Urban Services Planning
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Lecture 06
Service Planning Basics : Part 1

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Welcome back. In Lecture 6, we will talk about Service Planning Basics. And this is the Part 1 of the lecture. And subsequently, we will have other parts.

(Refer Slide Time: 00:37)

So, the different concepts that we will cover are the different service types, urban service provision, the process of urban service provision, then urban service planning and design process. Within that, we will talk about land use forecasting and population forecasting.

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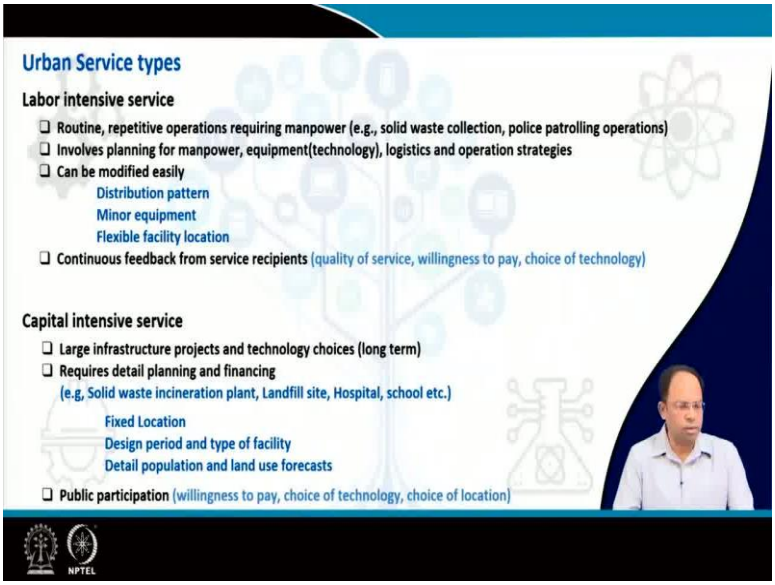

So, earlier we have discussed two types of urban services, labor intensive service and capital intensive service. Now, as you understand, the labor intensive service means mostly we use labor but that does not mean that we do not require equipment or require capital also. So, capital investment is required, but primarily, it is a labor oriented service.

So, of course, if it is a labor oriented service, it is a repetitive operation, which requires manpower that has to be done as per routine or as per a particular schedule, for example, solid waste collection, police patrolling operations, these are done every day by a group of people they have to provide a service as per a particular plan.

So, this requires planning for the manpower requirement, how many people are required to provide that service and manpower requirement is at different levels at different hierarchies, then requirement of equipment or we can say technology that means, what sort of equipment should be required to support the services that has to be provided. Then, the different logistics and operations strategies that are involved in that particular service provision.

For example, if I talk about solid waste collection, how will the door to door collection plan, so, what kind of vehicles we will use, how, from what time to what time the operation will happen, one vehicle will cover how many houses, all these are the different logistics and operation plans that has to be also created along with requirements for manpower and equipments.

So, these kind of plans or this kind of service planning can be modified pretty easily. That means, we can change it after a certain time based on requirements, based on changes in the

distribution pattern. Distribution pattern means changing the way people are distributed or what group of people we are providing the services. Earlier, we may have focused on certain areas of the city because of maybe that is a very growing area like commercial areas or developing commercial area, but later on we can focus on other areas as well.

So, the distribution pattern can be changed gradually over time. Similarly, the equipment that is utilized currently, we can change that equipment to a more modern version of that equipment or to another technology altogether. Then, the location of certain facilities, for example, in case of solid waste, maybe we were having our intermediate collection center at one location in the neighborhood, but in future we can change that location based on other constraints or based on other issues.

So, that means, this kind of plans can be modified at certain intervals. So, in addition to that, there is a continuous feedback from the service recipients. That means, from the people whom you are providing the service. And they can give us feedback on the quality of service that means, how good the service is or they can also tell us that what is their willingness to pay for those services.

Maybe for door to door collection, people may say that what is the amount of money they want to pay, and we can do this surveys regularly at certain intervals after three or five years so that we can update or we can improve increase on that those particular charges. So, similarly choice of technology could be also pointed out by the people.

So, all this feedback is continuously taken and this could be utilized to modify the plan after certain intervals. So, that is why labor intensive service, we can, it is a flexible service and we can keep on modifying it as per requirements. Whereas, in case of capital intensive service, as you understand, it requires a lot of capital. That means these are primarily large infrastructure projects. And when these are large infrastructure projects, it involves certain choices of technologies. So, these are long term choices, so we cannot change them immediately.

So, if the city decides that the city will go for a solid waste incineration plant, then it has to plan according to that. That means the solid waste collection, the processing of that waste that has been collected, how do I transport that waste, where it will be transferred, the entire plan is dependent on the decision that we would go for incineration plant. But if we had decided on something else, maybe the plan would have been totally different.

So, we, and also we cannot change the technology. Like, if I put a lot of money in developing installation plan, I cannot suddenly say that from, after two or three years, after five years, we will go for alternative technology. So, these are some of the issues. That means, we have to plan for this considering a lot of things, we have to consider the detail population and the land use focus for this particular areas, we have to understand the design period for this kind of technology or this kind of facility and we have to also determine the locations as well.

