Urban Transportation Systems Planning
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Lecture - 59
Activity Based Modelling

Welcome to module I lecture one. In this module we shall discuss about the emerging trends in transportation planning. We will have two lectures in this module. The first one today is on activity based modelling.

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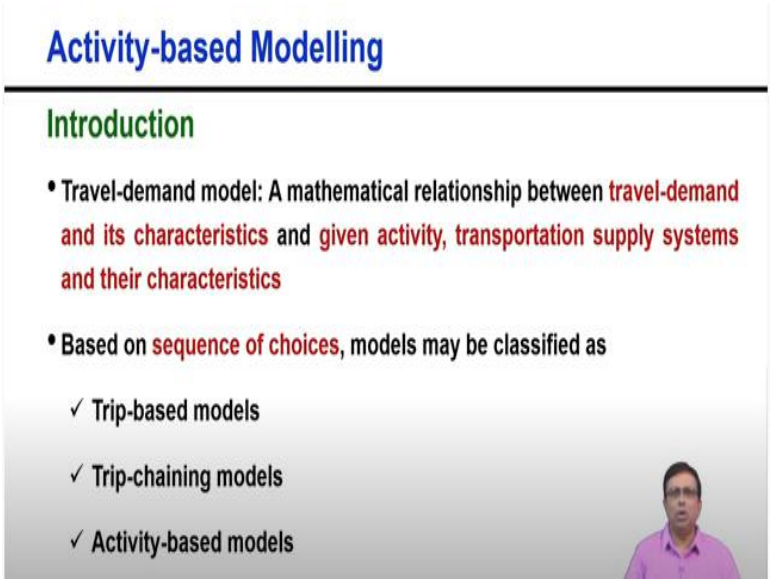

So, in this urban transportation systems planning course we are discussing about the travel demand model. Now just to remind you once again what is a travel demand model? It is a mathematical relationship between travel demand and its characteristics on one hand and given activity and transport supply systems and their characteristics on the other hand. So, we are trying to map the relationship between travel demand and its characteristics with given activity distribution transportation supply systems and their characteristics.

Now in so many ways we can classify the travel demand models. But based on sequence of choices models can be classified as trip based models, trip chaining models and activity based models.

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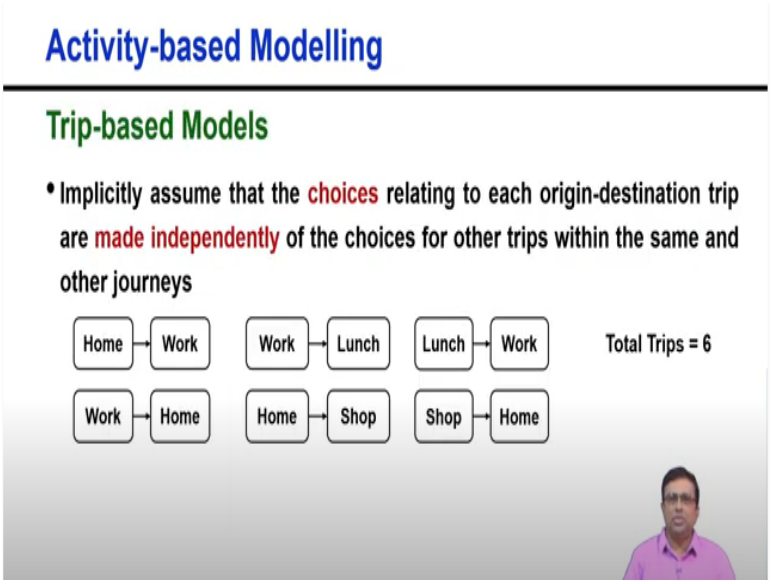

Now the trip based model you are familiar with this kind of models because all throughout this course the fourth stage transportation planning we have discussed about trips and these are basically all trip based models. So, what we are assuming say person starting from home going to work and then from work going for lunch coming back to office and then in the evening coming back home and then maybe again going out from home for shopping purposes, the home to shop and then coming back from shop to home.

So, each trip from one origin to another destination is a one way trip. So, in the trip based model we shall consider that there are total six, number of trips that are made by that person. And what we are implicitly assuming is that the choices related to each origin destination trip are made independently of the choices for other trips within the same or other journey. Say that means going from home to work is one trip, work to lunch another trip, lunch to work another trip.

And then work to home is one more trip. That is one probably back home just one round or one chain we can consider. But each of these trips is considered to be made independently. That means they are not dependent on each other but that is not very realistic. Say for example, if you are a person going from home to work the primary purpose is to go for work and then he will probably go to some nearby place for lunch.

And overall if you see these trips are not really they are discrete, they are different trips obviously. But they are not independent because a person morning to evening we know that we have to do many works and we accordingly try to schedule the works keeping in mind the purpose of the work, the location where it is, then the time when one has to go to that particular activity or go to that particular place where the activity is there. So, they are not completely independent or they are not completely independent.

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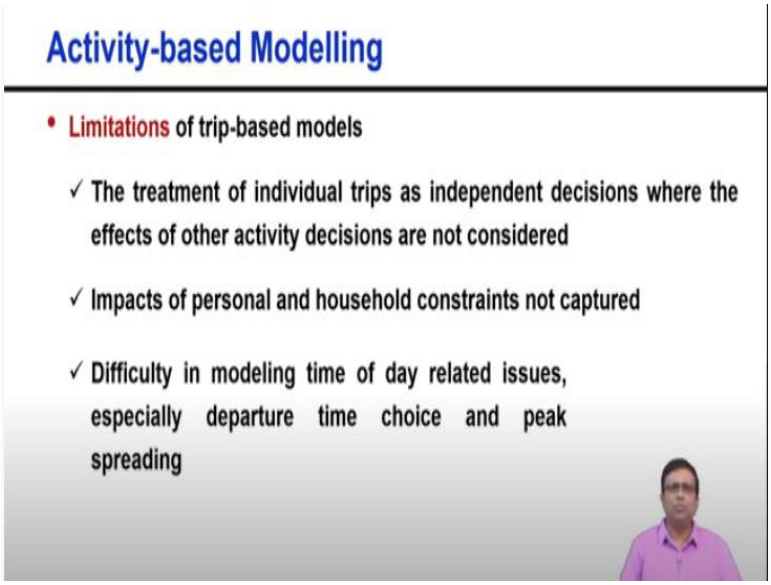

So, these limitations are there for the trip based model that the treatment of individual trips as independent decisions where the effects of other activity decisions are not considered. So, actually say morning somebody has to drop the child to school and then maybe do some kind of shopping and then go to the office and then from the office, maybe go to the bank for some work and like that.

