Urban Transportation Systems Planning
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Lecture - 06
Traditional Travel Demand Forecasting Process

Welcome to module B lecture one. In this module we shall discuss, about the overview of the four stage urban transportation planning process.

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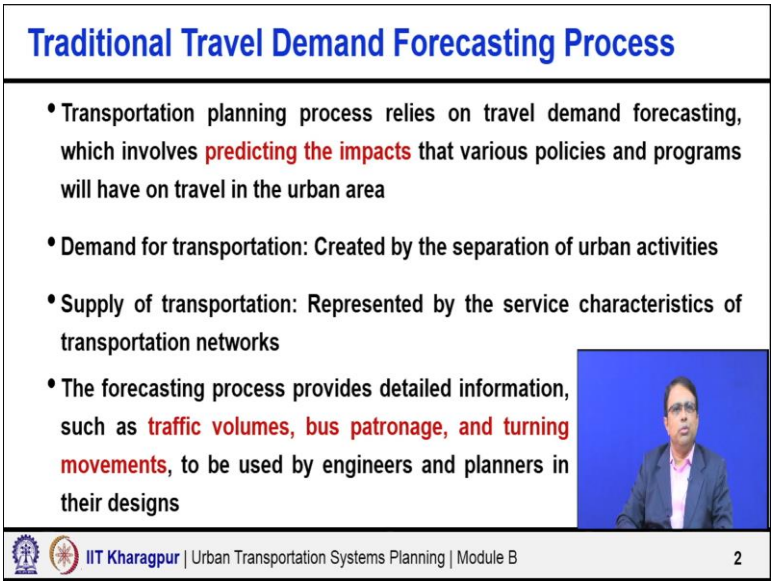

In urban transportation planning, the most important aspect is travel demand forecasting. We try to predict the travel demand that is expected to be served by the transportation system in the future and then we also in that manner try to predict the impacts of various policies and program on the travel demand in urban areas .You change the policy, you change the program, then how that is going to or how those are going to impact the travel demand in an urban area or in various contexts.

In an urban area the demand for transportation is created by the separation of urban activities. Urban activities are the key, all travel generates all travel happen before, because of this urban activities. So the demand is created by the special separation of urban activities. Activities located in different places .You live in one area, your office is in another area a school is located somewhere else, you know the shopping mall is located in another place.

So that is the special distribution of activities which create the transport demand. The supply of transport demand is represented by the service characteristics of the transportation network. Because you have set of roads in any given network, so each road has a capacity, overall road

corridor or network or the transportation system is there. So that capacity is offered to accommodate the demand for transport.

Now the forecasting whatever we get from the overall transport planning process is as I said the travel demand forecast is the key. Then, this travel demand forecast provides detailed information for various works. For example, we can understand that how much traffic volume will come on a particular link and thereby we can compare that you know whether the link capacity or the number of lanes which are there in that link.

Whether; that number of land is adequate to serve the demand with the expected level of service. Similarly one can get the bus patronage to understand you did some policies and programs. So what is the impact of that on bus patronage. It may increase it may decrease, so that is again the use of the transport demand. We can also understand, probably say, how much turning volumes or intersection volumes.

One intersection has to handle and if you can predict that in future. So much traffic volume is to be handled by this intersection then we can easily try to estimate or assess rather that. Whether you know that intersection will require signalization or not if we do the signalization, what kind of signalization will be necessary, then with signalization what kind of delay will occur in that intersection, all such kind of things can be you know worked out.

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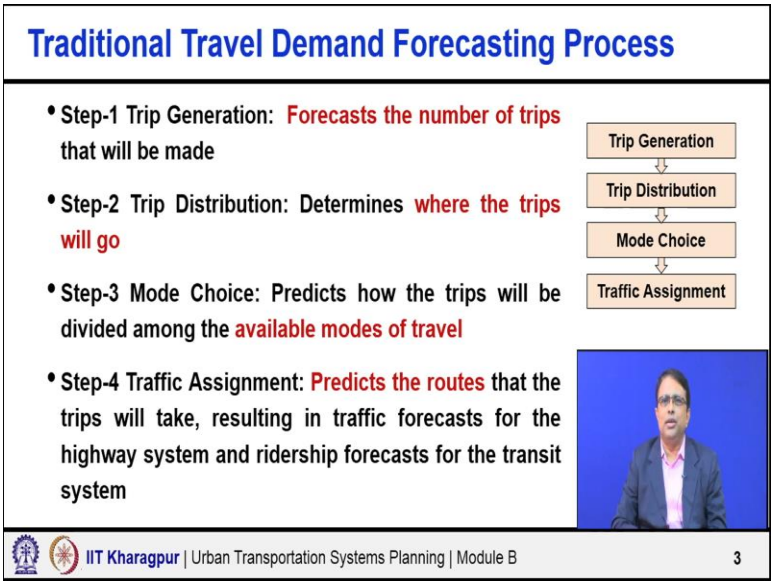

Then coming to this 4 stage we are saying that we are going to discuss here about the 4 stage planning process. So the 4 stages are or steps are first what is called as Trip Generation, here we try to forecast the number of trips that will be made. Given the land use given the activities in the whole study area, of course but, then in small pockets within the study area. So the study area is divided into smaller zone.