For example, location of a hospital, location of a school, this has to be fixed. And once it is fixed, construction is done that is going to be there for the next 20, 30, or even more number of years. So, that is why it is it requires a different kind of planning input compared to labor intensive services.

So, in this case also in case of very large projects also we go for public participation surveys and all, and here we see that we asked people about the willingness to pay, the choices of technology, choices of location, all these things are also, this kind of feedback taken from the people and based on their feedback, based on their acceptance, we can go on with those particular projects.

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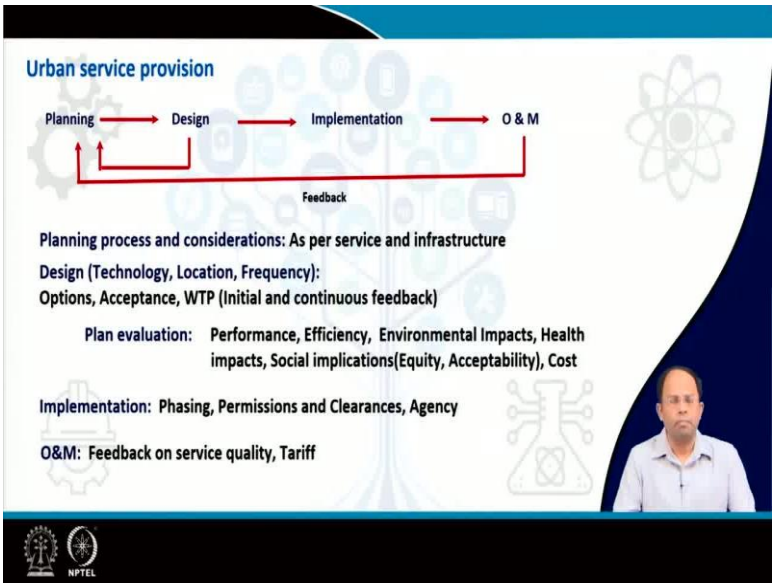

So, if I break the entire process of service, urban service provision, we can say that primarily there is a phase of planning, that means, we decide how we are going to provide the services, for whom we are going to provide the services or then we also have to understand that what kind of service we are providing, for whom we are providing it, and also what sort of infrastructure is involved in that kind of service provision.

For example, if I consider service provision for urban water supply, then we have to lay down the water supply network. So, the infrastructure and also the nature of service will determine our planning processes and consideration. Now, along with planning process and considerations come the design of it. That means, what sort of technology, what sort of location, what sort of frequency, suppose it is solid waste collection, then frequency of waste collection, all these different decisions about the design of that particular service has to be also taken.

Now, this planning process and the designing process are, more or less they go together or you can say that we can interchangeably use those two terms as well. And overall, we have to understand that what are the different options there in front of us, what are the technological options, what are the location options and so on. And then we have to determine is this accepted by the people? That means is this solution given for this particular problem, is it acceptable for the people. Then we have to take that initial as well as continuous feedback in terms of what we are willing to pay for the services and so on.

So, this is what the planning and design process is. And as you can understand, because when we are doing design, we can evaluate multiple alternatives. In that case, the design process and the planning process, there is a feedback loop from the design to the planning process, and this is done in a cyclic order, so that eventually we come out with certain feasible options.

Now, once the plan is more or less finalized, or the plan and design is finalized, we evaluate it based on its performance, how efficient it is, and then we go into the different impacts of this particular plan. For example, environmental impacts, health impacts, social impacts, and we can say that within social impacts, we look for equity, acceptability and so on. That means, is it equally considering all the people, is it equally considering all the geographic locations or is it acceptable by all groups and so on. And finally, the cost of provide providing that kind of a service.

So, this plant evaluation process involves the environmental impact assessment to certain extent, health impact assessment, social impact assessment, all these things along with the performance and efficiency of the plant is considered and then based on the evaluation process, we can finalize on certain options that is feasible for this particular geographic area.

Now, once that option is finalized, then we go for actual implementation. So, during implementation, we considered the phasing of the plan. That means, are we going to do the entire service provision at one go or we will phase it? That means, we will do certain areas first and then other areas later, or we do certain aspects of the service can be provided at the beginning and then gradually we can provide other aspects and so on. So in that order, we have to determine about phasing.

Then, we have to get the permission and clearances from multiple agencies who are supposed to give clearance. For example, for environmental clearance, we have to take, prepare environmental impact assessment report and take it to the relevant agencies for clearances. And also, which are the agencies or operators will be actually doing the implementation of this particular plan, that also has to be considered.

So, this is the implementation stage of the plan. And once basic implementation is done, then we have to continuously monitor that how this implement, how this plan actually works. So, we have to do this, the operation and maintenance part of the plan also is a very, very important part, and of this particular service is a very, very important part. And we take feedback on the service quality, we decide on the tariff of the service, how much we can charge for the service.

And all this feedback actually goes back into the planning process. And in certain cases, we can improve or fine tune the planning or the design of the process, so, that we can arrive at a better solution. So, in case of large service infrastructure, large infrastructure projects or capital intensive infrastructure projects, this feedback, even though it comes, there may be very limited options to change the actual option, but certain aspects could be changed, but in case of capital labor intensive projects, this feedback can immediately taken up and they can be used for implementing changes in the system design or the service design.