So, many activities in a day are scheduled and accordingly we try to plan our travel. So, this treatment of individual trips as independent decisions where the effect of other activity decisions are not considered is a limitation. Similarly the trip based models do not consider impacts of personal and household constraints. These are not captured in those models. So, that is another limitation.

So, we know that in a family all of us we live together and it is like one team. So, everybody it is distributed actually that what the uncle will do, what father will do, what the child will do, what the wife will do, everything activities are basically distributed. And then everybody does their work and accordingly the trips are produced. But in many cases the trip based model we do not consider the impacts of personal or household constraints while we are modeling the trips.

Then there are also difficulties in modeling time of the day related issues especially the departure time choice and peak spreading. Say any kind of we are doing the trip based model so I will discuss that even later also. Suppose there is condition pricing in the peak hour. Now how that will affect? I mean if we know that the peak hour the bus fare is very different or the congestion pricing is done people that will you know impact the departure time choice of people wherever possible.

Maybe still people will go to office but people will try to avoid other works during the time. So, the departure time choice peak spreading this kind of context state cannot be considered in trip based model.

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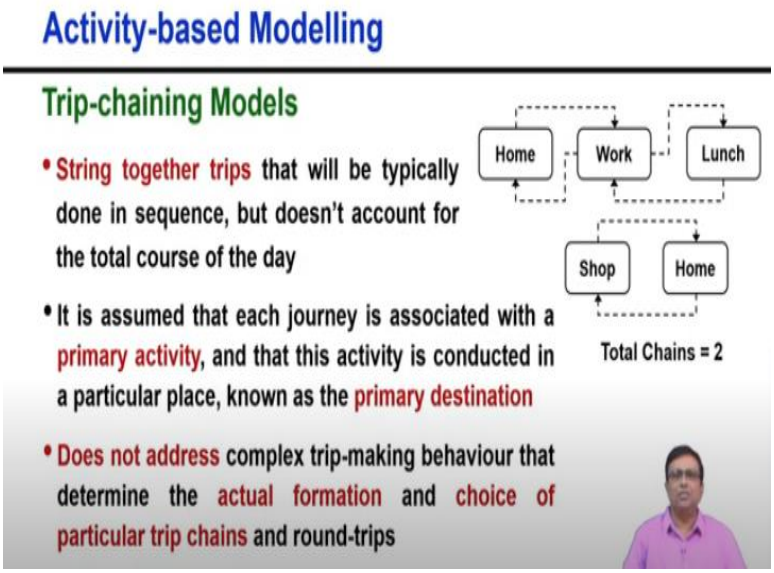

Now to overcome this difficulty next what it comes is basically trip chaining models. So, what we are doing here trip chaining models they string together, trips that will be typically done in sequence. But again does not account for the total course of the journey. That means I am

starting from home, going to work, work to lunch, lunch to back to work and then back home. So, home to home is just one trip, one chain.

But again then home to shop and shop to home back in the evening may be another trip chain. So, what we are doing we string together trips that will be typically done in sequence. People will start from home, go to work and then after some time probably will go for lunch during the lunch break and come back to work then in the evening as per the schedule probably will come back home.

So, the trips which will be typically done in sequence are considered together and that is one chain here. And similarly another chain shopping trip in the evening, home to shop and back home. So, there will be total of two trip chains. So, to some extent this is fine because we string together trips that will be typically done in sequence but do not account for the total course of the day.

The trip chain one and trip chain two they are almost considered independent. But they are also not independent because there could be some kind of policy, some kind of actions where the interdependency will be there. It is assumed that each journey is associated with a primary activity. So, that means this activity is considered in a particular place known as the primary destination.

For example, home to work and then work to lunch, back to work but we know that the primary activity is work not lunch. So, the primary activity is the work. So, there may be office is located at a certain particular place so that is the primary destination and that is the primary activity for which the trip is being made. Trip chaining model does not address complex trip-making behaviour that determines the actual formation and choice of particular trip chain and round trips.

Because as I say still we; are putting the trips together in a chain. But not really considering in a holistic or practical manner the actual reason for such kind of trouble and forming the sequence of trips in a realistic sense.

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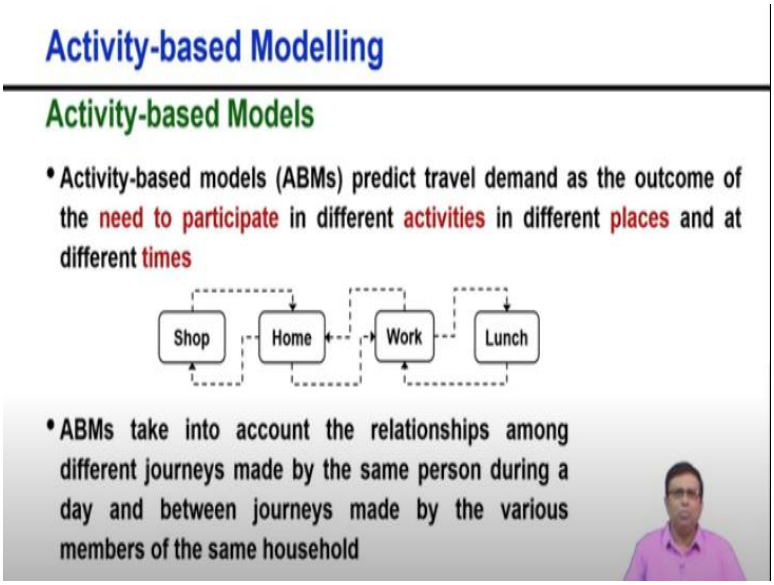

So, that brings the activity based model. That is the next development. Activity-based models predict travel demand as the outcome of the need to participate in different activities in different places at different times. Actually that is the way the actual travel happens. So, in the morning itself we know what all to be done. Children are to be dropped to school and then I have to go for shopping.

