Urban Transportation Systems Planning
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Lecture - 51
Land Use and Transportation –I

Welcome to module G, Lecture 1. In this module we shall discuss about land use and transportation.

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As we are using the terminology land use let us first understand what is land use? Land use can be defined as a series of operations on land, which are carried out by humans, we carry out these operations with the intention to obtain products and or benefits through using land resource. That means there is land resource, which is available. How we are using this land for various purposes either to obtain product or to derive some benefits out of it.

That is the basis for defining the land use. Now when you say land use there is often a another terminology, which is called land cover. So, you should also know what is and try to understand clearly what is really land cover. Land cover can be defined as vegetation it may be natural vegetation or it may be the plant vegetation as well or man-made construction. So, for example, building and other kinds of infrastructure which occur on this earth surface.

So, the whole earth surface is available how we are utilizing this whole earth surface there are you know water, ice, vegetation and man-made constructions all will be there. So, that is what we say that it includes water, ice, bare rock, sand and similar surfaces also count as land cover. So, that means the complete land, which is available or earth surface that is available and that the earth surface, what are the different types of cover that are there for this earth surface.

That covered may be part of it may be water something may be ice somewhere rock, sand some may be vegetation natural or planted or some may be some man made construction for buildings bridges and other things. So, all these are under land cover. So, we must understand the difference between land use and land cover very correctly.

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Land use we can also say refers to the purpose the land serves. The purpose and the nature is very different. So, what is the purpose? So, purpose wise, we are trying to see the land use or different activities which are carried out in them may be residential, commercial, recreational purpose. And remember that this residential, commercial, recreational all these actually, you know will dictate whether and how much trip will get generated in terms of either production or its attraction.

So, land use is the final one that detects the trip or that provides a linkage to the trip generation.

A recreational land use could come from various types of land cover. The purpose wise it is recreational. So, it may be a forest it may be a shrubland it may be a grassland or on a manicured lawn. So, the land cover wise various kinds of land cover could be still used for a single kind of you know, land use.

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Similarly land cover refers to the surface cover on the ground, whether vegetation whether urban infrastructure, water, bare soils and others. It does not describe what is the use of land and the use of land may be different for lands with the same cover time. So, land cover one land cover may be used for different purposes. So, the land use may be different and the same land use may come from different land cover both are possible.

Now in this case, we tell you for an example a land cover of forest that is the land cover, but it may you be used for different purposes. So, for example, we can use it for timber production we can use it for wildlife management we can also use it for recreational purpose. So, the same land cover may be used for different land uses. And previously we have shown that a single land use may also come from different land covers.

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In short if you have to say we say the land use indicates how people are using the land. Given the available land resource how we are utilizing the land for various activities or for deriving benefit for the society or for the livelihood. Whereas land cover indicates the what is the physical land type. So, from satellite imagery and aerial photograph we can easily understand the land cover, but in order to infer about the land use we often require more knowledge about the study region.

Even in the same way we will say it may say that it is a building, but it cannot say so it is a man-made structure, building is there. But it cannot say whether the building is really, you know for residential use or whether the building is for industrial use or for having a shopping mall it is a shopping mall is operating in that building. So, the type of land use will decide whether that kind of land use is going to produce trip.

Or going to attract trip or even, you know the nature of use even within you know, shopping means what kind of shopping residential use means what kind of residential use. That will dictate so we need even more information there in order to link this land use with the trip generation.

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So, understanding both land use and land cover and their transformation over time transformation over time, transformation is happening continuously throughout the civilization transformation is happening people are you know, the land coverage changing if you see a big concern is the forest area the is changing very fast. And we are using that a lot of places the forest area is being used for human development purpose.

So called human development purpose for building housing for community establishment and all other things. So, the land cover and the land use is also a changing appropriately. You see this some area which was at a time maybe purely residential area slowly after 10 years 20 years you find that the whole area has been transformed. And it is has basically becoming a big market area which most of the houses the ground floor or and the front edge portion is basically the shops.

So, the transformation happens continuously both for land cover and land use. So, it is very very important to understand that how this transformation is happening over time in urban planning, since the provided history and background of the urban growth process. And these understanding obviously helps urban planner to decide what to return where to plan new development what kind of development or the type of development that should be planned, what to connect and what to protect.

Maybe there is water body which needs to be protected all the water bodies. So, this change in

the land use not only the present land use and land cover and land use but also how the transformation has taken place that is very important. Because that tells us that in which direction we should go. So, mainly that where the new development we should place what kind of development we should have, you know what collections we should make and what to preserve and all such kind of decisions need to be taken.

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Now, we said that clearly what is land use and land cover initially and then what is land use. Then why we need land use planning? Land use planning is necessary and you if you remember this present course is on urban transportation systems planning. So, we are basically focusing in this course on transportation planning not so much directly on the land use transport planning or which I will also discuss little bit about the land use transport interaction.