Because every time we are saying the transport demand is special in nature, so not the whole demand from the study area, but in smaller pockets smaller geographical regions, how the demand will happen? So that number of trips that we try to forecast or assess in the trip generation stage. Then in next stage or step, what is called as Trip Distribution, we try to get the answer that, if hundred or thousand trips are getting generated in one area, where these trips are going.

Because every trip which is generated must be going somewhere you know. So there is a destination for the trip. So, how the trips are getting distributed? Similarly if I know that in one zone, so many trips are getting attracted. Then we would like to know in this stage, in trip distribution stage, where from the trips are coming. So if it is a generation that thousands or hundreds are getting generated, then how they are getting distributed to different zones.

Where they are going? And if I consider the other end that thousand or hundred trips are getting attracted to a zone then we also know from the stage or in this step that how, where from this hundred or thousand trips are coming. So we know completely the original destination of the trip. Then in step 3 or stage 3, whatever you say which is called the mode choice. We try to predict how the trips will be divided among the available modes of transport.

Till you know, this step 1 and step 2 you are talking about passenger trips, but then the roads are actually getting loaded with vehicles. So in between what is happening the passenger trips are getting converted into vehicle trips. So that is happening in this stage of what we call as mode choice. Say thousand people will travel from point A to point B for example how? Each of them is travelling using a car.

That would mean that there will be thousand cars between two points travelling at a given time. If they are all going by bus, then I know if it is a 50 seated bus then that will mean probably 20 buses that will get required. So understand that this mode choice is extremely important in the context of overall urban transportation planning process and especially the mood choice part is so important. That is why in the overall urban transportation planning process.

Because the number of vehicle volumes or the number of vehicles or the overall vehicle volume is decided or influenced heavily by the more choice decision. So lot of works are being carried out even till date to on the mode choice modeling, to see how we influence the mode choice decision of individual. And even then significantly are carrying same numbers of people from one point to another point, the number of vehicles can be very different.

And in the number of vehicles can be different, then the loading also on the road network will may be very different. The resulting emission, the resulting congestion will also be, you know entirely different, indicate entirely different scenario. So this is very important step. The last and step four or stage four is the traffic assignment. So we know where people and how many people

are trying to travel where they are going or if there are some people coming here, then where from they are coming, we also know by which mode they are coming .

But in a transportation network normally there are multiple paths available, if you want to travel in bigger cities. If you consider you know somebody is trying to travel from point A to point B, there are multiple options for travel. So here how this demand is getting distributed to different routes. Obviously personalized mode if you are traveling in a private vehicle you have much more choice, any route if you wish you can take. Buses they follow a fixed route.

Because normally bus routes follow certain sequence of links or certain you know a predetermined path. So, but whatever it is, this is the step where we know how the demand by a given mode from a point to another destination point, how the demand is getting distributed to different routes or how the root choice decision is happening. This is again very important, because you know in we said earlier and you already know that transport demand is temporal and special in nature.

So even in a transportation network, not all roads are equally loaded with traffic at a given time. Maybe some routes are highly congested and whereas some other routes it may not be really that congested. So this is very important to see how the route choice or the traffic assignment decision is made by an individual and what it means in a collective sense. So these are the 4 stages trip generation, trip distribution, then mode choice, then traffic assignment.

And we are assuming here that these decisions are made in a sequential manner. In reality in some cases it may be a combined decision you want to go to a destination. When you are thinking of the destination you are also may be thinking about the choice of mode or how which mode you will take to travel. But generally in this 4 stage planning, we consider that the decisions are made in a sequential manner.

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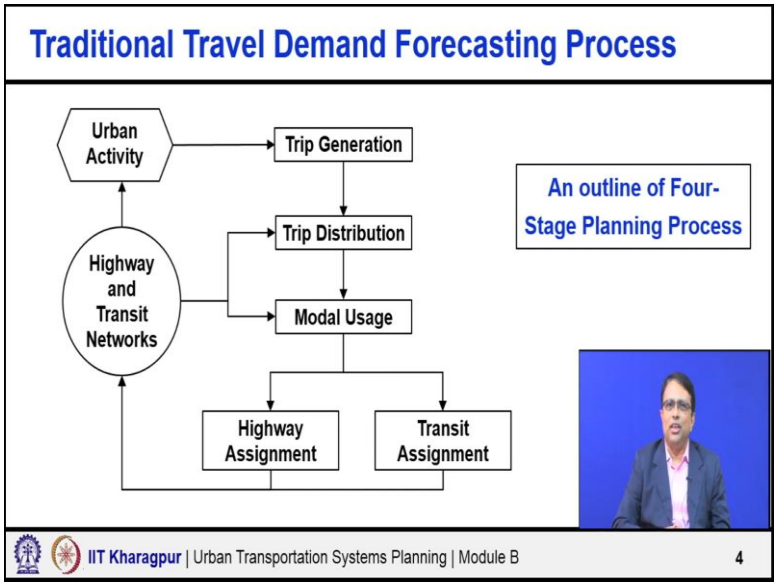

Then in this flowchart, I am trying to show an outline of the four stage planning process. As I said that everything starts with urban activity. That is the center, because the activities are distributed so people need to travel. Otherwise there is probably even no need to even travel in an urban area. So if everything of course you can still travel for recreational and social reasons. But suppose if your office is located in the same building hypothetically and if whatever you want you are all shops, bank anything you want is located in the same building.