And maybe go to the bank, sometimes to transfer some money or pay some money or bills and then go to my office. And then in the evening some invitation is there, so the family has to go together the invitation. In the whole day certain activities are to be done and each of these activities are to be done at different places at different times. So, accordingly we decide then how I make the sequence of trips so that I can be at the right place at the right time.

And I can do all these activities together which are supposed to be done by me on a particular day. So, as you can see that here the main focus is, the outcome is, the need to participate in different activities. That is the basic purpose in different times and at different locations. So, that; needs actually will produce probably multiple trips in a specific sequence at specific time targeting specific destinations.

So, activity based models take into account the relationship among different journeys. So, the interdependency or the linkage is considered very strongly made by the same persons during a day and between journeys made by the various members of the same household. As I say when I am going to drop my drop children then I have to accompany children and maybe in the evening when I am going for a marriage ceremony the whole family will accompany me.

Office I shall go alone, may be shopping I can go with my wife and so on so forth. So, all these aspects are in a very practical and holistic way are considered in the activity based model which are not considered in complete sense in the trip based model and also the trip chaining model. Trip chaining model is one step, advancement of what you say the trip based model but then the true things, more realistic, more practical things are getting considered in the activity based model.

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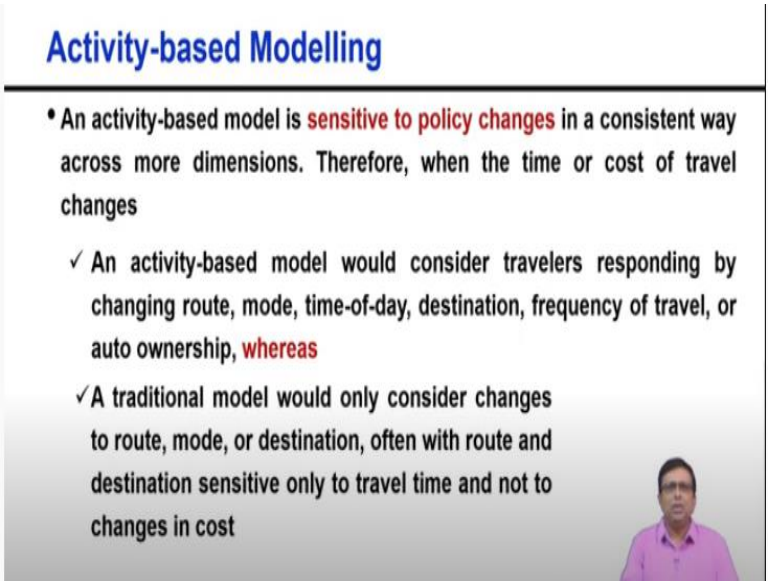

So, in an activity based model the most beautiful thing is that it is sensitive to policy changes in a consistent way across several dimensions. That is the beauty. Many of the questions you will see in the next few slides also which cannot be answered by traditional trip based models. They can be addressed and they can be investigated such kind of policy impact, how they will impact the travel.

That kind of things can be investigated very well using an activity based model. Say for example, when the time and cost of travel changes a traditional model would only consider change to route, mode or destination and many times we find the route and destination sensitive to only travel time and not to even change in the cost. So, what will happen? They will not consider anything beyond.

Same travel will be made at the same time but maybe if the cost or time changes then how the route will be changed, how the mode will be changed, those things will be captured. But then when you are doing the activity based model they would consider travelers responding by not only changing route, mode or destination but also the time of the day when the travel will be made.

Even the frequency of travel or even the change in the auto ownership so that kind of across several dimensions the things can be captured and the sensitivity will be there to various policy changes related to those aspects.

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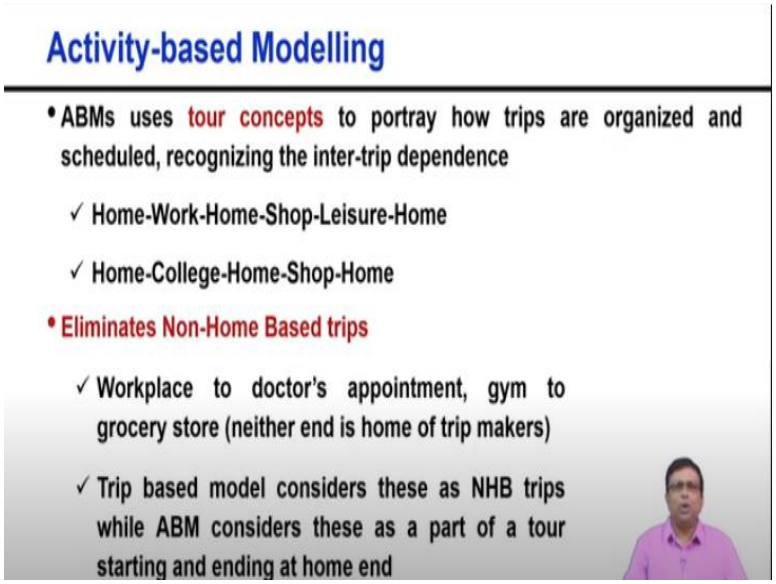

Activity based model uses tour concepts to portray how trips are organized and scheduled recognizing the inter trip dependence. That is the beautiful thing. Because I do not think about a trip, people do not think about a trip in isolation. They know that during the day what all activities are to be done. So, the whole planning is done keeping those activities in mind. Maybe

home to work and then back home, going to shop and then going to a park or somewhere for a leisure trip and then coming back home.

Or a student will probably go home to college, come back home and then evening again go out for shopping, coming back home. Now all such kinds of say in the first case the person knows that he has to go for work, he has to go for shop and he has to go for a leisure trip. And home is always the one end repeatedly coming there. So, in this case that to all other places he has to go probably only once, home multiple times.

