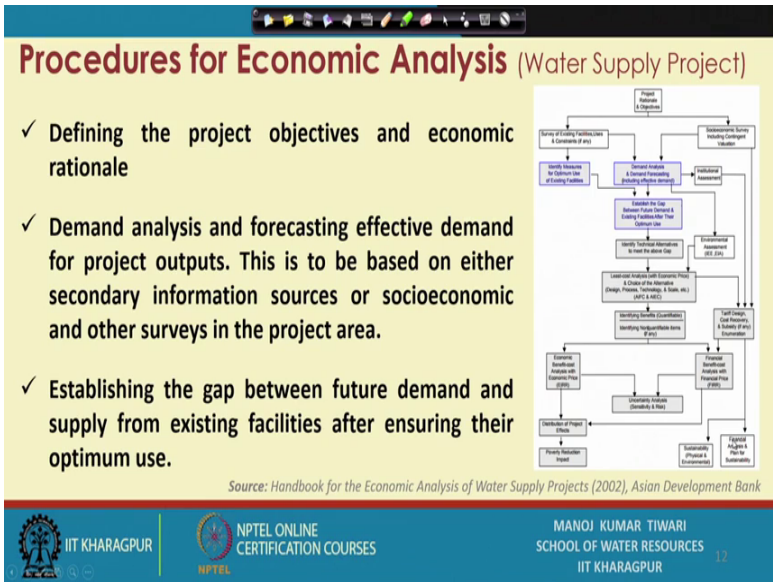
So, in such scenario, let us see such structure is proposed. So, the demand of water will eventually depend on the price or is believed to be depending on the price because if we are pricing water as a market commodity as or as a market good. So, it should follow the standard supply demand curve, so when there is a standard sorry price demand curve. So, when prices gets higher, the demand get lower or when it gets cheaper the demand gets more.

So, in such scenario the demand for water will depend on price charge, but the price that is going to be charged it is also depend on demand because your infrastructure would be based on how much demand is being exerted from the society. So, you end up building an infrastructure for certain capacity, now that capacity you worked out by estimating the demand; basic demand from the population. So, the demand is dependent on the price and since your infrastructure creation is depending on to the demand and eventually when you go on to the costing of the system, how much infrastructure is needed? How, what is the operational issues and all that. So, your price is also going to be dependent onto the demand.

So, demand is depending on price and price is depending on demand. So, this kind of interdependence requires a very careful analysis in water supply operations and similarly like there is a scope of better integrating social and economic consideration in overall project design because then, we will be able to use economic analysis as a tool in designing operations as well, not just the like final balance sheet only.

So, safe water should be generally provided as at an affordable price using appropriate level of services, which is sort of matching the beneficiaries performance as well as their willingness to pay. So, this is all integrated, all depending on to 1 other.

(Refer Slide Time: 06:26)



Now, if you see the procedure for economic analysis for a water supply project which is this analysis is being adopted from a Asian development bank report. So, this the economic analysis, the procedure or these steps for economic analysis involves different kind of, different steps or different kind of approaches. The first thing one need to do, is define the project objective and economic rationale. So, we did discuss that there is economic rationale for each activity and one needs to clearly define that what kind of economic output is being planned from the project.

Now, the demand analysis and forecasting effective demand for project output is going to be the next step and this is to be based on either secondary information sources or socio economic or other surveys in the project area because when one is going to put through a water supply project, you do not know how much demand is going to be exerted, you do not know this information in a precise way, the only thing that is you can basically sort of estimate it.

Now, the estimation will obviously be based on either secondary information sources, there are some standard manuals that suggest you take this demand as a per capita demand, further you know if one is planning to go for a creation of infrastructure for a water supply project, he first needs to fix up a design period.

So, a design period is need to be fixed first, now let us say the design period is 30 year for example, so if 30 year is the design period for the project that you are going to

implement or design today for next 30 year and you presume or you believe or you want that your system to serve for the next 30 year. The first thing is that population is not going to remain the same, so there would be change in the population.

So, how much population change is expected in this 30 year? Is to be estimated using certain standard population forecasting methods. So, there are various population forecasting methods, which derive key information based on the statistical analysis. So, like there are standard like algebraic increase method, then incremental increase method, geometric increase method, logistic curve method or graphical comparison method.