Probably you do not need to travel outside your building. So you need to travel predominantly because the activities are specially distributed. So the key input to this four stage planning process is the distribution of urban activities and how the activities are distributed. So the urban activities that provide input to the strip generation process, and then the trip distribution, then the mode choice decision and then you can see here this, whatever I said as assignment.

Here actually I am showing it as two different boxes, one is Highway Assignment and the other is called as Transit Assignment. Now why these two boxes; because the principle followed for assigning traffic is different for private vehicle and the public transport mode. As I said public transport modes in most cases, public transport follow fixed route system. So the routes are predefined, the bus route will not change suddenly based on the traffic state.

Extreme situation it can change, if there is an accident, probably the road is blocked. So the bus can take a different route but otherwise not so. So in general that the assignment philosophy is very different, that is what is called the transit assignment and highway assignment basically, actually refers to the assignment of a private vehicle. Now you can see here highway and transit network it provides input to both trip distribution and to mode choice or mode usage, why?

Because both trip distribution and mode choice decision depends on the highway and transport networks, what are the characteristics of the transportation system that becomes very important.

Because where you want to go I mean giving two equally attractive destinations, two equally same shopping mall in two different locations. One is very well connected by transport network and you know the bus system is very well developed.

Connecting produces two points with frequent service and so and the other location. Shopping wise it is equally the same shopping mall, probably you can consider. But the transport connectivity is not so good. So where people will go more, people obviously will go more where you know the transport connection is better. So the transport and highway and transit network they influence the transportation distribution or the trip distribution.

Same way what modes one will choose for travel between point A to point B also will depend on the characteristics of the highway and transport network. So obviously if there are a very good bus system maybe more people would travel by bus and therefore you will find the more choice will show higher share in favor of public transport. Now these feedback arrows again after highway assignment going back to highway and transit network.

What is the reason for that, that reason may be explained as follows. When we are doing a trip distribution we are assuming some value of travel time on certain properties of the; or the characteristics of the highway and transit network. Same thing we are assuming certain characteristics of the highway and transit network when we are going the mode choice. But how much actually will come on a given link or on a given route and on a given intersection.

At a given intersection location and so on so forth will be known once the actual distribution and the mode choice and the route assignments are done. So whatever assumptions on travel time and network characteristics or properties we assume, we need to reach it. Maybe we assume that to travel between two points it will take 15 minutes. But after the loading of the network does it really take 15 minutes, it may take even 20 minutes, 25 minutes this may take a little bit lesser as well.

So we need to go back and again with the revised one we need to update, the network and the travel time, travel cost and every other parameter accordingly. And maybe we are need to go back to trip distribution or mode choice as the case may be and then repeat the procedure till the whole process is really stabilized.

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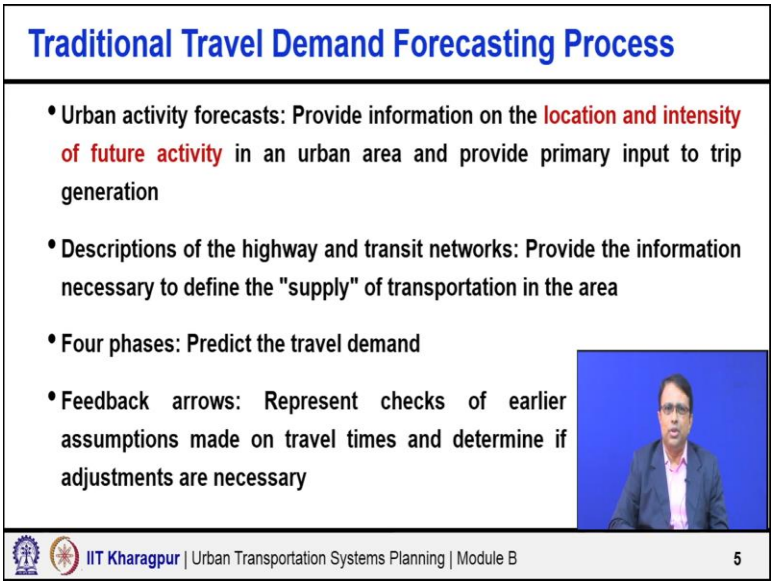

So if I have to show summarize this flowchart, we would say that as I said urban activity forecasts provide information on the location and intensity of future activity in an urban area and provide permanent primary input to the trip generation process. Everything starts travel demand forecasting starts the basic input is urban activity forecasts. So the description of highway and transit network, it provides information necessary to define the supply of the transportation in that area.

What is the supply of transportation, as I said earlier the supply relates to the transport network. So it defines the supply, it defines the characteristics that are important for the four stage planning process particularly the choice of destination, the choice of mode, the choice of route. And then the four stages, phases which show actually the try to predict the travel demand and the feedback arrows as you said that the arrow is coming back here.

So these feedback arrow as they represent checks on the earlier assumption made on travel time and determine if adjustments are necessary. As I said that we assumed certain characteristics of the transportation network and accordingly assumed some travel time, travel cost and based on those network characteristics or travel time, travel cost, we did distribution, we did more choice we need traffic assignment also after that .

So the actual now the loading is known, so you can check whether the travel time assumptions or travel cost assumptions what you, what were made earlier, whether they are still valid or whether they need some kind of update. So that is what is the process?