Because that is where the trips are finally produced and finally get terminated as well. Now the certain beautiful things with the activity based model will be mentioned now. The first one is it eliminates non-home-based trips. Now non-home based trips are always a problem. Non-home based trip to consider during the classification of trips I have mentioned and that trips could be classified as home-based trips and non-home based trips.

Non-home based trips are those where neither end of the trip is at home of the trip makers. So, for example, work place to go to a doctor's chamber for an appointment or as per an appointment then maybe going from gym to grocery store. So, such kinds of trips if you see neither end is home end and we generally in the trip based model we consider these trips to be non-home based trips.

Now; non-home based trips estimation is really a challenge. How do you estimate it? In non-home-based trips you can home-based strips you can estimate, you can model very nicely taking the characteristics of the households and in the zonal characteristics, production you can model, attraction you can model. But non-home based trip handling, non-home based trips also always a challenge.

Now this activity based model eliminates non-home based trips. What happens? That activity based model considers all such kinds of trips as a part of a tour which is starting and ending at home end. So, going from home and then plus 1, plus 2, plus 3, plus 4 finally coming back again home. So, there is nothing called which is non-home based trip. Because it is all the activities

which are forming this structure, how and at what sequence people will go using what modes, even mode interdependency will be there.

If I am going out with a car for shopping and then from there I am going to meet my friends or going for a recreational trip I may as well go by car only. Because I have gone by car so you see the choice of mode is also dependent. What I have done for one segment and then what I am doing for the other segment with the same trip chain. So, that is one advantage.

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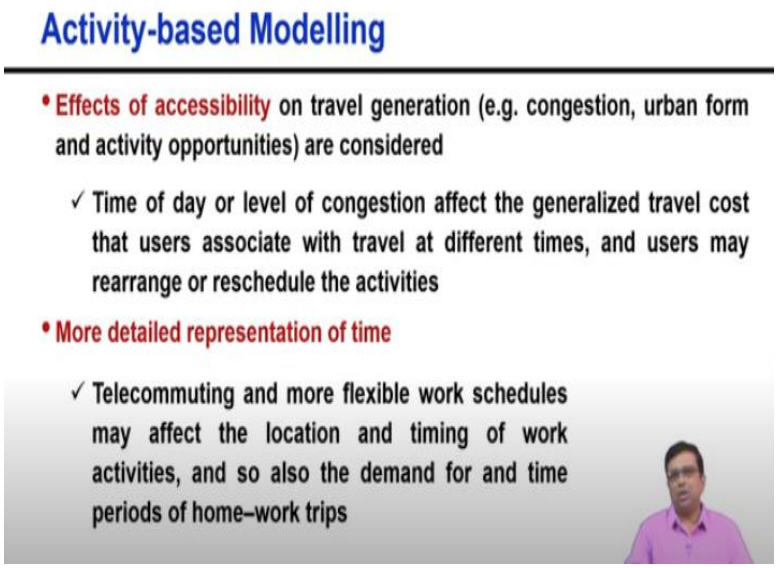

The second is the effects of accessibility on travel generation are considered. Say for example, what is the level of congestion, what is the urban form, what are the activity opportunities there and all such kinds of things how they are going to impact. So, basically the accessibility, what is the impact on travel generations that are considered. I have given an example here. Time of the; day or level of congestion affect the generalized cost of travel that users associated with travel in different times.

So, you know different may be the peak hour I go, I have different generalized cost then the generalized cost of travel in the off-peak hour and therefore users may rearrange or reschedule the activities. I may decide I will not go to this place for this purpose if possible of course. Something may be rigid also that if everyone has to go at ten o'clock then everybody has to go at ten o'clock if there is no other flexibility.

But many other activities can be rescheduled or users may rearrange or reschedule activity. Such kinds of things cannot be considered in conventional models but can be considered in the activity based model. Activity based models help to have more detailed representation of time. Say for example, telecommuting and more flexible work schedules may affect the location and timing of work activities.

People may use that opportunity if there are more flexible work hours. So, the demand for and time periods for home to work trip may change. Now how do you bring such kinds of things in a trip based model? We will not be able to understand the impact of such kind of policy interventions, how they are going to impact the travel.

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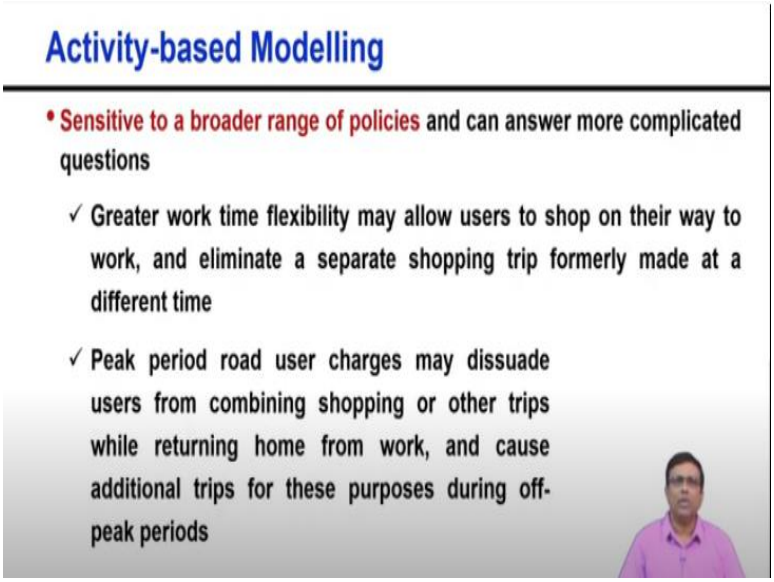

Similarly activity based modelling is sensitive to a broader range of policies. We are coming back to this again and again and trying to tell you probably in so many ways and therefore it can answer more complicated questions. Say for example, greater work time flexibility if that is available that may allow users to shop on the way to work. They may decide that I will finish my thing, I will do a little bit of shopping and then I will go to work.