So, there are different methods, different approaches for the forecasting population any standard project needs that. So, for a; such project one has to forecast the population, when your population forecasting is done, now you know what is your design population; so if your system is to serve for let us say next 15 year, 20 or 30 year what is going to be the population at that point of time? And then, next step is to estimate the demand.

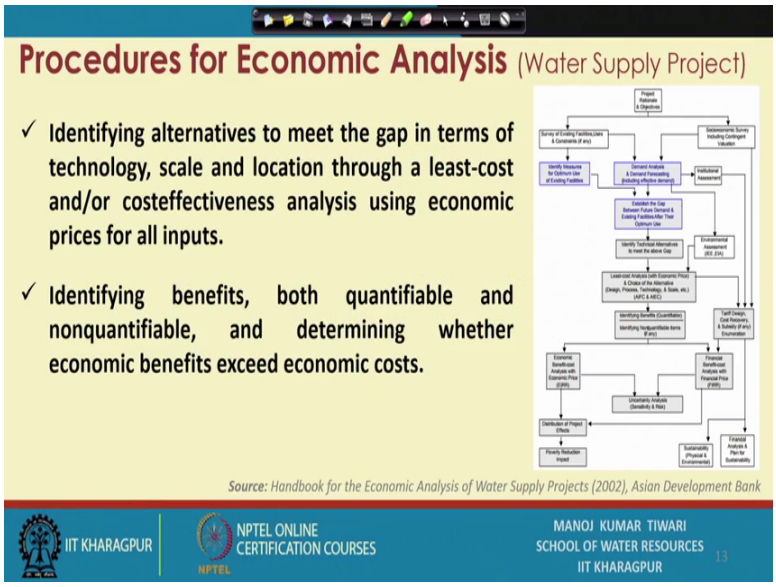
So, this population data is also not like real, it is just a forecasted data, it is just an estimate of likely population at that time and you do not know the exact lifestyle of the people during that age. So, it is very difficult to, like precisely know what kind of demand will be exerted at that time. So, based on again statistical data from the past, how the trains have been towards the changes in the demand pattern, changes in the population one actually forecast, population and when takes our demand as well, that this is likely demand is going to be the likely demand at that point of time.

Further, inputs can be taken from various other secondary data sources, some standard manuals, protocols, expert advices. So, those kind of inputs can also be taken in order to ascertain in demand and then when demand is fixed up then you go on to see that what is the gap between future demand and supply from existing facilities after ensuring their optimum use. So, if you know the demand, now for a completely new system you are at 0 level, so you know the demand so the gap is actually the total demand is your gap and you have to augment or you have to basically install a new system for that gap.

However, if you are augmentative system, if you want to expand an existing facility, so you already have some capacity of that facility and then when you forecast that this is going to be the demand in future. So, 1 can take that demand and use this gap as a design

criteria. So, your existing facility and the demand needed, how much further you need to cover up. So, for that particular additional coverage or additional supply, what kind of infrastructure is needed? So that gap needs to be estimated.

(Refer Slide Time: 12:18)



Now, once you know that, so you identify what are the various alternatives to meet the gap in terms of technology, scale and location through least cost or in other words, we can say the cost effectiveness manner and you analyze that cost effectiveness using economic prices for all inputs.

So, if we need; if we are planning to augment the existing facility, how we are going to enhance that facility? How we are going to increment that facility further? So, for this purpose you may have actually, one may have various alternatives for example, you are having an existing water supply system of 100 million liters per day, you estimate that for it is sufficient till 20 20, but if I want to use this till 20 30, I will need an additional 30 million liters per day of water to be supplied.

So, you identified that 30 is the gap that you need to cover up. So, you will have to expand your facility for 30 million liters a day more capacity. So, there could be different alternatives in terms of technology, scale and location for example, from where to get that raw water 30 ml d, whether to surface it from; whether to take it from surface water or to pump it from an aquifer.

So, there are different alternatives one needs to do the economic analysis from where you can get that water in a cost effective way including all inputs. Now, when we say that all inputs, it includes these social and environmental inputs as well. What is going to be the social implications of if I take additional 30 million liters per day water from the river? What is going to be the environmental implications of it? What is going to be the environmental implication in terms of if we abstract that water from ground water how much water table is going to dip? What is going to be the difference in the river flow if we are taking from surface water? So, how the ecology is changing there?

