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Lecture -59
Capital and Operational cost of Water Supply Systems

Hi, friends and welcome back. We have been discussing about the economics and pricing this week and in the last class we discussed about the basics of the economics particularly about the water supply system. Now as we discussed in the last week that it is very important to go for the economic evaluation of the large capital intensive project like water supply projects and for that purpose we need to estimate the cost as well as the options of recovery from these teams.

So in this particular class, we are going to talk about the cost of water supply system where we will be talking about the capital as well as operational cost of the water supply system.

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Now what we are going to discuss is the basic cost of water supply services then we will talk about the CapEx and OpEx in water supplies schemes. We will talk about the estimation of capital and operation and maintenance cost and we will talk about the cost optimization as well.

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So when we talk about the cost of water supply services, essentially when we are planning a water supply infrastructure or a water supply system, we need to consider the cost of the system and that will be basically helping in decision making and the managerial aspects of the supply systems. So total, cost of the systems include the cost for setting up of the infrastructure then operating and maintaining of this setup and then the disposal capital assets over there life cycle.

So if we are going to consider the entire lifecycle cost, then we will have to consider all three different aspects like; what is the capital investment? Then what is the requirement of funds during the operation and maintenance? And what will be there like depreciation of the assets or a period of time or over its a life cycle? But generally, particularly in the planning stage of water supply scheme the two major cost components that are considered are the capital expenditure which is also known as CapEx; which is basically the cost of setting up of the infrastructure.

And then operating expenditure which is usually known as OpEx; which is the cost for operation and maintenance.

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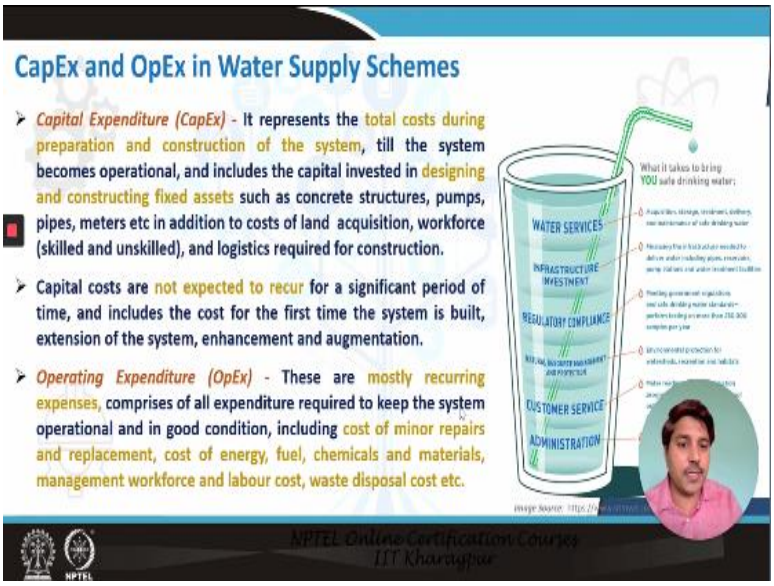

So, if we see this CapEx and OpEx particularly in a water supply scheme. So capital expenditure represents the total cost during the preparation and construction of the system. So this will be basically the Cost that is being invested in the designing as well as construction of the fixed assets. So what is the concrete structure, the procurement of pumps, pipes, meters, then other costs like the cost of land acquisition, cost of the designing, cost of the man power involved in construction not in the operation?

Operation manpower is a different thing. So man power involved in the construction phase like the skilled and unskilled manpower would be basically constructing the setup. So, and then other like logistic needed for their construction purpose. Then capital costs are such that they are not expected to recur. So they will be like just one time investment when we are sitting up infrastructure first.

So, then we need the design once the system is designed. We do not need to basically design it every year. So, once the system is designed the design cost is over. Similarly, on the system is constructed or the civil cost mechanical cost all these major costs all the capital cost is generally as one time investment or we may need them in a next stage when we go for the extension of the system for enhancement or augmentation.

Then also we may need capital cost which can be considered as a part of CapEx or many places

it is actually considered as a, like separate cost category. Then there are operating expenditure which is OpEx. So these are mostly recurring expenses operating expenditure because system is going to be operated for the next 20, 30 years. So each year, there will be costs associated like the minor cost for repair and replacement.