Because it is convenient at that; time and considering the location where these kinds of activities or shopping is located and so on. And therefore it may eliminate separate shopping trips which

were formerly made at a different time. But on the other hand if you consider that peak period you reduce the charges are to be done and then this may eventually dissuade users from combining shopping and other trips while returning home from work.

Because they know that the user charges will go up and the congestion price will go up. I mean the more time they travel probably they are going to pay more and therefore may cause additional trips for the purpose all those to satisfy all those needs during some off-peak periods. So, such kind of you see that policy implication is broader range of policies that can be investigated once you go for an activity based model.

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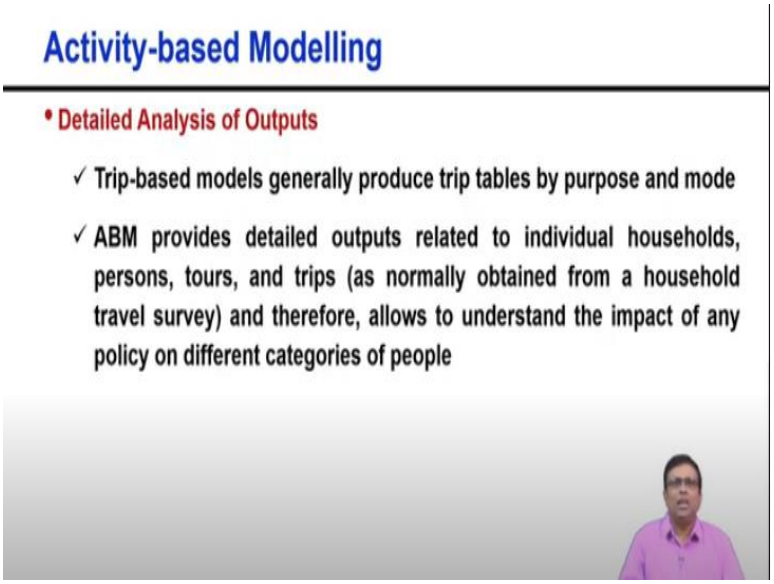

Then detailed analysis of outputs is possible. Say trip based models generally produce trip travel by purpose and mode. So, we can have different trip tables for different modes. Public transport trips, private transport trips, IPT intermediate public transport trips, like that you can do or even by purpose also. But then activity based models go much beyond that. It provides detailed output related to individual households then all the persons in that household then all the tours, individual trips.

It is almost like you get information from a typical household travel survey. That level of detailed information is available. So, you can actually classify them in so many ways the trips beyond what you could do are probably based on a trip based model. And therefore eventually is

it just by classifying it in so many ways how does it help? Because it; helps us or modellers to understand the impact of any policy on different categories of people. So, that is again an advantage.

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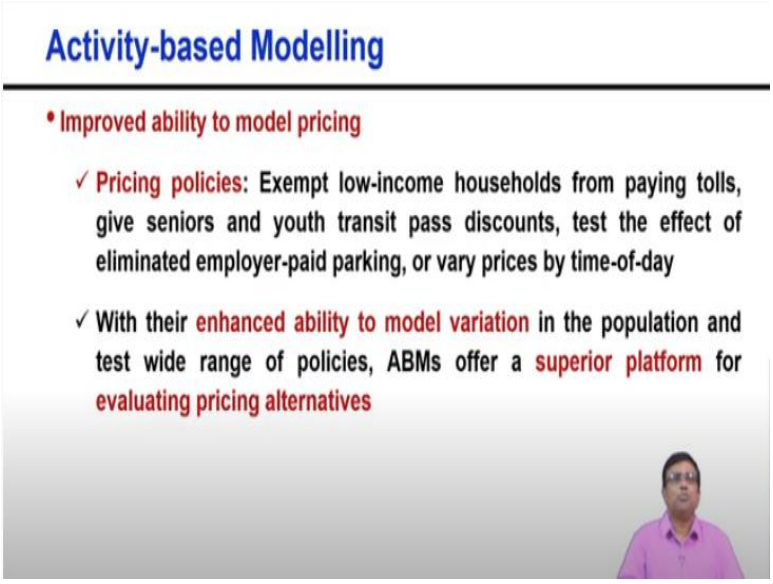

Activity based model helps us to have improved ability to model pricing. Pricing is a very very interesting and important issue and so many ways the pricing policy can be investigated. So, many ways really, say for example, exempt low income households from paying the toll. I mean you do not ask them to pay a toll or give seniors or youth some transit pass discount or test the effect of eliminated employer-paid parking. Employer-parking is a very peculiar thing.

If the parking charge is paid by your employer then whatever is the charge that you are going to get paid that amount by your employer. So, your requirement for parking or travel may not really get that way impacted by the pricing or the parking charges whereas people who do not remember that amount they will probably get impacted. And here I am saying test the effect of eliminating employer-paid parking or may be the very parking price by time of the day.

How that is going to impact the travel? Now such kind of things it is impossible for you to get through the trip based model. So, with their enhanced capacity to model variation in the population and test wide range of policies activity-based models offer a superior platform for evaluating pricing alternatives. So, many pricing related policies can be considered and can be

evaluated very effectively in a very practical manner when you are going for an activity based model.

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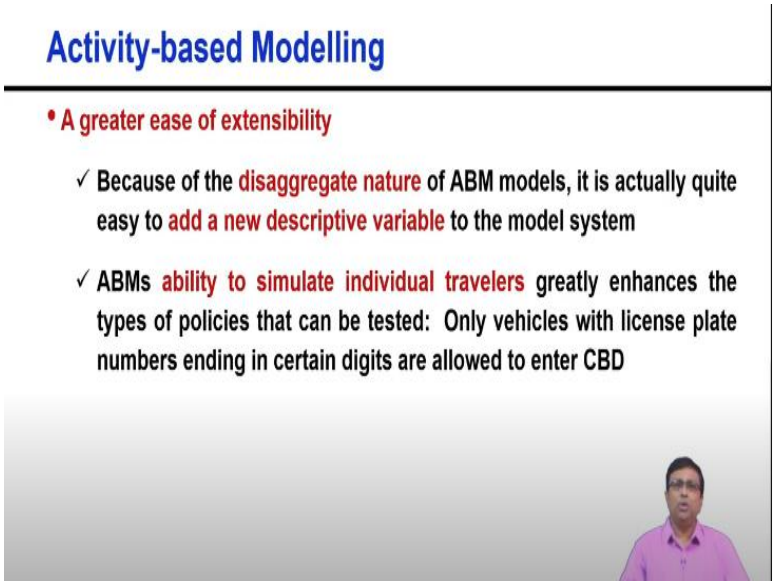

Similarly it offers a greater ease of extensibility. That is one unique advantage of activity based models. Now because of the disaggregate nature of ABM models they consider each person and try to simulate their behaviour and travel. So, it is actually quite easy to add a new descriptive variable to the model system. So, ABM's ability to simulate individual behaviour greatly enhances the type of policies that can be tested.