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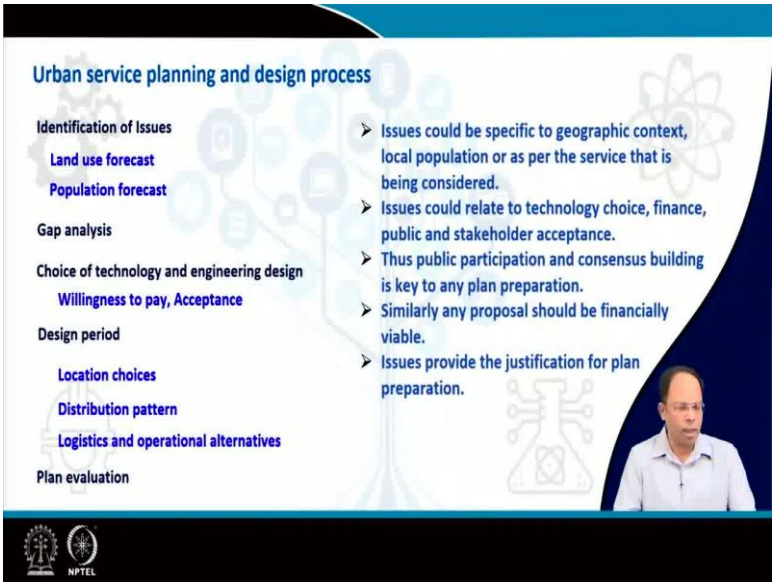

Then, coming to the details of the service planning and design process, particularly for urban municipal services, the first step is to identify the different issues. Now, identification of issues means, that means, as per that particular geographic context or that area, as per the local population or as per the service that is being provided, there could be multiple issues that has to be addressed.

So, some area may be low lying, so there is always water logging in that area. So, people may have certain issues regarding that. Or some areas has got a landfill site nearby. So, always, there is smell coming from that landfill site, or there is a lot of dust coming from there. So, maybe we have to do certain things about that. So, these are the different issues which are local to a certain area or it could be also as per the service that is being provided.

Then, issues could relate to, if I generalize, issues could relate to technology choice, finance, the amount of money that is required to do that particular service or provide that particular service, then public and stakeholder acceptance. So, these are the broad areas where the issues can be related to. And as you can see that public and stakeholder acceptance is a big deal and that is required for consensus building for any kind of plans and particularly this kind of service provision.

And similarly, the project has to be financially viable. That means, if we do not have finances, then we cannot even do start or launch the product or launch that particular service. So, financial viability or preparing a proper financial plan is very, very important. And issues provided, and this listing of issues actually provide the justification for preparation of the

plan in the first place. So, that is the reason we have to first identify the issues for which we have to provide a particular urban service. And once we have done that, then we have to go and do detailed land use forecasting for that area and the population forecasting.

Now, why these are important? Because this gives us directions of growth, they tell us that how the city is going to grow and for whom we are providing the service. If I do not know for whom or from where I am providing the service, it is difficult to even start the planning process. And after that, the next step is to go for gap analysis. That means to determine what should be provided and how much of service should be provided, is the service already there or not? All these things will play a role.

Then the choice of technology and the engineering designs. So, this gap analysis, choice of technology and engineering design, that can go simultaneously also. And when we determine that what should be the final option, then willingness to pay, acceptance, these kind of things are studied. And along with that, we also determined the design period as we just discussed in the last slide.

And within this planning process, three things, logistics, distribution pattern, and the location choices, these three are three important decisions that has to be taken particularly for provision of certain services or provide provision of certain facilities in certain areas or providing certain infrastructure in certain areas. So, once all these things are done, then comes the plant evaluation process where we go for environmental impact assessment or social impact assessment or health impact assessment, these kind of studies.

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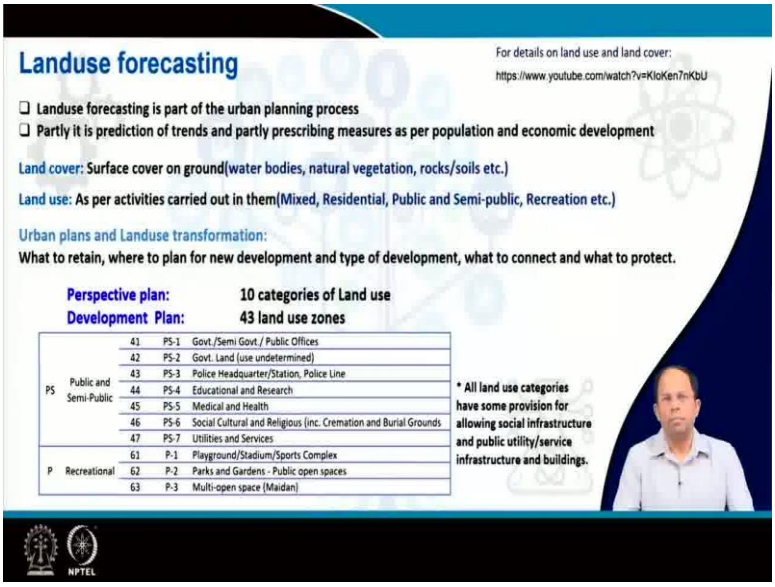

Now, going into the land use forecasting process, so like even though this is not the focus of this particular course, but land use forecasting is a part of the overall urban planning process and it involves two parts. One is to predict the trends that is based on what the area is right now, how it is going to grow.