Then cost of energy, fuel, mechanicals materials, then management workforce and labor costs, which is required, waste which is being generated, so disposal cost of that waste so all those are basically costs related to the operation and maintenance. Maintenance means small maintenance; we are not going to consider the like large overhauling or larger scale augmentation or extension of the system that is not part of OpEx.

OpEx considers the minor repair and replacement so small maintenance cost and then the cost of consumables, cost of manpower, cost of energy; energy is in fact one of the major component of the OpEx.

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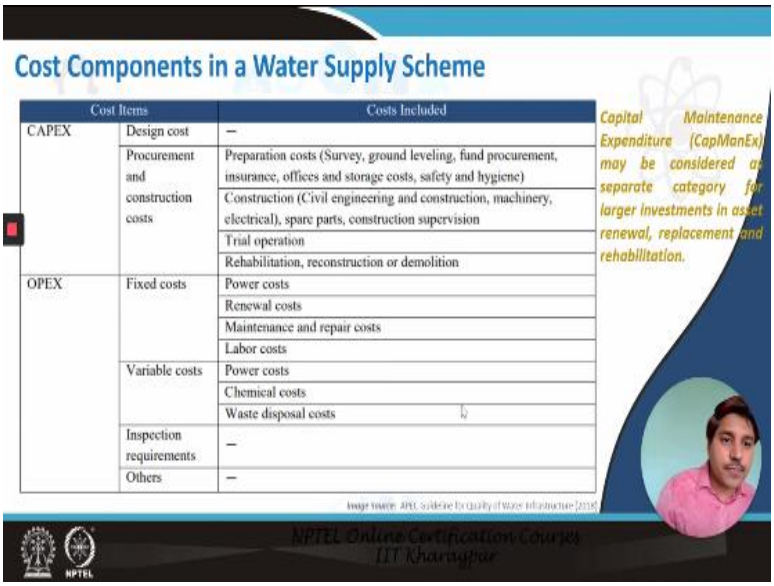

So, if you see these various cost components CapEx will include the design cost and then in the procurement and construction stage. So the preparation cost like survey ground leveling then insurance offices, storage safety hygiene all those which is needed for one time. When construction; there are civil engineering machinery electrical parts, spare parts construction supervision, all these style operations, rehabilitation reconstruction or demolition is needed.

So, all these are part of the CapEx whereas the OpEx is the power cost then renewal cost; like license renewal and those things which are going to like the requirement is going to come after a certain amount of time. So, all this mostly these are recurring costs, so labor cost, chemical cost, waste disposal cost, inspection requirements all these and the cost for larger investment in assets renewal replacement and rehabilitation might be considered as a separate head under the capital maintenance expenditure.

So, CapManEx which is capital maintenance expenditure cost, so that also can be considered as a separate category otherwise this may be included in the CapEx at that time when we are planning the rehabilitation or asset renewal of the system then we can consider that as CapEx component, but it is not included generally in the OpEx.

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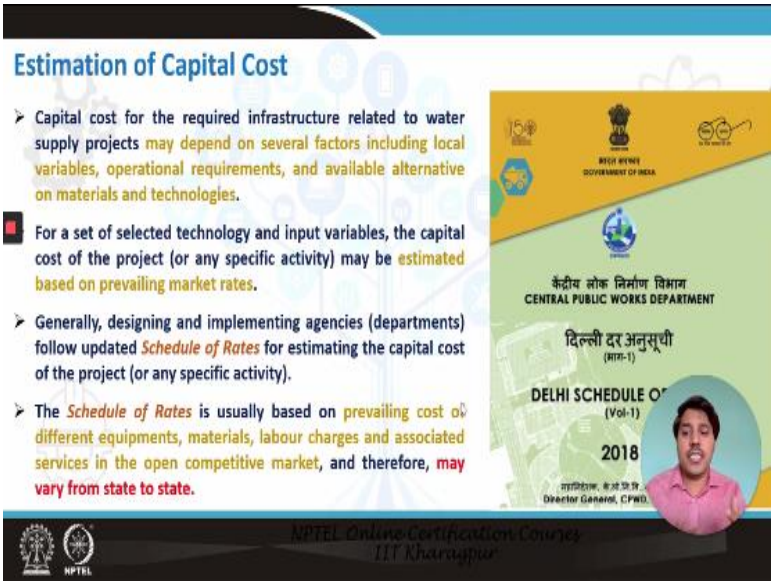

And how do we estimate costs? Capital costs are basically infrastructure related mostly, so they depend on the various factors like the local variables then how we are going to operate the system, what are available on the alternate materials and technologies? Though all these are needed for estimating the capital cost and then once we fix these variables, once we fix a design, once we fix what material we are going to use then we can take the cost of those based on the prevailing market rates.