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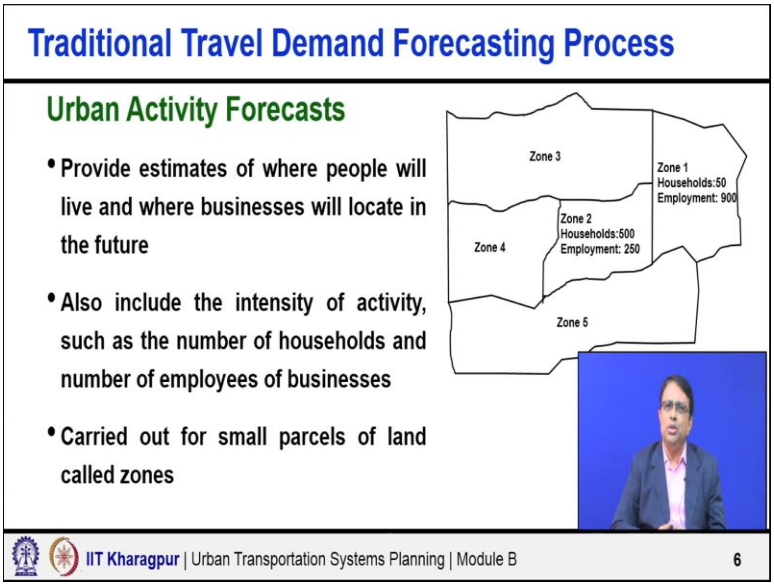

Now going to each stage, a little bit of urban activity forecast provide estimates of where people with or expected to live and where business will locate in the future because we are for going for forecasting. Forecasting means future, so we need to know the future land use and in particular the future activities. How the distributions will happen, maybe the development authority has certain plan that certain areas they want to develop at the residential areas.

Maybe a lot of housing projects are coming up. Similarly maybe the government has decided to develop some areas as the IT park that this area will be developed as a right as a big IT Park. So we need to know and this activity forecast help us to know how the activities will get located so where people are expected to live, how many people are expected to live, where the businesses are expect to be located.

So it includes intensity of activity that means in number how many numbers of households or how many number of business. And these numbers are available not for the whole study area at a gross level but also for smaller pockets or what we call it as traffic zones. So in smaller zones each traffic zone in the study area how many people are expected to live and what kind of business or employment opportunities are expected to be located.

These are all available through urban activity forecast and they provide the input those are the real inputs which are used for the trip generation process.

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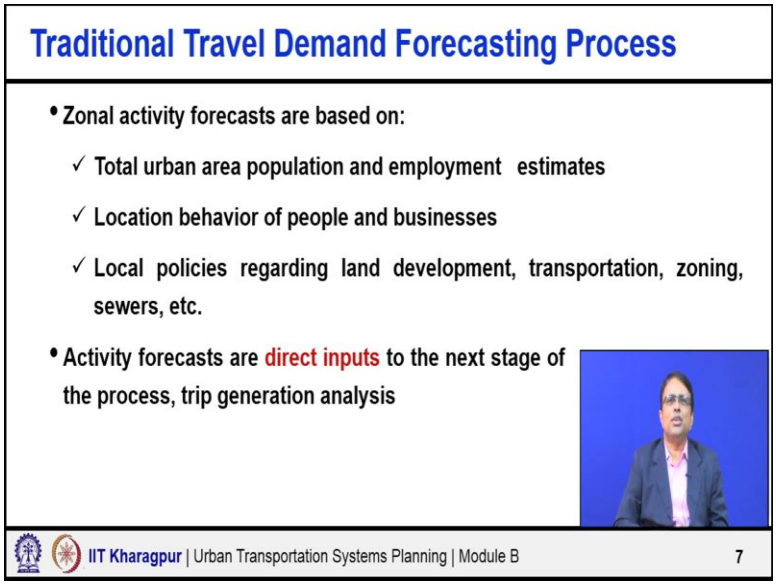

Now journal activity forecasts are primarily based on three major considerations. I would say one is the total urban area population and employment estimates. Because first you are talking about the study area in the whole total urban area you know what is the total population and employment that are expected to be there. Then how they will get distributed or in different areas that depends on.

Obviously, one way the location behavior of people and business where what kind of policies are there, where, which will be which are likely to be more preferred destination for locating a business house or a particular type of industry or where people would naturally prefer to live end of the day as residents locations. So locational behavior is people and business are important and also the local policies regarding land development, transportation, zoning and all other kinds of urban infrastructure.

So, how the government are trying to promote the policy? I mean it also depends because maybe the western and eastern subway both can develop. But the government can take you know policies to promote development of certain areas in certain directions. Because you may take land policy and development policy the kind of you know to the government policies can come in a big way to encourage or to promote development of certain areas.

So it depends on the three major areas, what is the total urban area population and employment estimate, what are the location behavior of people and business and what are the local policies regarding land development transportation zoning etc. Now activity forecast as I said are very, very important because they are the inputs to the trip generation or the four stage transport planning process. So activity forecasters direct inputs to the next stage of the process that is called trip generation analysis.