For example, if I look into two aspects, there is land cover and there is land use. Land cover means the surface cover on the earth, on the ground, you can say and it involves that where are the water bodies, the natural vegetations, developed areas where, what kind of rocks and soils are there and so on.

So, this how this land cover is gradually changing. So, based on how it is changing over the previous years, I can predict that these are the areas where there will be certain kinds of changes. Same goes for the land use as well. That means, as per the activities carried out in them, that is mixed use, residential use, public and semi public use, recreational use, I can predict that how that area is going to change over time based on correct, that emerging trends.

Now, this trend is, why this trend is important, because sometimes urban planners do designate that these are the areas for certain land uses, but at the end of the day, it is a person's choice to build something over there. So, if I provide an area for residential use, but nobody wants to buy a house over there or build houses over there. In that case, that area will remain empty.

So, urban planners will do that in the next iteration of the plan, they will update their land use and they will probably shift the land use of that particular area into something else. So that means it is it is a decision by urban planners based on certain criteria, but at the end of the day, it is a choice by the people to actually conduct their business or to stay in that particular area.

So, both trend analysis is important as well as the prescription part, that is, urban planners say that okay, this area is suitable for this purpose or they say that these are the areas which are most likely to have this kind of development. Accordingly, they will determine the land use plan for that area. So, both is important in this planning process. And it is interdependent on one another.

So, one helps to guide the development process and the other is the outcome of that plan that has been prepared and that actually influences the next stage of the guiding of this particular plan that is being prepared for this area. So, urban plans and land use is transformed over time. So, when urban planners decide that what should be the land use plan for the next thirty years or they prepare a development plan for that area, they have to decide on what should be retained.

That means, which are the land uses that has been provided earlier should be retained them as same land uses, that is, we are seeing that growth is happening, maybe it is not complete, but some areas are still empty and all, so we will continue to retain that. Or we can change certain areas. Like for example, earlier it was some sort of undeveloped land and all but now we can convert it based on certain new projects or certain new investment that is coming in. We can say that some of those areas could be converted into some other land uses.

Then, where to plan for new development and suppose new development is coming. So, we estimate that based on population growth, we can say that on economic development, we can say that we require more area for certain kinds of land uses. So, we have to propose where this new area should come and where to plan for new development and what type of development it is.

And like for example, if I propose areas for residences, I have to also propose areas for public and semi-public uses, which would be supporting those particular residences. For example, I have to create location for a substation, I have to create location for a water supply tank. So, this has to be decided and then we have to decide on what things needs to be brought

together, which land is meant to be brought together, which land uses needs to be retained, protected, so like there is a urban plantation area, we need to protect that so that it is not encroached upon, or there is a wetlands. So, we need to protect that. So, in that, so, that is the, these are the decisions that the other planners usually take or they incorporate these decisions when they prepared the different plans. And as you know that we can have perspective plans, development plan, we have discussed that in our earlier lecture.

And in perspective plan, usually we limit ourselves to broadly 10 categories of land use as per URDPFI guidelines. Whereas in the development plan, we can go for 43 land uses. And within that there is residential, commercial and then there are subcategories of residential. So, in case of urban services planning, two land uses are very, very important. One is, land use categories are very, very important. One is this public and semi-public use and the other is recreational use.

So within public and semi-public use, we usually consider space for public offices. Then government clients, police headquarters, educational and research institutes, medical and health institute, socio-cultural and religious facilities and utilities and services. So this are the different, we have to reserve zones based on this particular uses. And we have to designate which are the areas in the development plan or in a particular area, which are the plots where we have to retain this kind of, we have to provide these kind of land uses.

Similarly, for recreational, we have to decide on location of playground, location of parks and gardens and so on. Now, even though these are the two distinct land uses which influences service planning, but in general, all land use categories have some provision for allowing social infrastructure and public utility service infrastructure and buildings. For example, in residential area, you are also allowed to develop certain kinds of social infrastructure such as kindergartens and other things or similarly, some space for utilities and services and so on.

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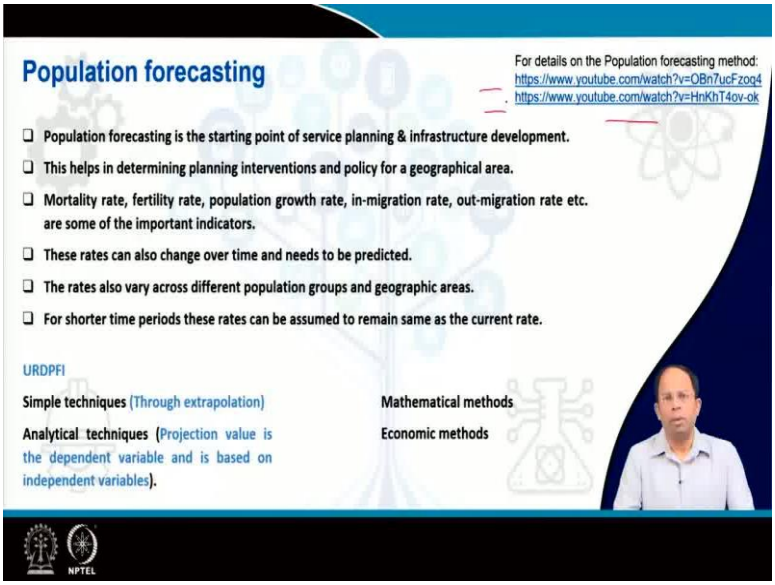

Now, coming to population forecasting, so, once the land use forecasting is done, which is again based on population forecasts, and the way the previous growth has happened, and also the decision of the planners, then comes the actual population forecasting process. Now, again, if you want to learn in detail about the different methods that is employed for population focusing, you can take a look into this two YouTube lectures, which are, which I have prepared earlier in my, one of my earlier NPTL courses. So, I have given the address, you can take a look at that. But broadly, I will cover the different techniques or methods that are usually employed.