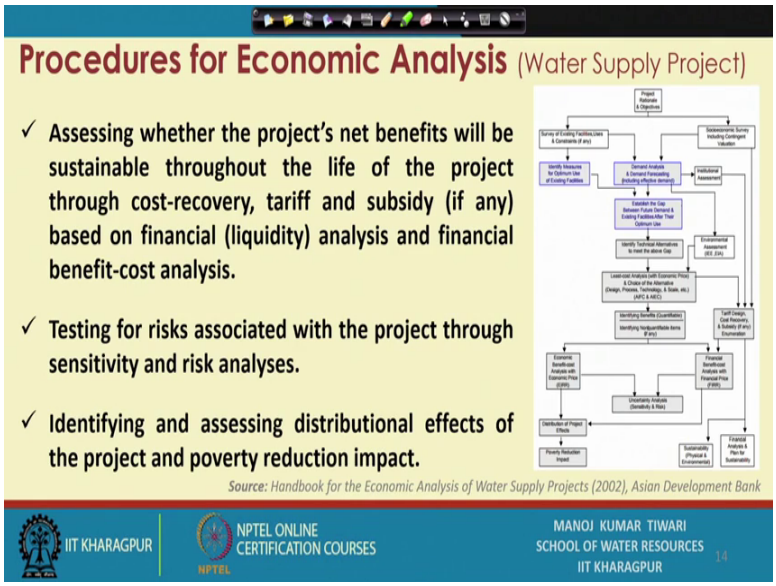
All these inputs is to be converted in terms of numbers, in terms of quantity as we are discussing, in terms of somehow monetary terms either rupees or dollars what is going to be the net impact and then based on these type of cost analysis you can choose your alternatives, I am going to abstract this water from this particular river.

What is the technology? There could be possible alternatives in terms of technology also, how to treat that? So, if you are taking ground water, you may need probably a very little treatment, there are not much suspended solids or not much impurities in the groundwater. So, that scale of treatment needed may be little over there, however, if you are taking surface water, the scale of treatment needed might be more there.

So, what are the available technologies? What is this scale? And what it is, what is scale I have to do? What is the location? Shall I do that additional documentation or enhanced capacity enhancement in existing plant or nearby or at some other location if you are having alternate source of water? What if I do this particular activity at this location and then cover up this area or the additional area from there which is going to be the close by.

So, there could be different alternatives and all alternatives has to be evaluated in terms of it is holistic approach. So, holistic approach for economic analysis converted in the tangible numbers, in the terms of monetary numbers. So, one needs to critically identify the net benefits both quantifiable and unquantifiable and determining, whether economic benefits are exceeding the economic cost. So, that is to be seen for considering the project.

(Refer Slide Time: 16:54)



Further, if you go, so assessing whether the projects net benefit will be sustainable throughout the life of the project through cost recovery, tariff and if there is any subsidies being proposed based on the financial analysis and financial benefit cost analysis. So, because whatever infrastructure is going to be installed, there is going to be some liquidity of that funds invested and when you get all the inputs.

So, all the benefits and all the cost, the quantifiable as well as non quantifiable one needs to convert as we are discussing in the previous session as well, one need to convert the non quantifiable gains and losses into the numbers using some tool and technique with there are certain standard approaches based on some factorization, some expert opinion, some general generic models are available these days. So, how you can our statistical data of course, so how you can convert these non quantifiable benefits and cost into the quantifiable into the numbers and then when you get everything in the number, then the project economic analysis, financial analysis is to be done and financial benefit cost analysis is to be examined to see which is outweighing what, whether the benefits are outweighing the cost. So, then it is likely a project which should be green signaled, should be good because benefits are outweighing the cost.

On the other hand, if you see that the cost; net implications of cost are higher than the benefits then it should a be a red signal project that probably it is not advisable in a

holistic approach considering the society, economic and financial implications of the project, it should not be initiated.

Further, once the benefit cost analysis is complete, one know every all these in numbers. So, then comes the testing for risk associated with the project through this sensitivity and risk analysis. We use many inputs in the process of evaluating a project, now these inputs how much your outcome is sensitive to these inputs is of very high importance.

For example, in mathematical models we see you have an equation and you want to see the sensitivity of input parameters on to the outcome of this, you vary slightly the input parameter and see how much effect is going to be there on to the output. So, the net change in the output per unit change in the input is called the sensitivity with respect to that input parameter.