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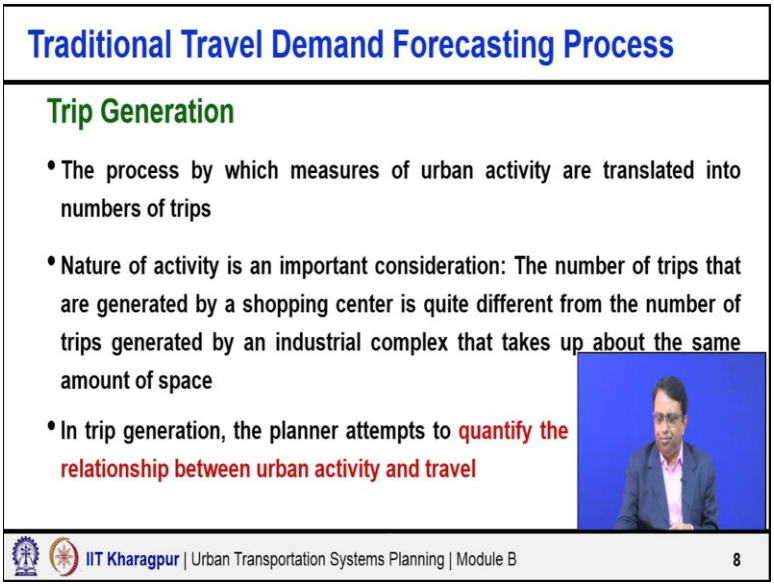

Now in trip generation analysis what we are doing we are taking the activities as an input and we are trying to predict then that will mean what level of trip generation, how much trip generation. So we can say in trip generation is the process by which measures of urban activities are translated into number of trips. Because we are taking input as urban activities, you know distribution.

And the output what we are getting from trip generation is basically the number of trips in each zone. So the nature of activity is very important consideration nature and quantity, so both are important. While the number is important we said that how many people, how many buildings or houses are expected to come or how many industries are expected to be located but that is the number is important.

But along with the number the nature of activity is also equally important. Because I say that lets say for example as given here, the number of trips that are generated by shopping center is quite different from the number of trips generated by an industrial complex. So even know if you consider say industry even within industry, a manufacturing industry and IT industry for example.

These two types of industry for the same area of the industry the number of people who are likely to be employed will be entirely different. So the nature of activities is also very important. So in trip generation the planner attempts to quantify actually what is the relation between urban activity and travel. So because why I am saying the relationship because my input to the trip generation process is urban activity forecasts.

What I am getting as output is the trip generation, number of trips. So that means somewhere the number of activities are getting translated to number of trips. So we are basically developing the

relationship, if this is the type of activity then this is going to be by number of trips. So I can say that the planner attempts to quantify the relationship between the urban activity and the travel.

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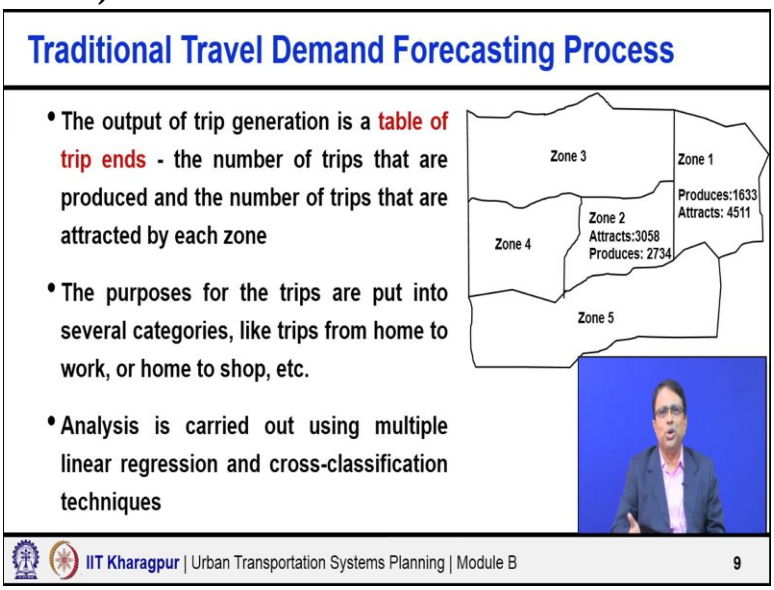

Then the output of the trip generation is a table of trip ends. That means if I consider it like a matrix if I have n number of zones in study area. Then each cell within that matrix will represent what trip from i to j. So if I add all the cells in a row that will say 1 to 1, 1 to 2, 1 to 3, 1 to 4, 1 to 5, like that up to 1 to n. That the total is how much is getting produced in on 1. Similarly if you take a column and try to add all the cells in a column it should be maybe 1 to i, 1 to j, 2 to j, 3 to j, 4 to j like that n to j.

So you add all this that means how much are coming to zone j. So by trip generation we estimate this row totals and the column totals. So basically I do not know the inner cells, but I know the row total for every row and the column total for every Column. So if I have n number of zones, then the row total gives how much each of this zone, is likely to produce and how much each of this zone is likely to attract.

Those are the column totals. So that is what I said that output of the trip generation is a stable of trip ends the number of trips that are produced and number of trips that are attracted by each zone. The purpose of the trip also could be you know we can classify trip by purpose and the analysis is critical out you know, because it is the first stage and what kind of method we use multiple linear regression or cross classification techniques.

We shall discuss about these techniques in detail in our next stage, next module when we go for the trip generation analysis.