Say for example, only vehicles with license plate numbers ending in certain digits are allowed to enter into CBD. So, in the Delhi situation also people did something like odd even policy. So, suppose you consider the CBD area where only on certain days certain vehicles ending with some digits are allowed to enter such kind of things how it will impact overall? Because people are residing in different locations they have different destinations. How it is going to impact overall sense can be very nicely captured if you are using activity based models?

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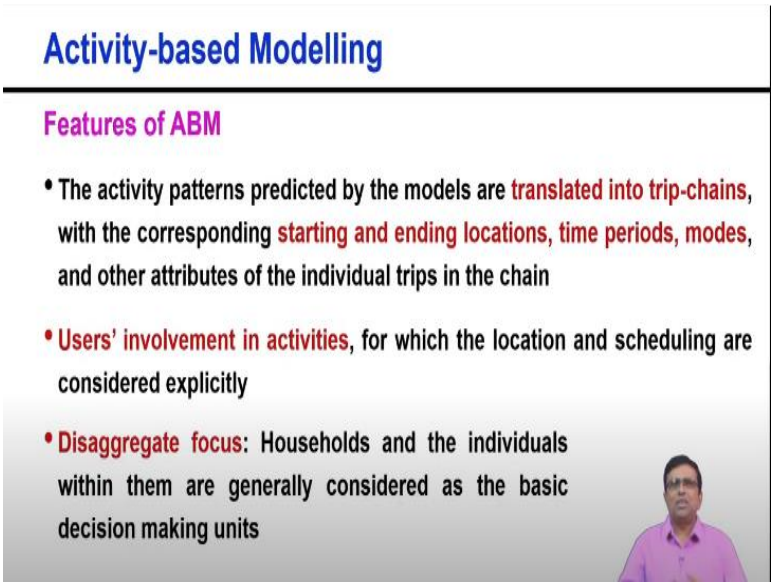

There are several features of activity based models which are interesting. The activity pattern predicted by the models are actually translated into trip chains with the corresponding starting and ending locations, the time period, the type of mode that is used and other attributes of individual trips in the chain. Now the user's involvement in activities is a major strength for which the location and also scheduling are considered explicitly in the activity based model.

Then there is a focus on disaggregate modeling households and the individuals when within them are generally considered as the basic decision making unit and we are eventually actually simulating each and every person each and every trip chains and tours or throughout the day how the trips are happening.

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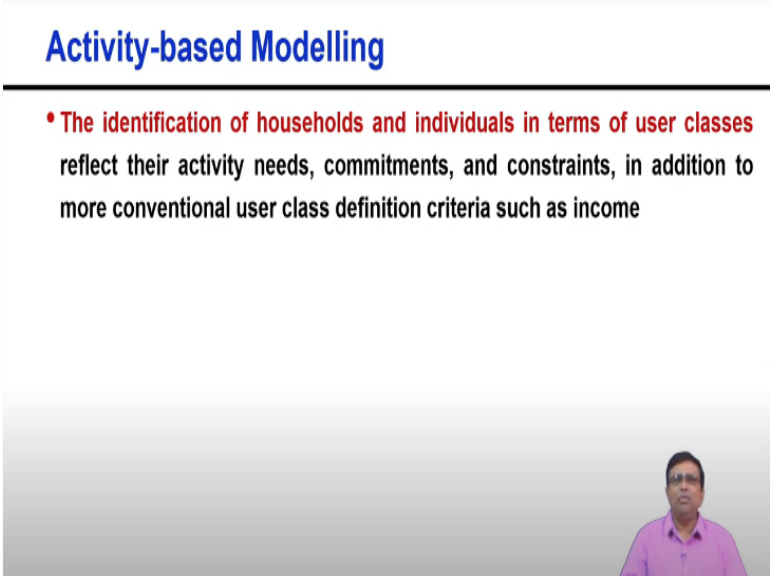

The identification of households and individuals in terms of user class reflect their activity needs, their commitments and constraints in addition to more conventional user class criteria such as income. As I said that in a trip based model also you can say how income influences it. But how the household constrained individual constraints all other kinds of issues influence the travel behaviour those cannot be captured in a trip based model but which can easily be investigated in activity based models.

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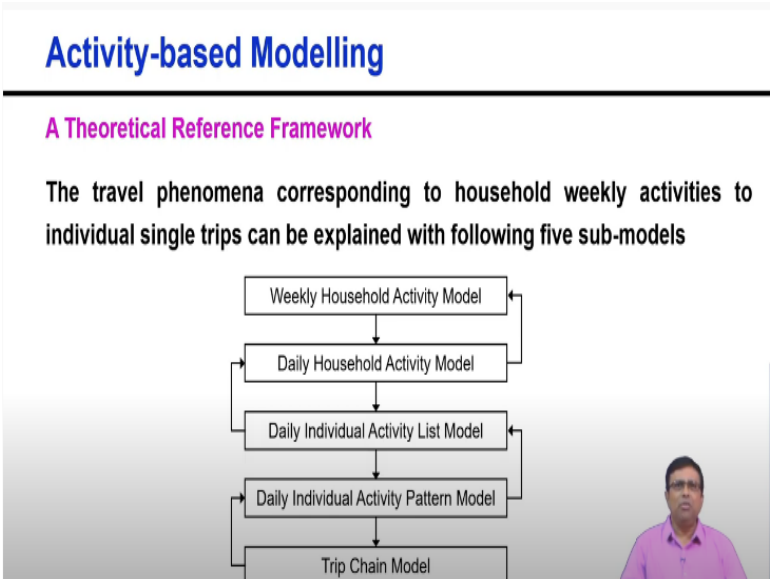

Quickly let us go through the theoretical reference framework. The travel phenomena corresponding to household weekly activities two individual single trips can be explained with the following five sub models. The first one is weekly household activity model then daily

household activity model then daily individual activity list model then daily individual activity pattern model and then finally the trip chain model with all feedback loops and the interchanges.