So, the focus is basically transport planning. So, land use planning actually is required because it helps us to predict the spatial organization of population, how the population will get distributed in different zones in a study area or in a region and economic activity as well. So, how the population is going to get distributed and how the economic activities are going to get distributed.

That will come from the land use planning. And you understand that is what we require as our basic input to start the four-stage transportation planning process. Trip generation starts with

these inputs and these activities are converted into number of trips and then subsequently, you know, all other stages we cover distribution mode choice, route assignment etcetera. So, land use models serve to distinct purposes if we say, number one first of all forecasting of total activities in an area.

How the total activities are going to look like over a period of time? So, you remember that we do the transportation planning in the base here where we develop all these models and we apply it for the future which is called horizon year. So, forecasting total activities in that urban area, and then allocating these activities among a predetermined set. So, forecasting the total activities and then allocating these activities both are very very important.

And you can easily link it with the transportation planning process. And that is what is really our interest why we want to talk about the land use as a part of this course and little bit also try to understand the land use transport interaction. Now land use planning for a city is definitely a complex task and need to be done very carefully, one major reason is that we have to keep in mind that changes in the land use patterns are generally irreversible.

So, you have a vacant land what you want to do and how we want to develop that land or use that land. But once you know, you start doing something changing the land use pattern at a later date is not so easy. It does not mean the land use pattern does not change land use pattern changes, but changes naturally, you know because of the demand and it changes in one direction, I mean the value of land increases over time in the CVD area.

So, the transformation takes place, the facilities gets developed there, so it changes. That does not mean that it does not change. But it is much more difficult to change the land use pattern. Because of generally irreversible. So, before we plan and rather, I would say that it may be much more complex to change the pattern a related it. So, it is better that when we planned the thing we should plan meticulously carefully and considering all the related aspects.

The kind of direction the one the development to happen, a city you decide the land use in the beginning and then that will drive the development. So, if there is a specific direction if you do

not do it automatically, you know, as it is there or in some direction it will take. And the literal on we will refer that will probably realize that it was not a proper planning in terms of the land use.

And in fact, let me tell you many of the urban transportation problem the traffic problems so, called if you see the root cause of this problem if you try to see you will reach to the land use. May be if you have done the land use planning in a slightly different way the transportation impact could have been entirely different. So, root cause of many of the transportation problem is actually the land use, rather I will say that not proper land use planning.

And which we cannot correct so easily, because you know that it is very difficult to revert back or do something or some significant change in the land use. Often that is not possible. So, you have to bear with it and we try to then see that we cannot change the land use but then what else we can do to elevate the traffic problem.

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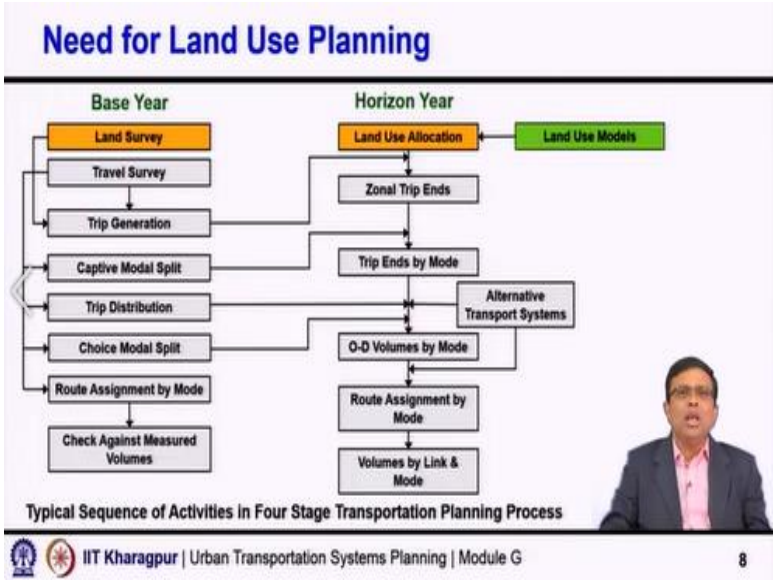

Now I will just you are familiar with this flowchart, which we use the typical sequence of activities in four-stage transportation planning process where we talked about development the model in the base year with four stages to generation distribution mode choice traffic assignment. And applying that model the calibrated validated model in the horizon year for forecasting purpose.

So, here you can see both the base year and the horizon year the activity starts with the land use. The base year we know the existing land use and based on that the land use so we know the travel so we start with trip generation model and where values is really the basic input. So, I can say that whole transport planning process when we are building the model in the base year, it starts with the basic input that land survey or land use.

Even in the horizon year, it starts with land use allocation. We use the word allocation because that is the forecast, that is what you expect for the planners or what the plant, you know development for the city or for the study region. So, the land use allocation has to come that. And for this land use a location the land use planning or land use model are very important. Because the outcome of the land use models are actually used as input for this forecasting process if you want to use four stage transportation planning.