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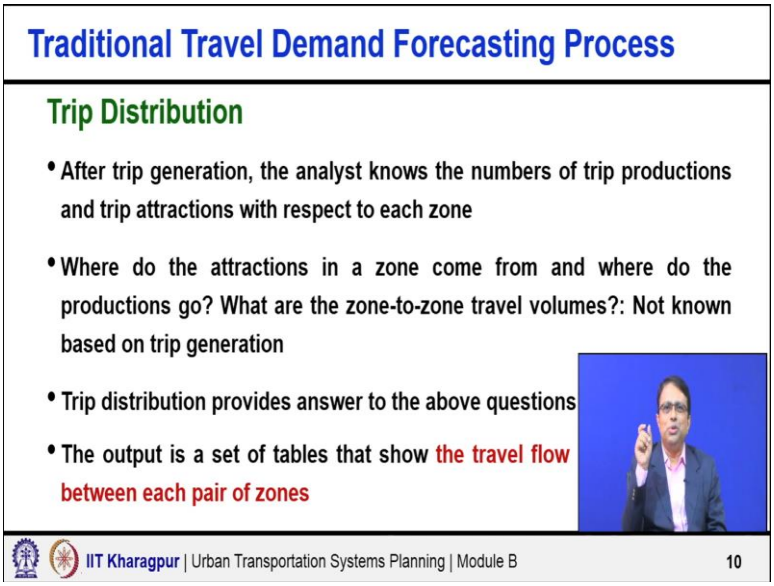

The next is the trip distribution, what I said if I simply refer to these matrices and what I was referring to that. We know the row total and the column total. But we do not know what are the inner cells? So the trip distribution is the process where we are trying to identify what are the individual cell values. So that if you add each zone all the cells in a row you get the row total what you have estimated from the trip generation.

And if you add all the cells in a column that cells some should give you the column total which is the attraction you have estimated from the trip generation. So trip generation gives me row total and the column totals. But not the individual cell, distribution gives us the individual cells. I can say also in other words that if I am saying that trip generation will tell me thousand trips are getting produced from one area.

But it does not tell me how the thousand trips are going to different zone, how many are going to zone 1, how many are going to zone 2 and so on. So forth, similarly trip generation may tell me the thousand trips are getting attracted to a zone, but I do not know where from they are all coming. How many are coming from zone 1, how many coming from zone 2. So those information are given in the trip distribution.

So that is what I have written here, that where do the attractions in a zone come from or where do the productions go, what are the zone to zone travel volumes, that is the individual cells which are not known in the based on trip generation and that is what we get in the trip distribution. The output of the trips is a set of tables that show the travel flow between each pair of zones or you get each individual cell in that matrix.

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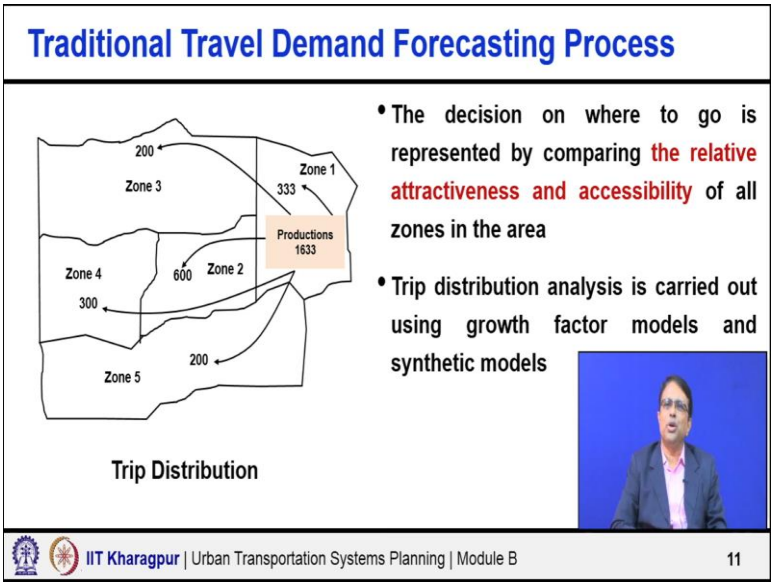

So by the end of the distribution as you know that in generation stage probably we only found out that. Example, here 1633 trips are expected to get produced in zone 1. But how they are or where they are going that we are not knowing. But once we have done the distribution we know that out of 1633 maybe 333 trips are going to terminate in zone 1 itself, because there may be some attraction points within that zone itself where they will get terminated.

Similarly 600 trips probably will go to zone 2, 200 will go to zone 3, 300 will go to zone 4 and 200 trips are expected to go to zone 5. So like that we know how they are getting distributed right. So the decision on where to go is represented by comparing the relative attractiveness and activity of all the zones. And mainly two types of approaches we take for modeling of trip distribution.

One is called the growth factor based models and we also use synthetic models for getting the trip distribution. As usual as, I said like the trip generation model, so here also the trip distribution models in details we will discuss. When we go to the module D, A, B, C is trip generation, d is the trip distribution. So when we go to module D we shall discuss in details about this factor growth factor based model and the synthetic models.