Generally what happens that the various designing and implementing agencies or departments have their own schedule of rates for estimating the capital cost of the projects? So for say if somebody is going to construct a water treatment system, so there is a under schedule of rate, they can see what is the rate for the earth work? What is the rate for the concrete work? What is the rate for the mechanical powers equipment? What is the labor cost?

What is the cost of per unit pipe? What is the cost of chemicals? So all these will be actually mentioned in the schedule of rates and then based on that schedule of rates one can actually take the appropriate cost from that schedule of rates and add them up in order to get the total cost. But this schedule of rates usually based on the prevailing cost of the different equipment material labor charges and various other associated services in the open market.

And because from place to place these rates may vary. So there is a possibility of variation in the schedule of rates from again state to state or place to place.

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These are some of the example of schedule of rates, we just earlier saw the schedule of like reasoning, sample of schedule of rate from central public works departments. CPCP, for Delhi regions. Similarly we have examples of schedule of rates from government of Bihar, government of Karnataka. So basically, all these states, some agencies in the state have their own schedule of rates.

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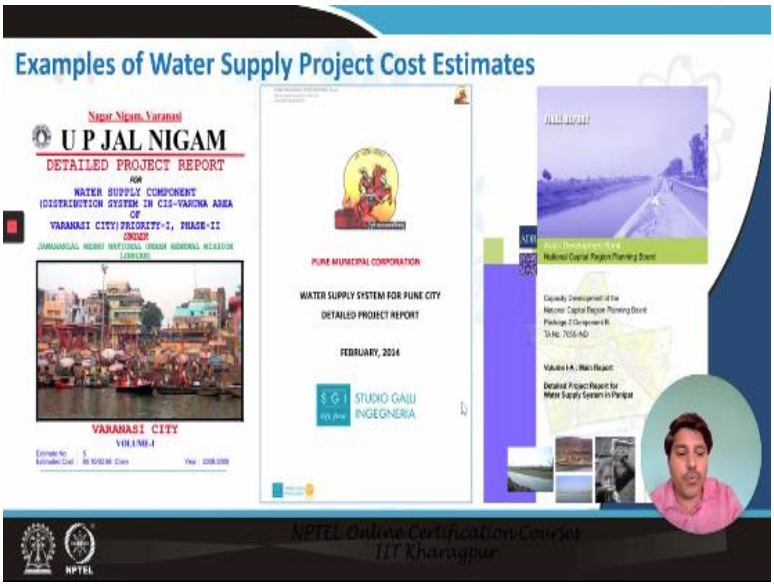

Which are usually followed, these documents may be referred for getting the project cost estimates, how the cost estimates is done for what is supply projects, like this is about a Varanasi city project from UP Jal Nigam and the other one is for Pune municipal corporation, this one is for Panipat city. So that way we can actually, like these documents have the detail cost estimates.

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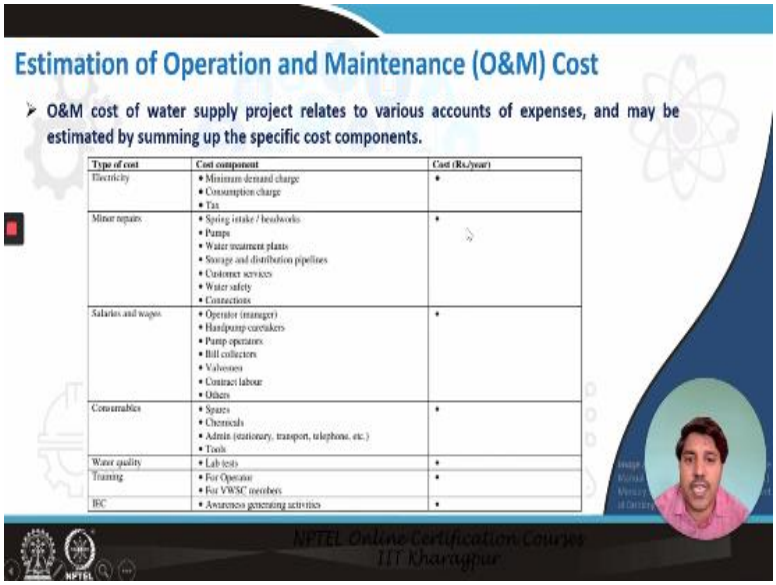