So, as you understand, population forecasting is the starting point of service planning and infrastructure development. So, it helps in determining planning interventions and policy for a geographical area. So, it is the starting part. If I do not know how many people are staying in an area, I cannot do any kind of plan. So, few parameters are very, very important or you because if you indicate as a very, very important. These is our mortality rate, fertility rate, population growth rate, in-migration rate, out-migration rate and so on. So, these are the parameters. If I know these parameters, then I can predict the population of a particular area.

So, mortality rate is the rate of death. That means, for different age groups or for different population groups or for the overall city itself, what is the rate of, how many people die per 1000 people a population per year. So, that is the mortality rate. Similarly, we have got fertility rate, how many people are born to different age groups of women, and then population, overall population growth rate for the city. In-migration rate, how many people are coming into the city every year, out-migration rate, how many people are going out of the

city per 1000 population, of course. So, these are the rates, if I know, then I can predict the future population of a particular area.

Now, these rates can also change. That means, not only these rates helps in predicting the future population, but that rates can also change over time. For example, the fertility rate, the fertility rate in India is gradually coming down. So, the rates also change over time and that also needs to be predicted. So, how is this prediction done? As you know that a certain parameter or a certain indicator like fertility rate depends on many things. It depends on the economic level, the income level of the people, it depends on the household size, it depends on many, many parameters influences the fertility rate of a country.

For example, if both, the husband and wife both are working, automatically the fertility rate will come down. So, all these issues actually play a role in determining fertility rate. And so, these rates also needs to be predicted and we can use regression models to do based on this extraordinary variables, which influences this particular aspect, we can predict that what is going to be the fertility rate in the near future. And same goes for the other parameters.

So, these rates also vary as per different population groups. Of course, fertility rate for different income, age groups of women is not the same. So, of course, women in the age group of 18 to 30 is probably more fertile compared to age group up 40 to 50. So, these are the things that also can be considered, or that mortality rate of certain groups would be much higher. For example, in case of lower income groups, probably the mortality rate is also higher.

So, similarly, it may vary as per geographic areas. Based on the geography of that area or the climate of the area, the mortality rate could be, or the growth, or the overall population growth rate may vary. And similarly, we, but in normal estimates and all we can assume that for shorter time periods like 5, 10 years, these rates are more or less remain stagnant. That means, this rates will not change. So, using these fixed rates, which are there, we can actually assume that these rates will remain same and using those rates we can predict the overall population growth of a particular area.

Now, there are different approaches to do population forecasting and then there are different techniques also. The first approach is of course, simple techniques such as extrapolation like we take the current rate and we can predict for the future rate, whereas the, we can take the same rate as well, whereas, there are analytical techniques where production value is the

dependent variable and is based on many independent variables, which influences that particular outcome. So, both approaches could be there. So, one could be a regression based approach, other could be some sort of extrapolation based approach. Then there are mathematical models and economic models.

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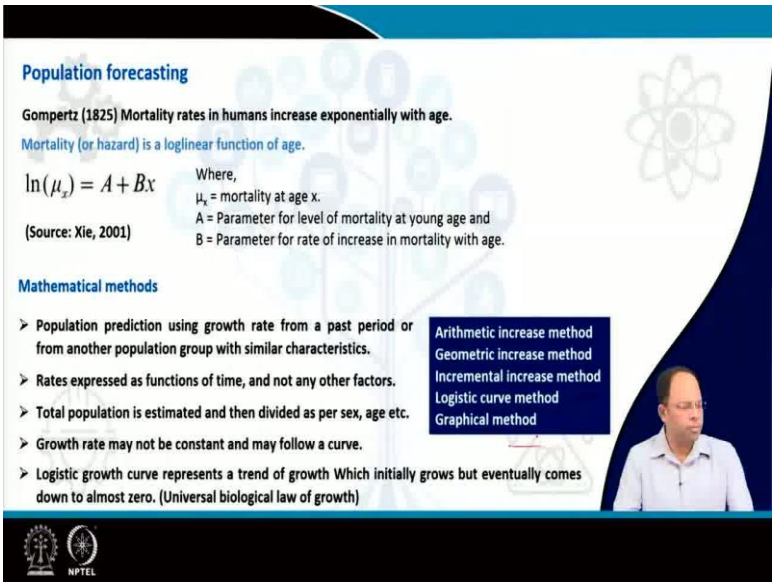

Now, the first example that we give is, like here, you see that Gompertz, he predicted the mortality rate in humans and he said that it increases exponentially with age. What he says is with different age groups, the mortality rate changes. For example, when you are older, you are more likely to die, the rate of mortality is much higher compared to a younger population.