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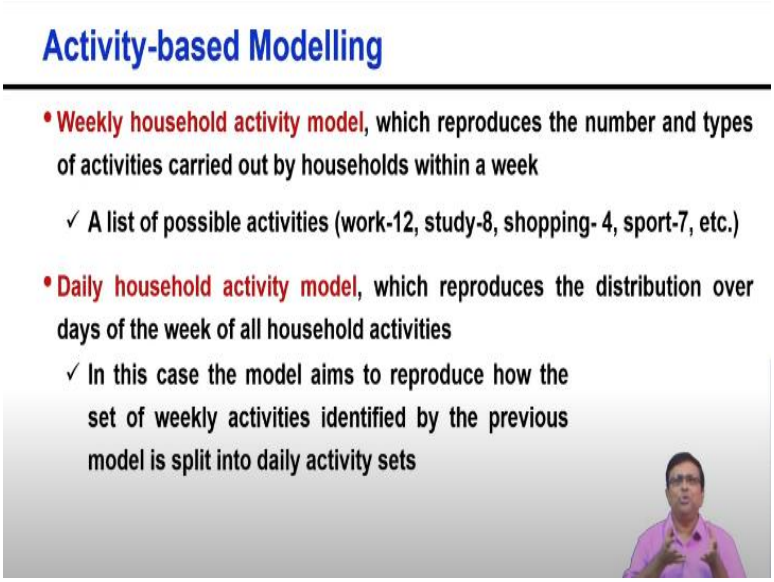

So, what we are saying let us explain it. Weekly household activity model here we consider how many number of trips and what type of activities are to be carried out by households within a week. So, every household weekly what all things to be done for example, maybe there has to be 12 work trips and 8 study trips or educational trips then 4 shopping trips, 7 sports trips maybe some more like recreational trips, social trips and so on.

So, you know that almost in a house it is just like a team. So, in a typical cricket or football team what happens? All members contribute their own way and collectively the team works the whole thing or the whole team then can serve the purpose. So, here also like the overall household, what all needs to be done? That is considered in weekly household activity model. Then week means multiple days form a week.

So, then we try to then consider if that is the weekly household activity model then what will be the daily household activity model? That means which represents or reproduces the distribution over the days of a week of all household activities. That means I know that 12 work trips to be made probably every day Monday to Saturday 6 work trips will be there and maybe study trips on certain days.

So, shopping not every day or not may be consecutive four days maybe some particular pattern will be there. So, distribute this, weekly household activities to daily activities that if weekly I have to do this thing that means every day then what all needs to be done. So, in this case the model aims to produce how the set of weekly activities identified by the previous model is split into daily activity sets and obviously the total of all weekly activities has to match with the weekly household activity because those constraints are to be satisfied.

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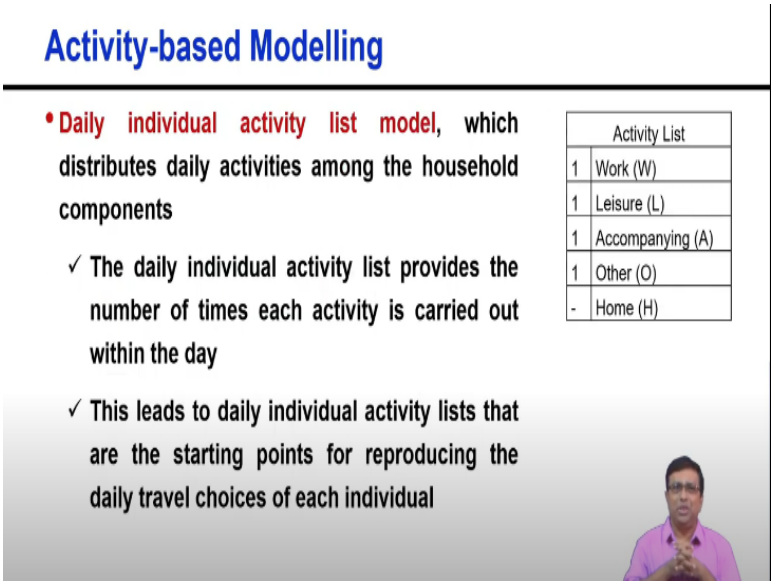

Then we know that every day how many activities to be done. But there are several members in the household who will actually participate in those activities, sometimes individuals, sometimes together. So, now what we do? We do the daily individual activity list model. So, weekly activity for the household then for daily activity for the household then daily how an individual member has to do participate in various activities.

So, it distributes daily activities among the household components. So, daily individual activity provides the number of times each activity is carried out within the day and this leads to a daily individual activity list that is the starting points for reproducing the daily travel choices of each individual. For example, maybe an example is one work trip for one member, maybe one work trip, one leisure trip, one accompanying trip going with mother or going with wife or somebody and then one other trip and of course home can come multiple times.