So, similarly as the first, second step was to identify all the inputs that is needed for the analysis. So, if one is having all those inputs available, 1 should go for the detail sensitivity analysis, where the inputs and inputs are examined for their sensitivity in order to producing, in order to basically sort of yielding how much impact they are creating on to the net value of the project.

So, this sensitivity analysis is very important, we may see that some specific parameters are very sensitive. So, you 1 needs to be extra careful with the, those parameters in which range these are likely to vary in their financial analysis as well and certainly what are the risk analysis. So, because whatsoever activity is planned is there is certain risk attached with those activities and what kind of risk it is leading to on to the overall output, overall performance of the project needs to be seen.

Post this, the identifying and assessing the distributional effect of the project and poverty reduction impact is analyzed, particularly for because as in the beginning we said that this is an example for water supply project. So, one of the aim of water supply project is to distribute water in a equitable fashion to the society and to work towards the poverty reduction.

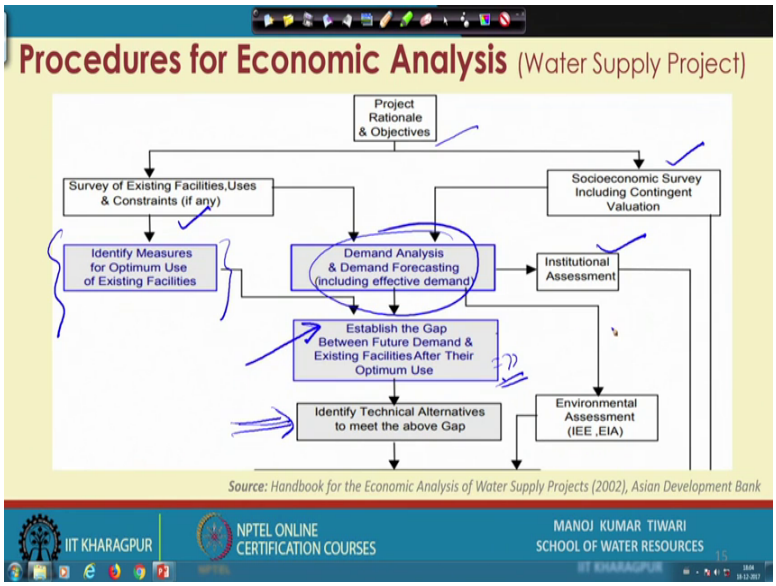
So, the net post your risk and sensitivity analysis, one should go actually to identifying and assessing it is net impact; on to the net impact of the project on to the society in terms of poverty reduction. In fact, it is not necessarily limited to just poverty reduction

impact, but with additional all other aspects or all other intended goal of the project, which has been considered at the time of accounting because the poverty reduction, if it is likely to do poverty reduction so, even that has to be considered as in externalities. These are for, what you have the term financial externalities.

So, what your financial externalities should include these terms that at the time of estimation of the net benefits that this process is likely to work in favor of a poverty reduction and that would be added in a social benefit. So, that is an added advantage, that is in a sort of benefit which is in form of the externality. So, such scenario is considered for economic analysis of the project; overall project.

Now, the process flow diagram is a suggested in the again handbook of economic analysis of a water supply projects by Asian development bank.

(Refer Slide Time: 23:59)



So, they suggest, if you follow this flow diagram, showing different step what you are seeing at present at the screen is only half of it, then remaining half is in the next slide, so in order to make it readable.

Now, if you see, the first thing is to set project rational and objective as we discussed and then a survey is to be done for the existing facility and constraint if any. If there is in any existing facility available, it has to be properly surveyed and measured and at the same time there is to be socio economic survey including contingent valuation needs to be

done. Once, existing facilities are known or the socio economic survey like the population forecasting and all these thing is done, then one can go to the demand analysis.

So, how much demand is needed, one can forecast the demand including the effective demand and that needs to be considered, then what is the institutional assessment? How much infrastructure? How much institutional support, how much institutional ability is already available, existing and then it can taken further from there. The other hand, when the survey of existing facilities and existing constraints is done, it can be used to identify the measures for optimum use of existing facility, this is another very important point that if let us say, you see that you have a capacity of 100 million liters per day installed and from your socio economic survey and demand analysis you figure out that you need 30 ml d.