So, you can see that he, what he suggested is mortality or hazard is a loglinear function of age, where you can see that mu x is mortality at age x, and A and B are two parameters which are given, which is A is the parameter for level of mortality for a person of young age and B is the parameter for rate of increase in mortality with age, and when we multiply it with the, at particular age group, then we can get that value of the final mortality for this particular, this, the group for which we are predicting.

So, this is how you can see that the rates also actually change. Now, when we go for other methods like extrapolation methods, one of the, if I go for extrapolation methods, that means, we do not say the rates are going to change, we will use fixed rates. Then there are certain techniques, which we can ask you to predict the population. So, there are mathematical model methods and then there are economic methods.

In mathematical methods, the, what we do is we predict the population using a growth rate from the past period, or it could be from another population group with similar characteristics. That means, we use the rate from the previous decade to predict the growth for the next decade. Or we can take the rate for another geographic area, which is almost similar, and we can use that same rate for this particular geographic area. Rate means the rate of growth of population for that particular area.

Now, rates are expressed as a function of time and not on any other factors. That means, only with time, the rates may, we multiply rates with the time, we get the final population. Other factors are not considered. And total population is estimated. And then we can divide it as per age and sex based on surveys and all, or we can sometimes also predict this population growth for different age groups and then we can add that up and then also we can predict. But in mathematical methods, usually we do overall prediction.

Then growth rates may not be constant and may follow up particular curve. That means, the rate of growth, we may assume it to remain same, but we can use some methods where we can, based on the trends, earlier trends, we can take some calls on how this rate is going to change. But this will be fixed rates of change.

And then sometimes we can go for a logistic growth curve method which represents a trend of growth where, which initially grows, but eventually comes down to almost zero. That means, initially the growth starts, then it becomes very fast and then eventually, it becomes very slow. That means, any population once, it matures, the growth rate will come down.

So, this is also known as a biological, this follows the Universal Biological Law of Growth. So, if I list down the methods, these are arithmetic increase method, geometric increase method, incremental increase method, we will discuss that, then the logistic curve method, that is the last one, and the graphical method. In graphical method, what we do is, if we plot the population for the last few decades, we can see the trend. And based on our judgment, we can take a call on what is going to be the change in the near, in the next decade. So, that is the graphical method.

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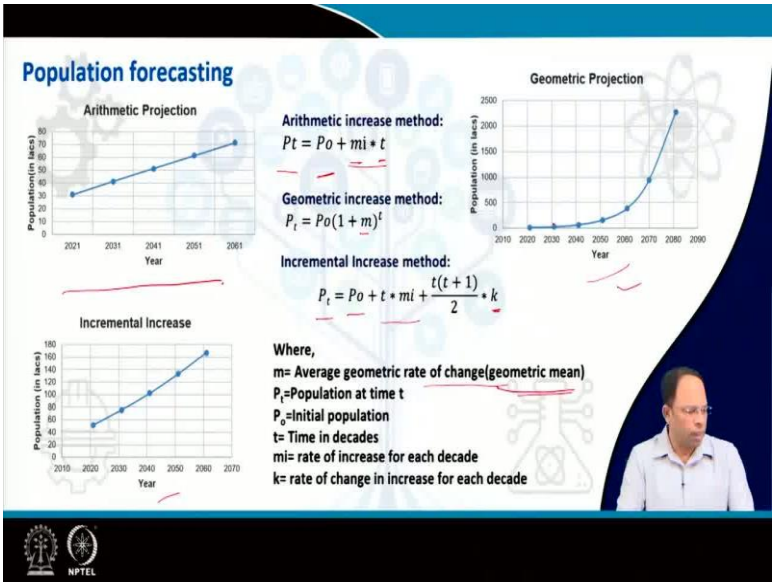

So, if you can see this particular, in this slide, we have shown you examples of the three arithmetic methods. And the first method is the arithmetic increase method. And you can see the curve, also here. So it is a straight line. So, we can predict the P t, that is population at time t. If I know the population at time 0, that is, the initial population, and also the rate, that is, m i is the rate of increase for each decade.

So we take the rate of increase of previous decade. If we know the rate of increase of the last two decades, we can take the values, average it out and then get the rate as well. And we multiply with the number of time periods for which we are going to predict. And accordingly, we can get the population for that particular decade or that particular period. So, this is the arithmetic increase method. As you can see, it is a straight line, it is a straightforward way of projecting the population, which, it shows that everything remains the same, how the city is going to grow.

Now, in case of cities where we see that the growth is, the city is growing very, very fast, that means the rate is changing every decade and all, instead of using arithmetic increase method we can go for a geometric increase. That means we considered this increasing rate of change in, while we do the prediction. So, that means instead of taking the rate as a constant increase rate, we take it as that it is an average geometric rate of change for this particular area. Now, it is, we take the geometric mean of the rates of the earlier decades.

So if I have got rates of growth for the earlier two decades, I will multiply those two and then take a square root of that two decades. If it is for three decades, then I will multiply these

three decades and then take a cube root of that. So, that is the geometric mean. And we use that rate to predict the future growth, and we put that in this equation where P t is equal to P 0 which is the initial population, multiplied by 1 plus m to the power t. t is the number of time periods for which we are going to predict.