So, this can be referred in order to get the cost estimate or specifically the capital cost estimate for water supply project. How it is done? Mostly, followed based on the schedule rate available from the different agencies. For operation and maintenance cost the water supply project there are various activities which need cost during the operation and maintenance of these systems. So,

we can list out those costs, so what are the different types of costs?

We can say electricity, minor repair, salaries and wages consumable, then water quality testing training. So all these and then what are the various cost components like in electricity what are the minimum demands charges, consumption charges Tax? Similarly for various minor repairs for salaries and wages. So we can list all these costs per year and then sum them up for getting the operation and maintenance cost.

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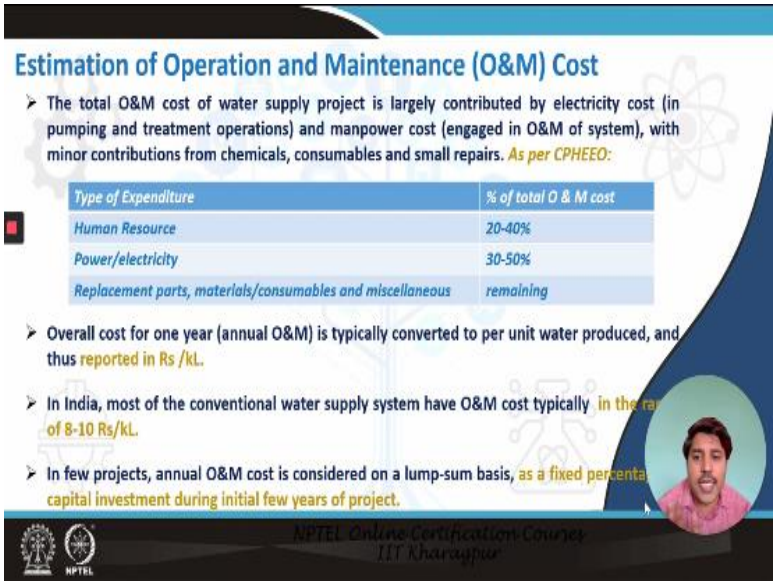

So, that is the one simple approach for getting the O and M cost. Now another like a way for estimation of the operation and maintenance cost is usually like in few projects the O and M cost is considered on the lump sum basis. It is a fixed percentage of the capital investment. So you see that based on your capacity if this is going to be the capital investment what is going to be the O and M cost per year?

That way or based on the capacity or capital investment, it can be taken. Typically, the different, under the different heads of expenditure in the O and M costs. The major contribution comes from the power and electricity which as per CPHO can cover up to 30-50% and then human resources which usually covers from 20 to 40% range of the O AND M cost. Then there are replacement cost material and consumables miscellaneous, so the remaining portion goes there.

Overall cost for one year is typically, basically converted to the unit produced in a year and that

is when the O AND M cost is usually reported in rupees per kilo liter. So in a monitory value per kilo liter, per unit of water produced. If say kiloliter or meter cube per meter cube of water produced, What is going to be the O AND M cost? So it is represented in this way and in India for most of the conventional water supply system the O AND M cost typically comes in the range of 8 to 10 rupees per kilo liter. So that is what is the typical range.