So, all what we have studied up to this previous module, you know the inputs to this whole process is through the land use model. So, land use model gives us the land use allocation and from that point onwards the traffic models are there, but in a way there we are saying the land use model is somewhere and the traffic model is somewhere. So, land use model is done output of the land use model is fed to the as input to the transport model.

But are the really independent? The answer is no. This what we deal with and any modelling exercise any work we will have certain kind of approximation. So, not everything will be absolutely correct, it is approximation, modelling also is approximate, modelling it will has to have to be it will always have some error. So, it will always have some assumption. So, here we are saying the land use model and the transport models are separate.

But actually, there is the close to a interaction between the land use and transport. So, the whole land use as we are saying we do the land use planning and then the outcome we are feeding to transport as if they do not you know have any interdependence. But actually, land uses influenced by transport and transport is also influenced by land use.

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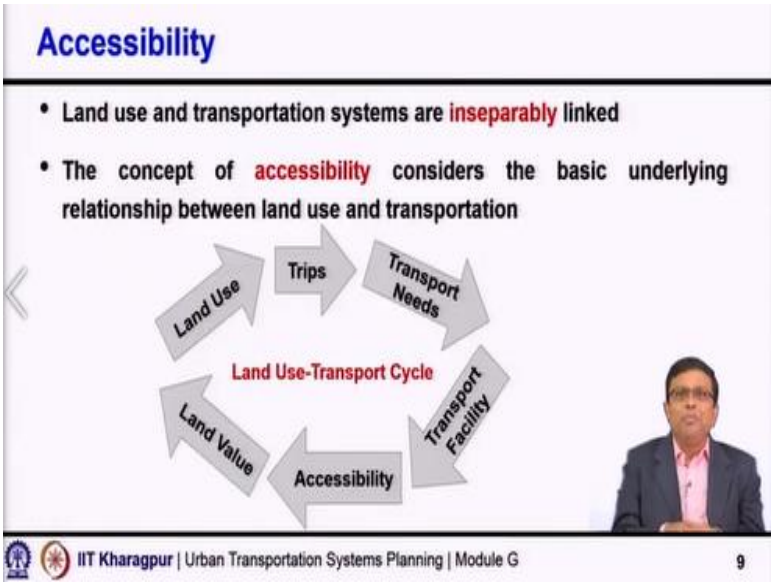

So, if you try to see the land use and transport system are actually inseparably linked. You cannot really separate them. We separate them the traditional model the early models actually considered it like this the land use planning or urban planning the focus was very different and the transferred planning was part of the urban planning. And the land use is dealt separately and the outcome of the land use.

Now you know that however the residentials will be located, where the activities or businesses are going to be located and accordingly you take that land use and start your land use a transport planning. There are advantages there are simplicity because you know that urban transportation planning this so many feedback loops are there is going back. And if we make the whole thing is a function even the land use gets changed.

Then the whole of feedback will again go to the land use and then the land use model then the transport model the whole thing has to go in a loop or in an iterative way probably until the whole thing gets settled. Here we are trying to tell you in a very simple manner that to justify this statement that land use and transport systems are inseparably linked. How there? You just consider that let us start with existing land use. So, something is existing today.

So, existing land use because the activities will be there activities will be distributed. So, that will generate trips obviously the landings will generate trip. Now the trip will generate the need

for the transport systems. So, maybe you will you know, slow that so many people want to travel so, you need to have roads you need to have bus transportation system. So, the transport is in facility will be provided facility will be developed.

Because there are people who want to travel demand will get generated and demand will naturally (())(20:45)), you know, when more people want to travel you drive in road you introduce bus system you introduce metro system and like that the transport system gets developed. Now once the transport system gets developed then it improves the accessibility. We have not yet defined the accessibility properly, we shall do that in this module itself.

But it improves the accessibility easily, you know, connections happen people can move easily a place gets connected to all other places. So, accessibility increases. Though once the accessibility increases, what happens immediately? People would like love to more and more would love to stay there. So, the land value changes and the moment the land value changes the builders and all other people they would be more interested to come and build.

May be housing, officers would try to locate there because the connections are better. So, the land value will actually force the change in the land use. And again, this whole cycle will go. So, you can see that it is not that land use is separate transport is separate and outcome of the land use planning is just feeding in one way feeding it the inputs to the transport planning process. But transport planning also have a feedback through this kind of cycle as we have explained here.

Land use transport cycle that it will influence the land use. So, transport will influence the land use land use will influence transport and the cycle goes on. And that is what you see the better the transport the land development more and more development takes place that means land use will change more land use change in the land use more activities will come there more development will happen.

So, again, the transport demand will get aggravative, that is the way things are happening. And this cycle is keeping will keep on happening over a period of time.