If you can identify the measures for optimum use of existing facility and see it can lead any further like your with optimum use of technology or optimum use of setup, you can use the existing facility which is maybe 400 ml d, but by optimizing use if it can produce let us say 110 ml d or 120 ml d or somehow you can use certain tools to reduce the demand that way. So, these 2 things in combination your demand analysis and the; this optimization of the process, would give the, what are the net gap.

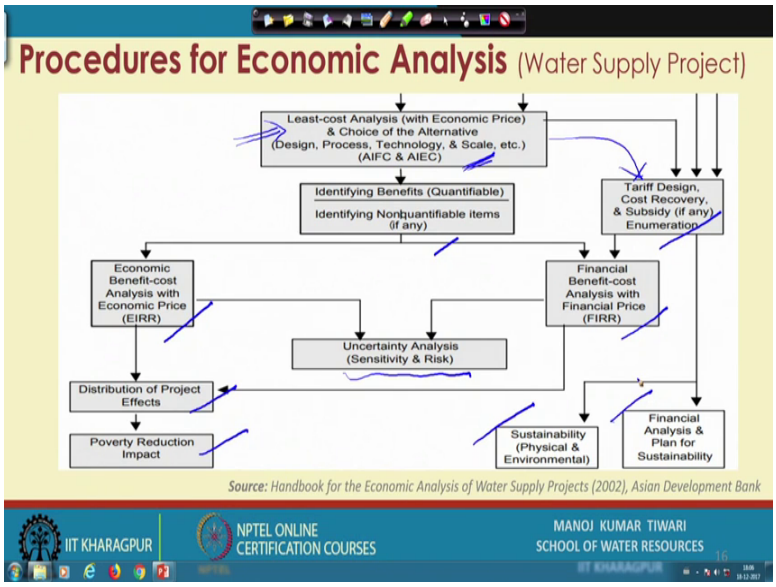
So, if certain can, certain additional demand can be augmented by the optimum use, so you may not need to basically in enhance the infrastructure for it, but if it is not. So, what is the additional gap that needs to be established between future demand and existing facilities after their optimum use.

So, when their existing facilities are being used at an optimum level what is the additional demand that needs to be worked out, as we were discussing, so this will be worked out. Further, for the demand analysis, the environmental assessment or EIA and this thing will be an intermediate step that needs to be done and when the gap is identified, so the one needs to look for what are the different technical alternatives to meet the above gap.

So, if one needs the capacity augmentation, the enhancing the capacity or maybe enhancing some process maybe installing an additional unit or maybe moving for other place. So, all the different technical alternatives need to be identified which can meet the

gap, which can meet the demand over here. So, from here for the next step we will move to the next slide, but you see here that your institutional assessment and the economic survey are also coming down over here.

(Refer Slide Time: 28:35)



So, these 2 also connect towards the tariff design further, how the tariff is designed? So, your tariff design would actually incorporate various units including the impact assessment of the demand, how much environmental footprints it is going to create or what your socio economic survey willingness to pay all those aspects, then the alternatives which have been identified they also will be used further for least cost analysis or the cost minimization.

So, in the most cost effectiveness way in terms of economic price, which alternative choice is the best and their design, process, technology, scale all these things needs to be; incorporated needs to be considered. So, all those things will be estimated over here, this also gives you a feedback for tariff design because here you are analyzing the cost aspect.

So, what are going to be the net financial implications of that augmentation of that additional capacity augmentation, is to be worked out here and then, you identify the benefits which are quantifiable and identify the non quantifiable items as well and then you do a economic benefit cost analysis with the economic price, a financial benefit cost

analysis with financial price and uncertainty and risk analysis as we were discussing earlier.

So, all these analysis needs to be done and then one actually taking clue from this, one says that, the distribution project and it is effect, what are it is poverty reduction effects? What is the sustainability in terms of physical infrastructure and environmental system? What is financial analysis and plant for sustainability? So, all these final outputs are to be derived by this economic analysis.

So, this economic analysis will eventually lead us an idea in terms of which alternative is suitable and what is going to be it is a cost and risk analysis? How much certainty or uncertainty is associated with the system? These kind of output will be presented to us with such analysis. So, we will conclude this session here and in the next session we will talk about how the, some calculations are derived for the financial analysis purpose.

Thank you.