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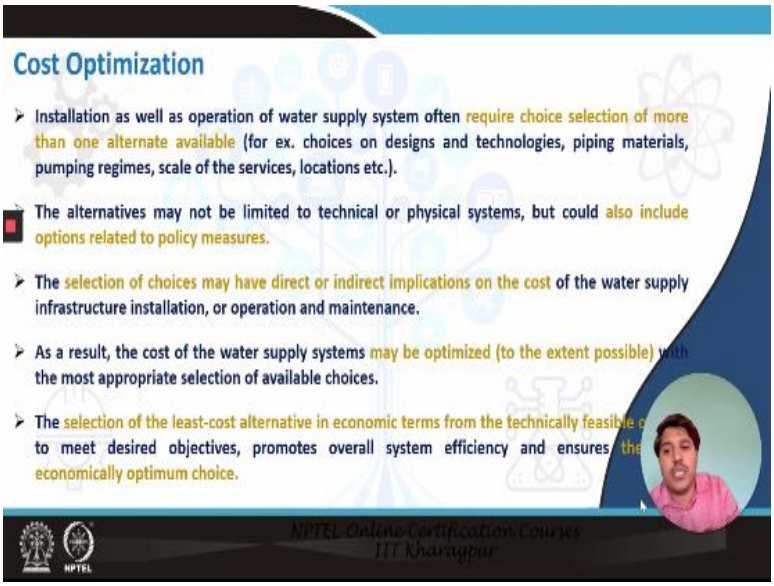

So many, like times it is just taken into this range or it can be taken then can be taken based on the capacity, can be taken based on the percentage of the capital investment. Now, there are various approaches to optimize the cost as well. So particularly for both, so installation as well as operational cost in the system may require selection of the alternative.

So, if there are more than one alternatives available like there could be choices further design and technologies for treatment you want to go for x-unit or y-unit, instead of that there could be choices based on the piping material, whether you want to go for GI pipe or some other material pipe, then there are pumping regimes, scale of services, location you want to install, here you want to install some other place.

So there could be like various choices or options available. These alternatives may not be just limited to technical or physical system but could also include the policy measure. So there could be various options related to the policy measures as well. So selection of these choices may have

direct or indirect implication on the cost of these water supply infrastructure installation operation and maintenance.

So the cost of this water supply system may be optimized with the selection of the most suitable choice particularly in terms of giving the most benefit or least cost. So we can optimize to the extent possible, of course, it is not like the completely minimization of maximization as the standard optimization procedures are rather we like based on available choices. And the choices we must be careful to see that our basic objective is being fulfilled.

So the choices that we are selecting should meet the desired objectives, and then among those choices we can select the least cost alternative in economic terms which are technically feasible and that will give us the economically optimum choice.

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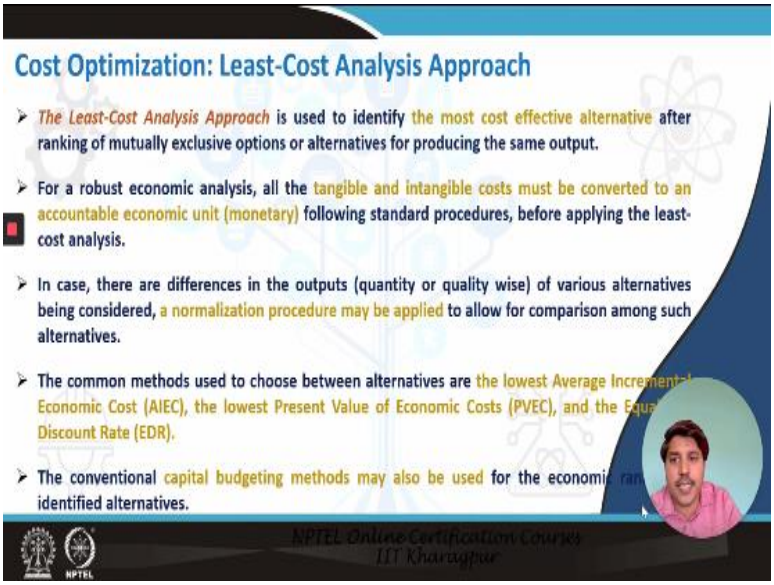

So we can select that kind of choices. The least cost analysis approaches usually identify the most cost effective alternative after ranking the mutually exclusive options. So if let us say we have three mutually exclusive technologies for one particular objective. So we can select out of these three like, we can do the least cost analysis and see which one is going to be the most cost effective giving this similar type of output.