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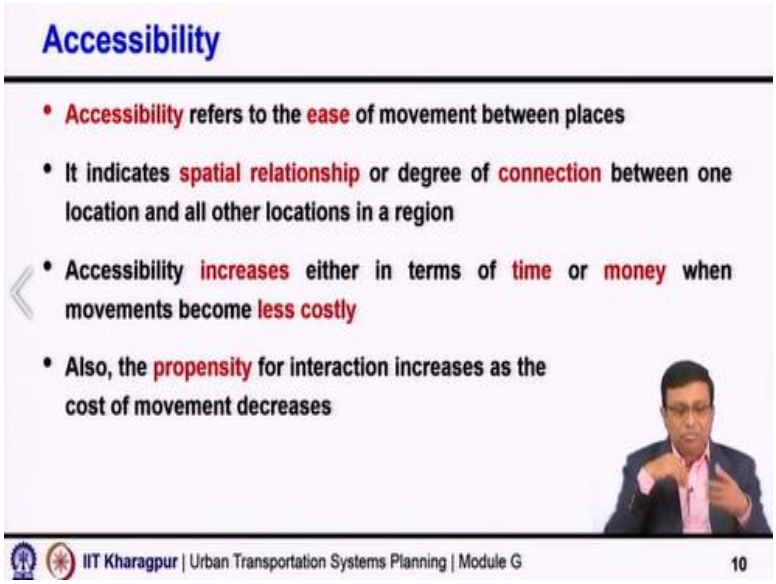

Now the accessibility term is very very important for us. And which refers to the use of movement between places, how easily generally we can say that accessibility refers to the ease of movement. We start with very simple concept and then gradually try to define. So, it refers to the use of movement between places and therefore it indicates the spatial relationship remember the word spatial because geographically things are located in different places.

Your residence is located somewhere school is located somewhere bank is located somewhere market is located somewhere, so these are all the activities are special in nature attached to geographical coordinates so, location. So, it indicates the spatial relationship or degree of connection between one location and all of the locations in the region accessibility increases generally either in terms of time or in terms of money to start with in a very simple manner.

When it improves or when accessibility increases now when the movement becomes less costly. If I can from one place you can if I can travel easily to all different places around that. Then I can set my accessibility as improved. So, whatever is the present travel time to get connected to all the places. If I built the road and if I, you know improve the wide and the road make good transportation system, and now you can travel faster.

So, obviously we can say that this improvement in the travel time or travel cost itself will mean

in a way that that accessibility is improved. So, also once the accessibility improves the propensity of interaction increases as the cost of movement decreases, again I said the cost may be the actual cost or cost may be the travel time direct cost of travel the bus fare, it could mean anything cost is a general deterrence.

So, what all we are saying that deterrence decreases distance, you know the time reduces, cost reduces so naturally the propensity of interaction improves between that zone and all other zone in that study region.

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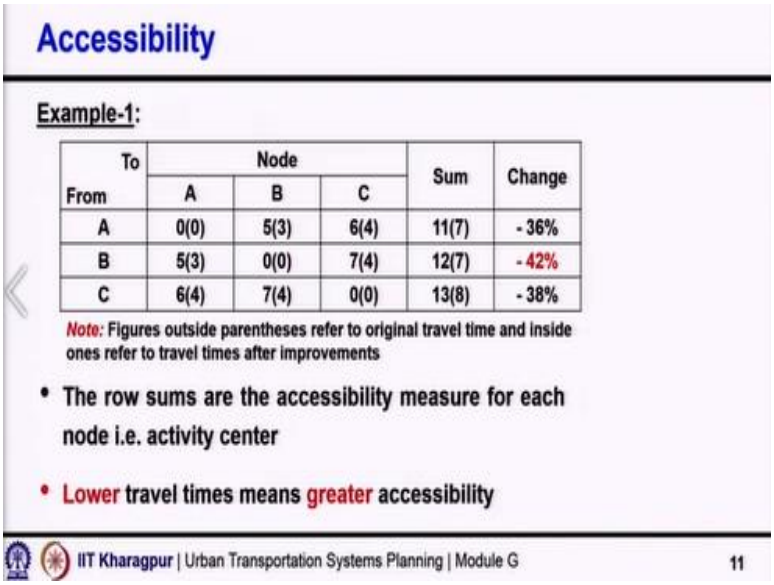

Let us look at this example 1 the table, there are three zones A B C and the movements are taking place and you can see in each cell I am showing two values. One value the 1 is within bracket and 1 is outside. The outside value indicates what is the present travel time. These are all indicative some example value I have taken, what is the present travel time. And the values in the bracket they indicate the improved travel time.

Maybe we have widened the road we have improved the transportation system. So, the travel time is reduced. So, let us say for example A to B we want to move our present travel time is 5 minute and now we improve the road or improve the transportation system to make it 3 minute. Similarly, A to C present travel time is 6 minute and we try to improve it and maybe we make it now 4 minutes.

So, overall improvement happens. Now, if you see A to B, A to C and within A of course within either time is 0 taken is taken as 0 in this example. So, what is the sum of travel times? Sum of travel time is 11 now. And we all improvement of connectivity between A and B and A and C that reduced travel time is 7. So, what is really happening? We can say that there is basically 36% reduction in the sum of time.