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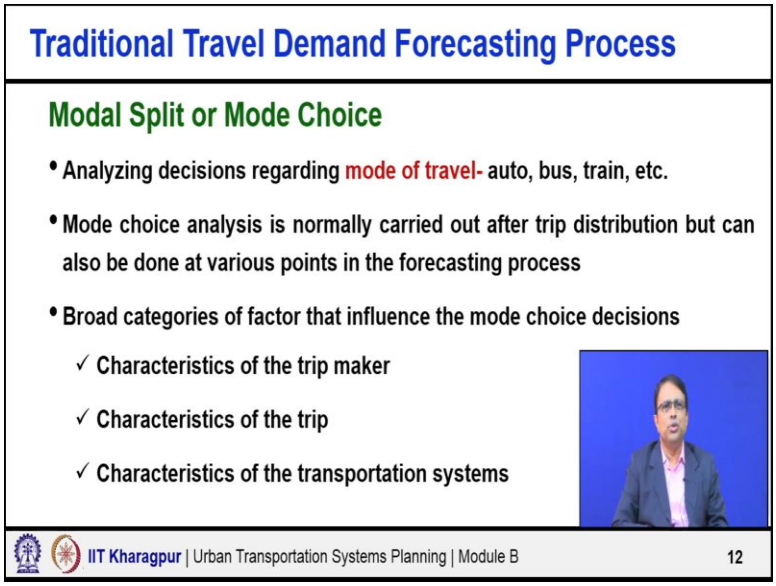

Third as I say by which mode they will go. So, here we are analyzing decisions regarding mode of travel, whether how many trips are going to be made by auto, auto means the car or the personalized vehicle. How many are going to use bus or train or taxi and so on. So mode choice analysis is normally carried out after trip generation, but also can be done at various points in the forecasting process. As I said sometimes even it may be taken simultaneously with the decision.

But here we are considering for simplicity that the decisions are made in sequence generated then the destination, then the mode and then what route to take. So broad categories of factors which may influence the more choice decision may include characteristics of the trip maker, how much income I have, high income, low income, male, female even young person and old person.

So the socio-economic characteristics and you know the characteristics of trip maker are very important. They may influence the more choice decision. Characteristics of the trip also may influence some more choice decisions. Say for example somebody is going to the office maybe the travel time is the most important factor. So he or she will probably take a mode where you know the travel can be faster.

But the same person in the weekend when going or out along with the family to a restaurant or for a social trip may prefer to travel in a more comfortable manner. So the comfort may get much higher priority and accordingly the more choice decision will happen. Similarly the characteristics of the transportation system, what are the available, how the service is available, whether taxes are or autos shared, autos shared modes are available.

What is the travel cost, how much time it takes all these are also going to influence the choice decision. So the characteristics of trip makers, characteristics of trip and also the characteristics of the transportation system all are going to influence the mode choice decision.

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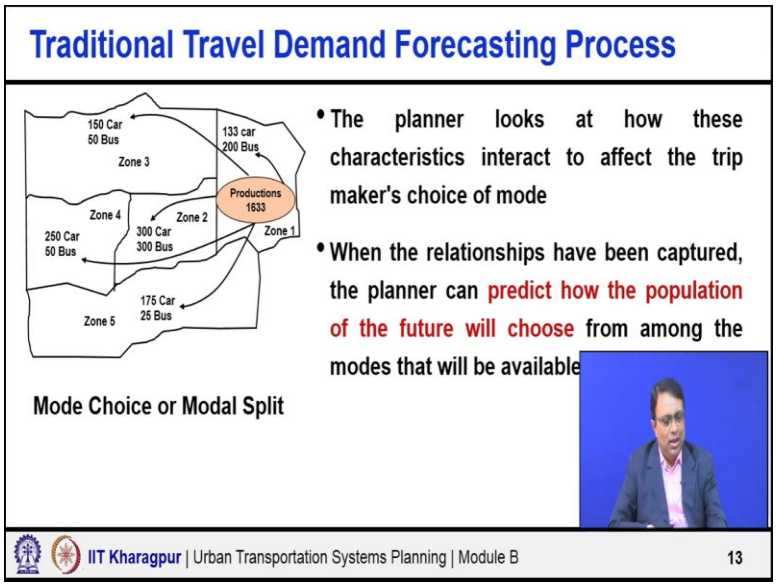

So when the mode choice decision has been done, then we know not only that, how many are going to a particular zone. But we also know say for example, 200 people are going to zone 3, but we know after more choice analysis out of 200, 150 will go by car and 50 will go by bus such kind of information. So the person trips are actually getting translated into vehicular trips. So when the relationships have been captured.

That, how the choice decision made. The planner can predict how the population in future will choose among the available modes that are likely to be available.