So for robust economic analysis, we have to consider these outputs in a one single term generally

the monetary terms are used. So we need to convert the tangible as well as intangible cost as well as benefits in terms of the say accountable economic unit. And then we can do this least cost analysis. There might be cases when these outputs vary. Let us say we are putting a groundwater pumping system and we are having a surface water pumping system.

Now the output from both could be different one can say from one we are able to produce 500 MLD from another system we are just able to produce 400 MLD. So here the scale of outputs are different so in these cases when the outputs are different and we want to compare the two systems then we can use a normalizing procedure to allow comparison. So like per unit volume of water production, what is going to be the cost from a groundwater pumping system and a surface water intake system.

So then we can normalize based on the volume in that sense. There are various common methods used to choose between these alternatives like the lowest average incremental cost that means for incremental volume of water or incremental amount of services what is going to be that the additional cost average cost and if there are 2, 3 alternatives, so which alternative is going to give us the lowest average incremental cost.

Similarly we have lowest present value of the economic cost or the Equalization discount rate, so all these methods are there which can be used for least cost analysis. The conventional capital budgeting methods also may be used like the one that we were discussing in the earlier class as well. So Profitability Index or benefit cost ratio then IRR or NPV. So, all these capital budgeting methods can also be used to rank the different alternatives.

So if we are having more than one alternative we can rank, which one is going to give us the highest IRR? Which one will have the highest say NPV? Which one will have the better benefit cost ratio? Which one is having the lowest payback period? So, based on that we can rank these alternatives and then select the best out of that.

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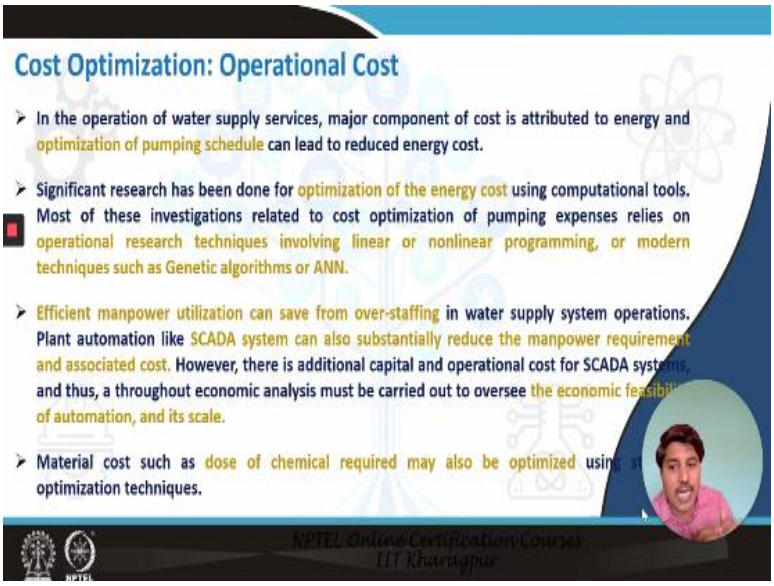

The operational cost can also be optimized so the purpose of optimization of operational cost we need to basically see what are this course where we can put optimization for reducing the operational cost. Now the major operational cost comes from the energy so the optimization of the pumping schedule can lead to reduce the energy cost like there is lot of research going on in optimizing the energy cost.

So various optimization cost optimization method on the pumping which mostly relies on the operational research. So, we will like people are using linear programming, nonlinear programming many are using the modern techniques also such that the genetic algorithms terms or artificial neural networks for these optimization of the pumping schedules or the pumping expenses.

So that way we can reduce the operational cost in terms of the energy cost, the other major component, which is the manpower. So, efficient manpower utilization also is being studied, so if we are able to efficiently utilize the available manpower we can prevent the over-staffing. So that we can save on the manpower costs further there are automation systems like SCADA. So if these systems are installed.

So manpower requirement is reduced to substantial scales, but then again there is a cost associated with the installation and operation of this kind of system. So again, we need a

thorough economic study to see whether the installation of SCADA system is actually saving on the operational cost or not. Then material cost such as dose of chemical required can also be optimized using the standard optimization technique.