Similarly, for B it is 42% reduction, for C it is 38% reduction. All I am trying to say in a very simple manner that we improve the transport connectivity by improving road, building new roads. So, overall that influence the accessibility. And this is one way we are trying to see in a very simple way that my how the benefit is coming and you can say that lower the travel time means the greater accessibility we said that the travel time gets reduced travel cost will be reduced gets reduced.

That means the accessibility improves. And propensity of interaction also will improve or in case. So, this is a very simple way we can tell that how this road improvement in the road connectivity or the transportation system have helped us to improve the accessibility.

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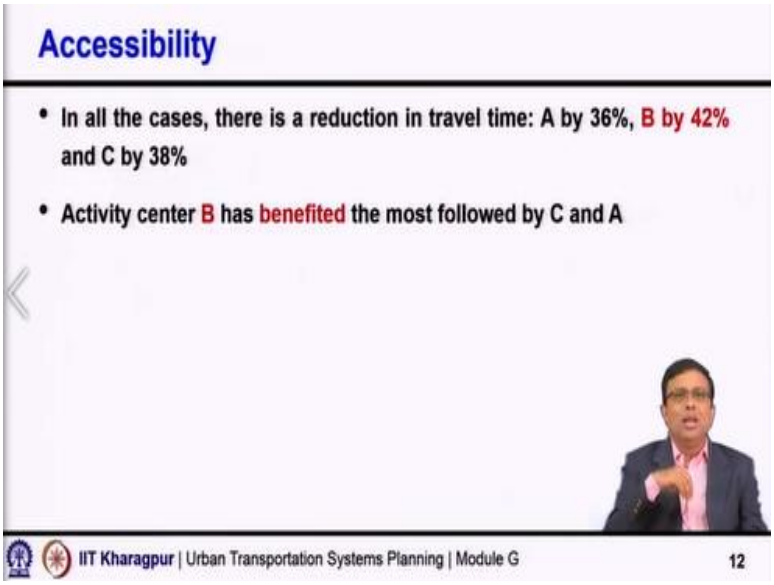

Now as you say there all cases there is a reduction in travel time A by 36%, B by 42% and C by 38%. Now activity center B has been benefited the most because the that benefit is 42% followed

by C which is 38% and then A which is by 36%. This is a very very simple way of looking at the things looking at the accessibility.

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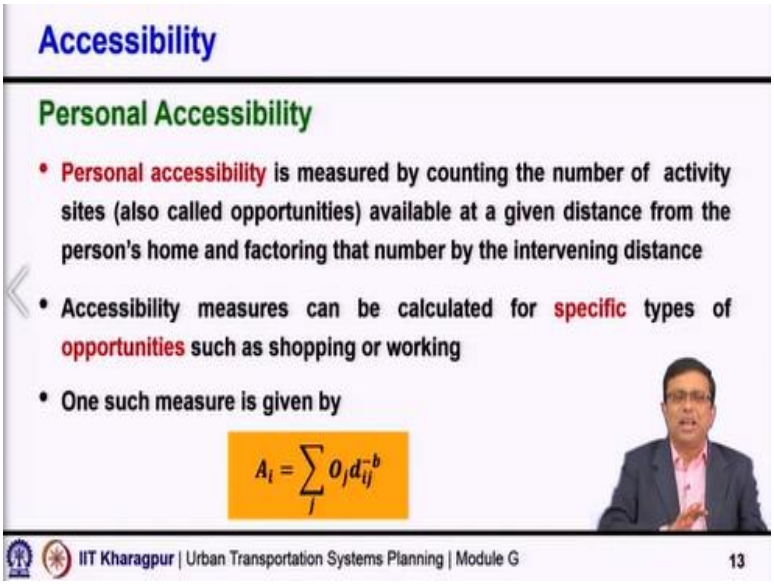

Now when we come to the Personal Accessibility. Then Personal accessibility is measured by counting the number of activity sites, you can also say it has opportunity we can also say as employment or anything anyway, we can define. We can say general opportunity available at a given distance, that means I am staying in one region how easily I am able to access the opportunities which are there in these surrounding locations.

So, my home is located somewhere and all around there are many opportunities somewhere in the shopping somewhere, you know other kinds of facilities and so. So, how easily I can access all those facilities. That will mean the personal accessibility, what is the accessibility level I am enjoying. But then these are all spatially separated. So, they will be at certain distance surrounding but they will be at certain distance not in the next door.

So, there is a thing that we are trying to do this factoring that by number of intervening distance. So, some kind of discounting or so we are doing to say that if an opportunity is at a longer distance or at the longer travel time then some kind of discounting will happen. So, did it again once again the personal accessibility is measured or may be measured you can say by counting the number of activity sites or the opportunities which are available at a given distance from a

person's home.