So, as you can see, that there is a steep increase in this particular curve and cities which are growing very fast, we can probably go for this kind of a method. Now, if I say that well arithmetic projection, geometric projection, both are at two extreme edges, so we can take something which takes feedback from both. That means, we take, we increase this gradual, or that constant rate of change. That component we include in the prediction process and also this incremental change is also considered.

So, in incremental increase method, you see that P t, which is population at time t, depends on P 0. And then the first part t into m 1, this is the arithmetic increase parth, that is, this is standard m i is the rate of increase for each decade, the standard increase rate, and we multiply by t. Then what we do is for the incremental part, what we do is for the increase in population in each decade, that we take that increment part, we multiply that into t into t plus 1 divided by 2. This is done because for different number of decades that we are utilizing, we considered that many increments.

So, this incremental part is also added into the process. So, you see that this curve is somewhere in between the arithmetic projection as well as the geometric projection. So, this is a more moderate way of predicting the population. So, these are the three very, very popular methods any you can use any one or you can select the one which you feel based on the trend of that particular city, based on the previous population of the city, you can take a call on which one to use.

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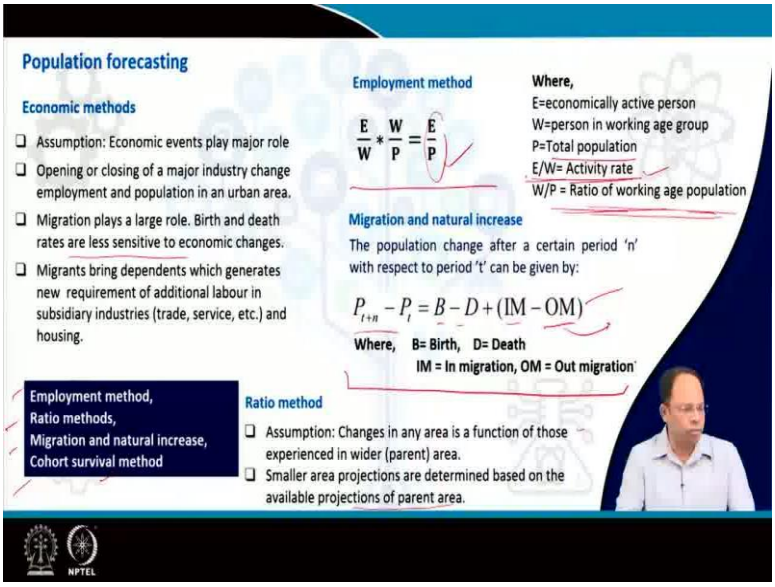

But in any case, the arithmetic methods are very crude to a certain extent, because we assume that overall, the city will grow, everything else will remain same. So in that way, but a city changes. The way, the life in city changes. That means, a city get, sometimes a city gets a new investment. Suddenly, based on government policies, we can decide that some new, a city decided that they will provide a lot of incentives for IT companies to come and set up shop in that city.

So, definitely a lot of new, they will do certain take some measures, they said make some changes in policy, which will enable IT companies to come to the city. So, once IT companies come, they will require a lot of people to work in those particular city, in those particular companies. So, when this, so where will these people come from? Some people will come definitely from the local population, but most of it will come from outside. So there will be a lot of migration, in-migration.

Now, once in-migration happens, then these people are also coming with their families, they, and when people are coming with families, that means the population increases. And when these people will also require other services, subsidiary and that means that when new industries, new service industries are being started, like for example, markets or certain kinds of services has to be provided, certain trains has to be provided, so, it will again encourage further in-migration, and again subsequently in-migration will bring in more families and the process goes on.

So, in economic methods, this is what is being considered. That means, we assume that economic events play a major role and opening or closing of a major industry changes employment and population in an urban area. And of course, that leads to migration, because birth and death rates are very, very less sensitive to economic changes. That means, more or less, the birth and death, it changes, but it does not change very often. It changes very, the rate of change is very slow.

So, migrate, that means immediately migration is affected, but birth and rate is not that affected. And migrants also bring in dependents. So, which generate new requirement of additional labor and so on. So, that is what economic method is all about. So, these consideration has to be taken. And there are a few methods under this. One is the employment method, which is a very basic method. The ratio method, migration and natural increase method and the cohort survival method.

Now, the employment methods, there are three parts to it. We say that when employment rate of a particular area changes, it will also change the population of that particular area. Two ratios are taken, one is the activity rate E by W, where E is economically active person and W is the person in active, in the working age group. And the other ratio is ratio of working age population, which means, W is person in working age and P is the total population.

So, when these are the two things which we can, which changes. That means, activity rate of a particular city may change. That is, with coming of new industries, new policies, the activity rate will change. And similarly, the ratio of working age population sometimes changes. Why? Because when in-migration happens, that it may be bringing a lot of people with single member families. So, that may change the ratio of working age population or people who are migrating is of a certain age. So, it changes the ratio of working age population. So, in any case, it also changes for other reasons as well.

So, if I can predict these two, then base, if I multiply this E W into W by P, automatically, we will get E by P. So, E by P is economically active percent divided by total population. So, this total population, if I can predict these two, definitely I can predict the future population of a particular area. So, this is how this employment method works. And then, there is the migration and natural increase method.