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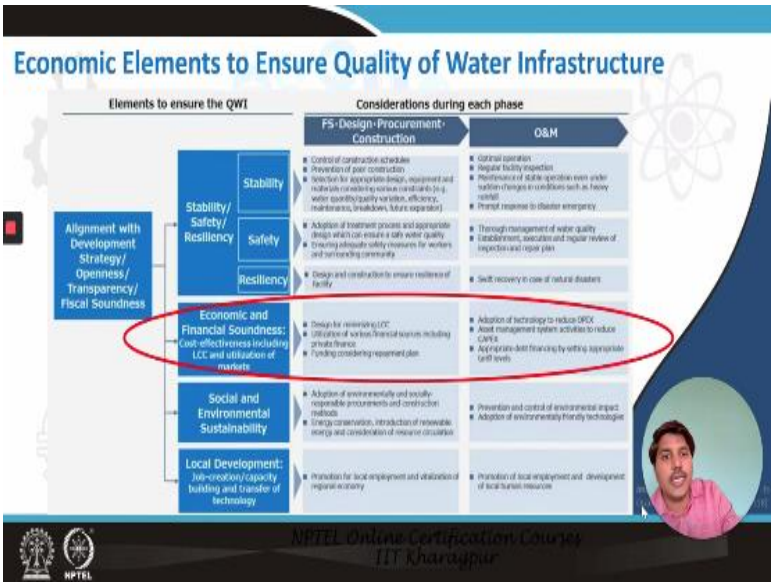

So if we see the economic elements like to ensure the quality of water infrastructure relies on the different elements that includes like a stability, safety, resilient, residency of the system, then social and environmental sustainability, overall local development. But if we see the economy and financial soundness is criteria, so we have to see that which system is the most cost effective. So we need to focus on the cost effectiveness, including the lifecycle cost and the utilization of the markets.

So, this can be basically at the CapEx scale means design procurement and construction scale also. So, basically we focus the design in such a way that we minimize the life cycle costs, overall life cycle costs from the very basic design scale itself, or we can utilize the various other financial sources or services of the financing these systems. So one optimization can be there and at a O AND Mlabel, we can adopt the technology that basically reduces the operation and maintenance cost.

We can see the proper asset management through the operation and maintenance stage. So this will reduce the subsequent stage CapEx or CapManEx. And those are basically ways to ensure

that the quality of the infrastructure is maintained in a better way.

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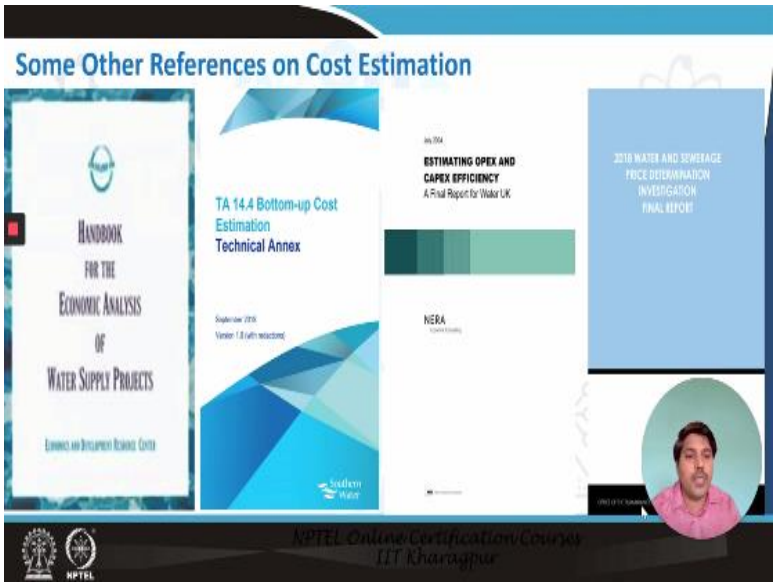

So these are some additional references, which can be used for the cost estimation like one popular is from the Asian development bank on the handbook of economic analysis of water supply, then there are from southern water in Australia there is a bottom of cost estimation approach. So then report is from UK on estimating OpEx and CapEx efficiency. So there are various like national as well as international reports available for more detail on this.

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So with this we conclude this class, we have talked about the distribution of the operation maintenance as well as capital cost of the water supply system. Now in next class, we will start

discussing about the recovery aspects, so how do we price water? How do we kind of plan the revenue recovery by setting up tariff structures? So that will be discussing in the next classes. So thank you for joining, see you in the next class.