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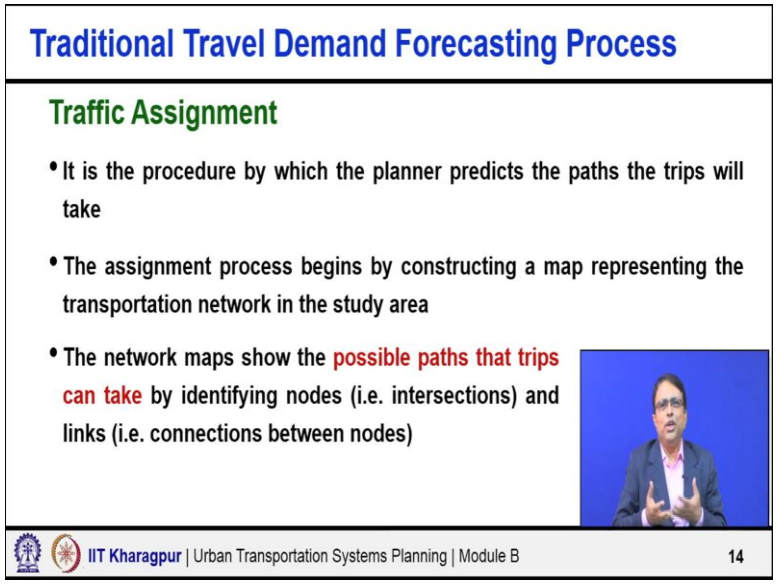

The last is basically the traffic assignment. As I said this tells you how or the path or the route choice decision will be made. So destination decision, then the mode choice decision, and now

the route or the path choice decision which route or which path to be taken. So it is the process by which planners predict the path, the trips will take the assignment process begins with conducting a map representing the transportation network in the study area.

You need to know how the transportation network is there, what are the characteristics, how much is the travel time, what are the possible paths the trip can take and so on and so forth. That means the intersection, how many intersections will come on this path, what are the links, what are the travel time along the links, all such things are so the network properties become very important.

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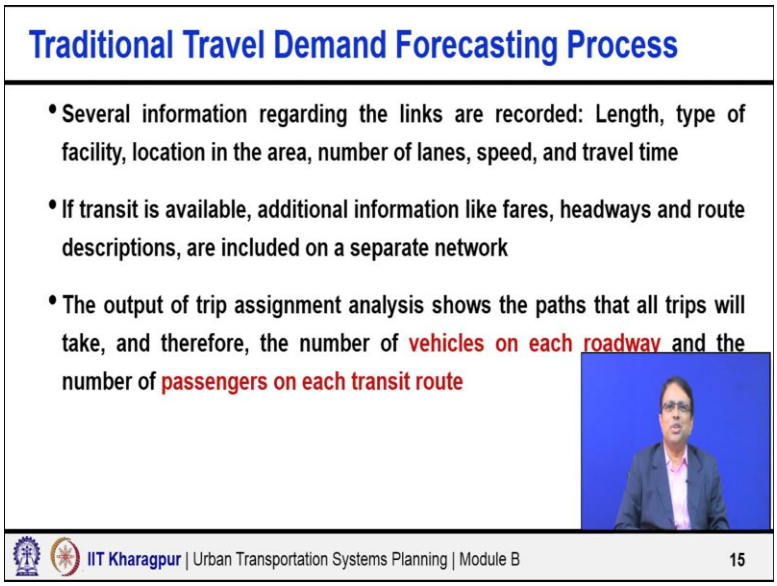

Several information regarding the links are recorded. For example, the link the type of the facility, the location of the area, number of land, what is the speed or the travel time all such thing, if transit is available then what is the fare, what path it takes, how much time it will take all this will govern the choice decision about the route or the path and the output of the traffic assignment analysis.

So the paths, that the trip; will take and therefore the number of vehicles each roadway and the number of passengers on each transit routes. So finally, end of the traffic assignment the actual load for a given link or for a bus route and for a given intersection all these are available.

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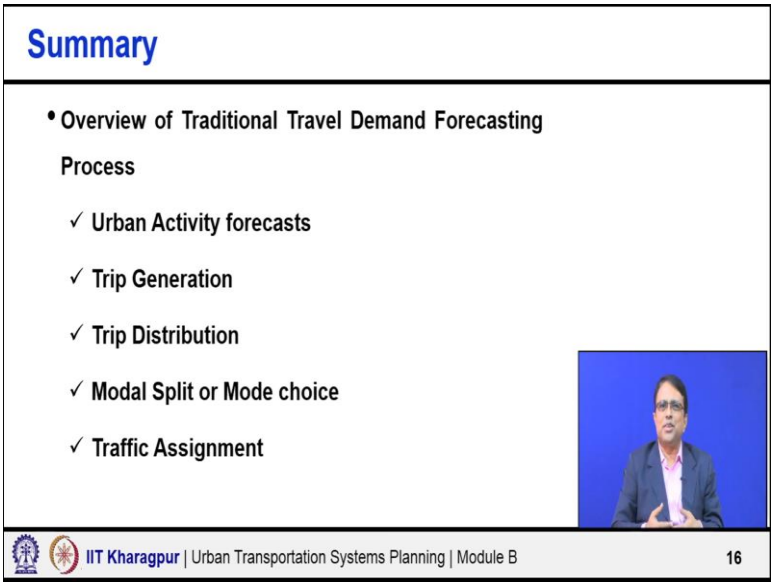

So that is what are the four stages, so what we discussed here quickly is the overview of the traditional travel demand forecasting process. As I say the inputs are coming from the urban activity forecast, so they are providing input to the four stages and four stages are namely the trip generation activities to number of trips distribution telling me the interchange where from the trips are coming or where the trips are going which are generated.

Then the mode choice decision, tell me how the trips are getting distributed to available modes and the traffic assign tell me that. How the trips from one point to another point using a particular mode, how they are getting distributed to different routes or different paths to give me the final demand in terms of link volume, intersection volume, bus ride receive and so on and so forth.