It is a very straightforward method that means, the population change after a certain period n with respect to period t, and it is given by B minus D, the number of births that happen minus

the number of deaths that happened in that particular time period plus the number of in-migration, number of people who have in-migrated, the number of people who have out-migrated.

Now, some students may go for different, to different cities for studying or some people may go for a job in different cities. So, that is out-migration. So, if I have these figures for the city for that particular time period, we can predict what is the change in population between these two time periods. So, the other method is the ratio method, where we assume that changes in any area is a function of those experienced in a wider parent area.

That means, if I am trying to predict for a small city, I will, I can look into the overall surroundings of that larger, the surrounding municipalities or municipal areas or maybe even the district and see how changes are happening over there. And based on those rates, we can apply those rates also in the smaller area or smaller area projections are determined based on available projections or parent area. So, if I know the projections for parent area, those could be also brought in for the smaller area. So, that is the ratio method.

Now, finally, we go into the cohort survival method, which is actually a, you can say an extension of the migration and natural increase method, but here, what we do is instead of looking into the overall city, we go for each age group of the city and also each age and gender of the city. Why? I will come to that.

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So, future population is predicted based on the survival of the existing population and new births. Now, survival of the existing population and new birth, if I divide the entire city into

different age groups, and as we have discussed earlier, the mortality rate of each age group is different. Similarly, the mortality rate of each gender group is also different. Similarly, the birth rate or the fertility rate is only a function of the group which is the female population. So, in that case, we can see that how the mortality, the fertility rate also changes as per the different female age groups.

So, in that way, if I know these figures for each cohort, that means we divide the entire population into different cohorts, or age groups and for each group, if I know these values, I can predict what changes will happen in a time period. Say, that time period is one year or even five years. So typically, it involves a five year steps.

We can even do it for one year. So, within that one year period whatever changes happen in terms of fertility, mortality, migration and so on, this may vary, this varies for each cohort, but if I know these particular values, I can multiply that with the number of people in each of those cohorts and we can get that how many people are born in during that five year period, how many people are died during that period.

And accordingly what happens, in the next time period, I will add those people in the age group where they belong. What it means is, the people who are born they come to the lowest age group, that is, 0 to 5. Whereas the people who just have died, the remaining people will move on to the next age group, which is suppose somewhere, we are talking about 35 to 39. So, after five year period, after taking out the number of people who have died, the remaining people will move on to 40 to 44 age group.

So, that is how the operation is continued for a time period and we can predict the population after, for a certain time period. So, projected populations of t plus 1th year becomes input for the calculation of t plus 2th year and so on. So, this continuously is done, and as you can see in this particular figure, you can see the existing male population and the projected male population for a particular time period and the existing female population and the projected female population is also given on this side.

Now, the beauty of this way of doing the analysis is each age group has got different rates of fertility, mortality and so on. That is reflected. So, the prediction is much, much more accurate. Similarly, for each age group, we can do migration. Migration, also, the people who are involved, who are coming to the city, they may belong to certain age groups, not for all

age groups and so on. What families they are bringing in, that also belongs to certain age that also, that also, that is being considered.

The other is, we can see the trend of the change in the structure of the cohorts. For example, in this particular image, you can see the young population is decreasing. So, what does, what implications does it have? That means that the services for, or facilities such as schools, we will not require so many schools in the future years. So, what will happen with those, that infrastructure.

Or people in age group 15 and above are increasing, maybe the older people are going to use, increase. So, in that case, we have to provide more services for the older population. So, these kind of decisions are facilitated, if I go, if I do this kind of cohort survival method or if you use the cohort survival method or this kind of analysis. So, this is how more or less population forecasting is done.

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So, these are some of the references you can use.

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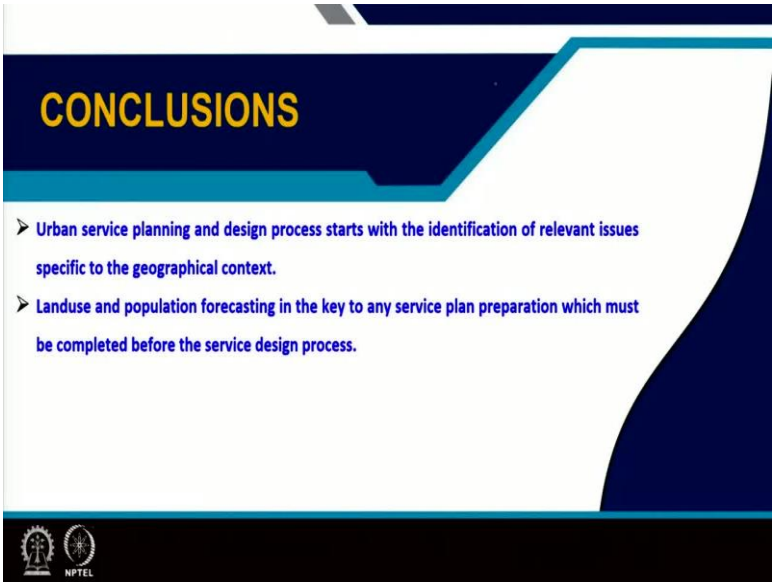

And to conclude, urban service planning and design process starts with the identification of relevant issues specific to the geographical context. And landuse in population forecasting in that, is key to any service plan preparation, which must be completed before the service design process. Thank you.