And then not just summing up but different activities or opportunities are available at different distance of time. So, therefore factoring that number by the intervening distance, distance is again used as a deterrence here. So, accessibility measures can be calculated for specific type of opportunities because the way the shopping will be distributed the work way the employment opportunity will get distributed the way the education will opportunities will get distributed is not going to be the same.

So, you can if you wish you can also define this accessibility separately with respect to shopping with respect to working or employment or with respect to education with respect to medical facilities if we wish we can do that. So, let us see how we can measure it, one very simple kind of measurement could be like this as it is shown A i is the accessibility of provided all opportunities giving to person i, is sum over j o j d ij to the power minus b.

As I said, what is the opportunity? There are say j you know zones or j things around and each of the j plays you have o j amount of opportunities that is available I can access that. But then each o j I am saying that factoring the number by intervening distance or doing some kind of discounting. So, o j multiplied by d ij to the power d to the power minus b. So, the distance is increasing.

So, the o j is getting discounted or getting factor by that distance or intervening distance. And like that every opportunity j location o j opportunity distances d ij, so getting discounted so why j divided by d ij to the power b. And there are j such opportunities around so sum over all j. That is the overall, you know, accessibility that is provided.

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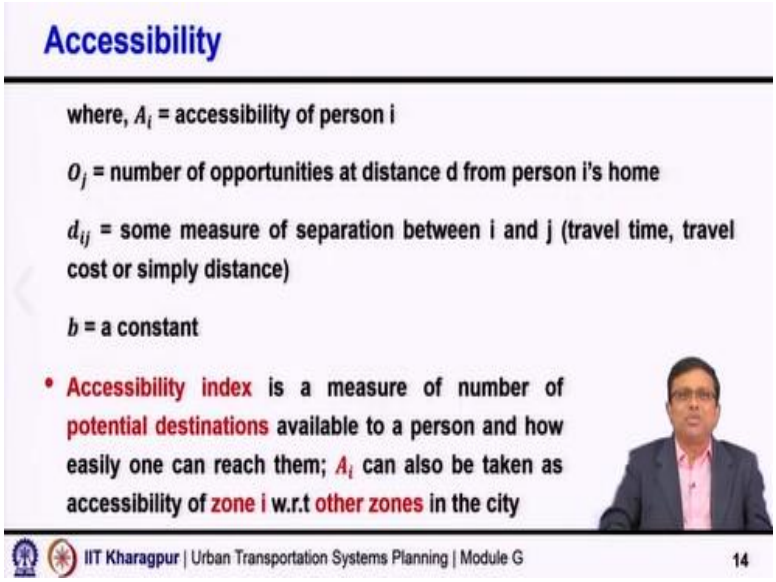

That is what we say A i is the accessibility of person i, o j is the number of opportunities and distance d from persons i's home d ij is the some measure of separation may be travel time, travel cost or whatever you said this is an exponent or a constant. Now accessibility index is measured in terms of is a measure of number of potential destinations available to a persons. And how easily one can reach them.

So, A i can also be taken as accessibility of a particular zone if I am living instead of a person or locating a house you can consider zone together kind of homogeneity you can assume. So, zone centroid the zone centroid you can think. So, we can also define that accessibility for a zone. So, how the accessibility for a zone i is the same thing you now consider it is not a person but you consider it is for all people who are living in a particular zone i. In a very simple way, we can explain it.

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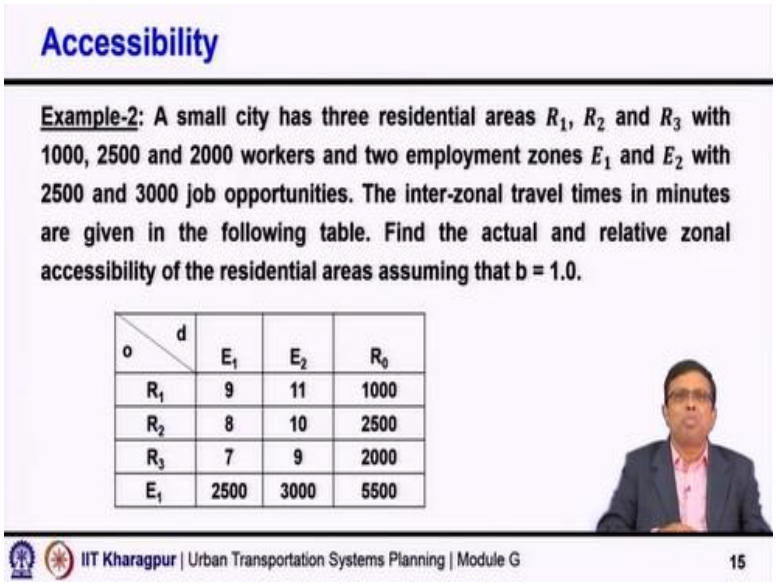

So, if I take some example that considered there are three residential area and two employment zones residential areas have you know, 1000, 2500 and 2000 worker and two employment zone where 2500 and 3000 job opportunities are there. And these are the travel times 9, 11, 8, 7, 9 and you know how the R zones residential zones are getting connected to each zone employment zone.

That is given you can consider b as 1. Then how the distribution how you can calculate the accessibility of each zone.

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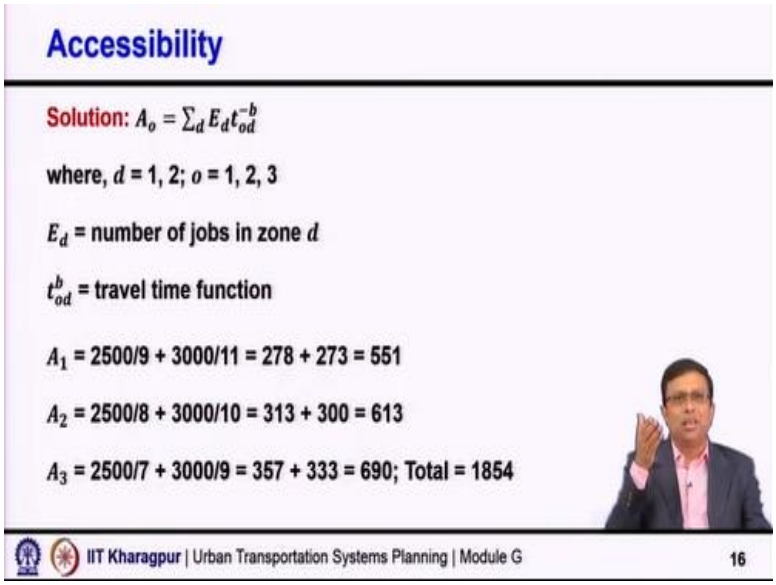

So, we can use the simple thing just the this is same formula which is used A i equal to sum over

o j d ij to the power minus b. So, we do that in this case, we know the distance d R 1 and 2, or basically E 1 E 2 and the origins are basically R 1, R 2, R 3. So, we calculate what is the A 1 what is A 2 what is A 3 and that calculation is shown here.

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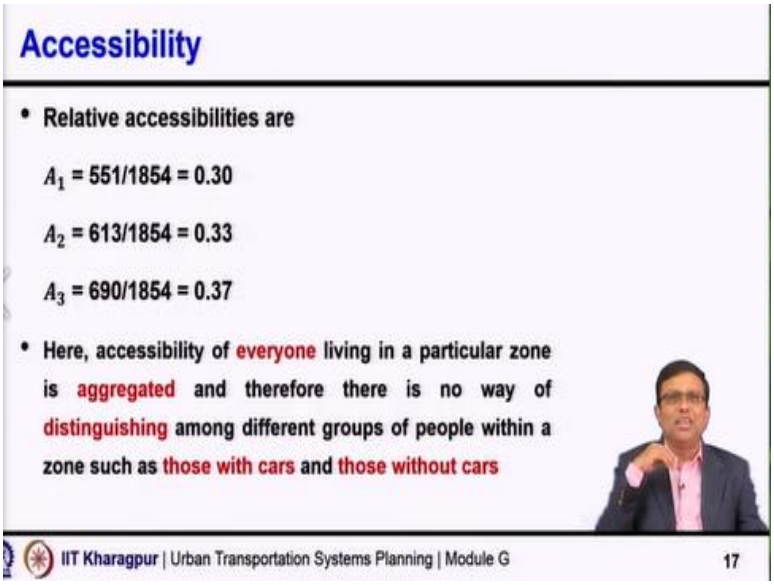

So, like this now we can also calculate the relative accessibilities because we know the accessibility values of zone 1 is 551, 2 is 613 and 3 is 690. So, what is the relative accessibility? We know the relative accessibility of A1 is 0.3 A 2 is 0.33 and A 3 is 0.37. So, which one is better, better is obviously A 3 where the highest value of relative accessibility is there. So, here accessibility interestingly is for everyone we are considering same, everyone in that zone.

Can you think it much deeper? Yes, we can think much deeper. So, you can think here that accessibility of everyone living in a particular zone is aggregated and therefore there is no way of distinguishing among different groups of people within a zone those who have cars and those who do not have cars.

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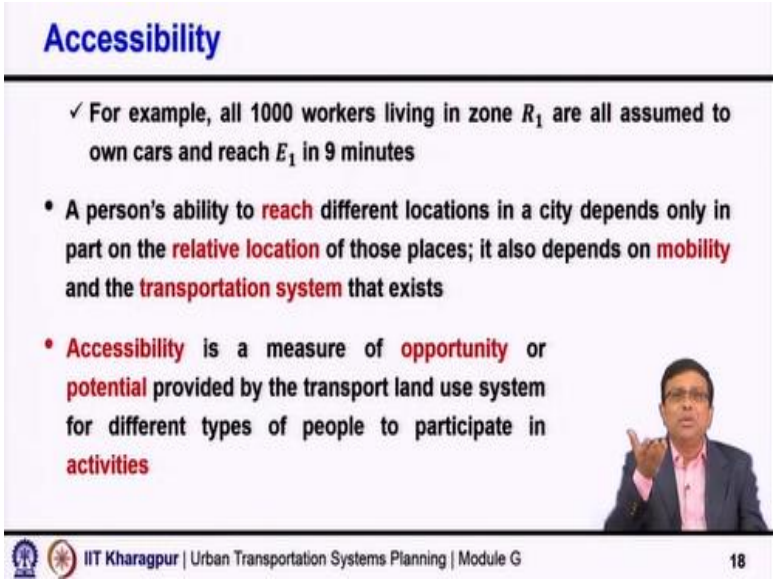

Now suppose you consider in a particular zone say for R 1 zone all 1000 workers have got car and they can reach to zone E 1 just in 9 minutes. So, you can calculate separately accessibility for different income groups. So, a person's ability to reach different locations in a city depends on the part of the relative location of those places. It also depends on the mobility and the transportation system that exists.

So, we can say that accessibility is a measure of opportunity or potential provided by the transport and land use system. The combined thing for different types of people because different income groups are so accessibility could be different to participate in various activities.

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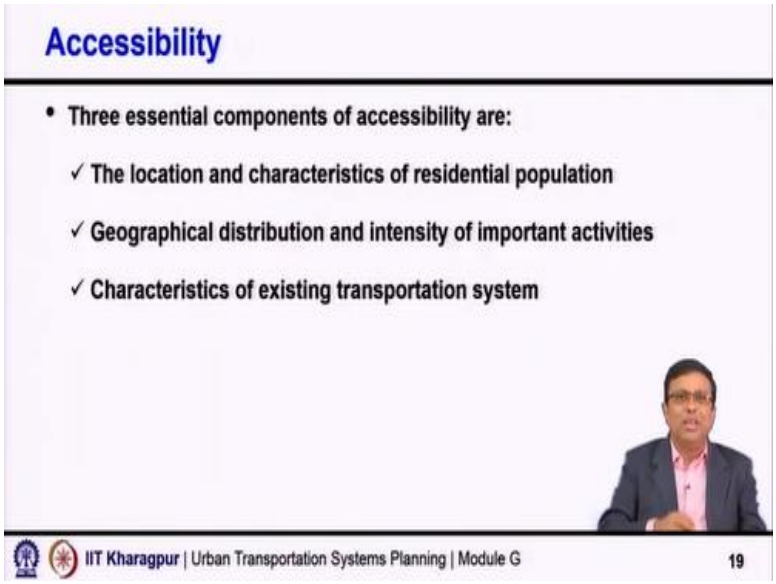

So, in that way, if you see there are three essential components. First of accessibility, one is the location and characteristics of residential population how the populations are distributed in different zone, how the geographically the activities are distributed employment to shopping to education to medical facilities all how they are getting distributed. And then who is connecting them? The connection is provided through the transport system. So, what is the characteristics of the transport network.

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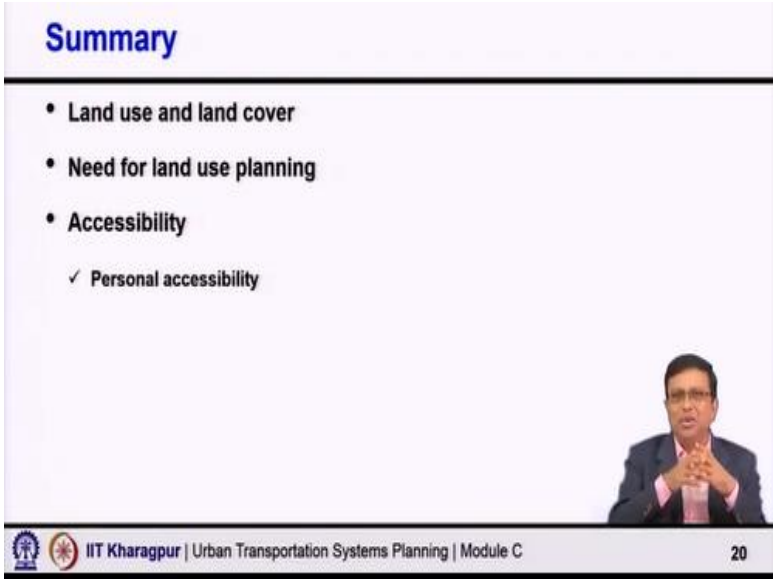

So, in a summary, we discussed about the land use and land cover told you clearly what is and how they are different. Then we discussed about the need for land use planning why we need land use planning and then started introducing or introduced to you in a very simple way initially the concept of accessibility. Then little bit refinement and then saying that how even the accessibility for individual for a zone.

And then also different types of people based on their economic status, maybe income may be car ownership opportunity etc. how you can define. So, try to give you some basic understanding of the concept of accessibility. So, with this we close we shall continue in the next lecture. Thank you so much.