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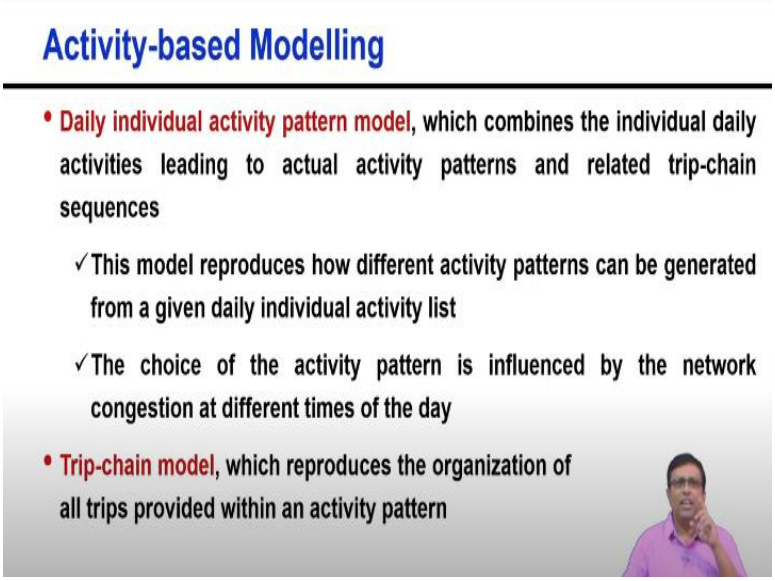

So, then next is we know that every individual what activities they have to do. Now every individual daily individual activity pattern model here what we do we combine the individual daily activities leading to actual activity patterns and related trip chaining sequences. Now here this model reproduces how different activity patterns can be generated from a given daily individual activity list.

And the choice of the activity pattern is also influenced by the network congestion at different times of the day, pricing policy, congestion pricing, other kinds of policy intervention. Then what is the sequence and knowing the commitment that certain place certain activities are there at certain times. Sometimes the time is rigid sometimes the time may be flexible also. I can decide when I want to go for shopping or when I want to visit friends depending on a certain range or within a certain boundary because I can only go for shopping when the shop is open.

That kind of thing will be there. But it may not be as rigid as when I am going to the office that I have to go at 10 o'clock only. So, there is certain flexibility and the whole thing can be organized accordingly. So, the trip chain model which produces the organization of all trips produced within an activity pattern.

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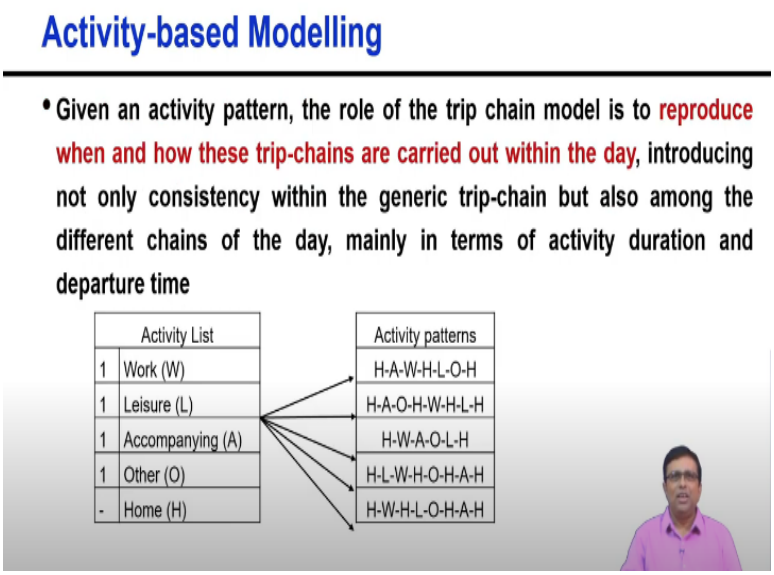

Now I have shown here you can see the activities and from that activity how different activity patterns can be formulated. So, all the activities are done with different possible activity patterns and who can come back again and again. You can say home to accompany the trip and then to work and then to home and then to leisure and then again another trip and back home or it could be the second one, third one.

So, you can see that for the same activity list there are possible several activity patterns. Now given an activity pattern what is the difference between activity pattern and the trip chain. Now trip chain model is to produce when and how these trips are carried out within the day. So, introducing not only the; consistency within the generic trip chain but also the different chains of the day mainly in terms of activity duration and departure time.

So, how much time you are required for each of this activity and what will be the departure time those kinds of completeness will be provided when you will be considered when you are making the trip chain model. So, interestingly if you consider what are the three things, first is the weekly household activity then daily household activity then how much will be done by the individual. These three are called upper level decisions which are the long term thing.

Because it depends on a very different context, the household and how many people are there, what are the household requirements.

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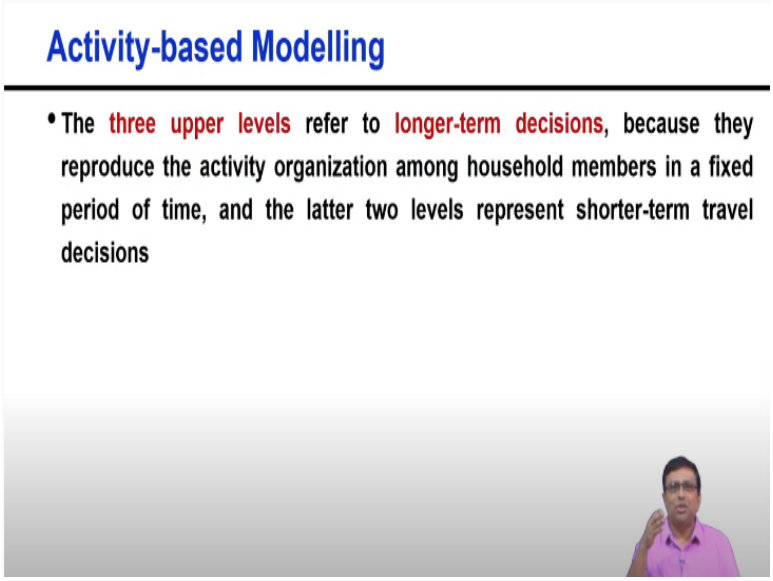

But then the last two mainly means the daily activity pattern model and trip chain model; those are generally called short-term travel decisions and these decisions are influenced by various transport related policies. What pricing, what restrictions and where the congestion occurs and all such kind of factors which are related to the network, related to the transport system they are called the short term travel decision.

The broad thing remains the same, broad thing does not change every day. But these things get adjusted depending on the transport network and other pulse intervention.

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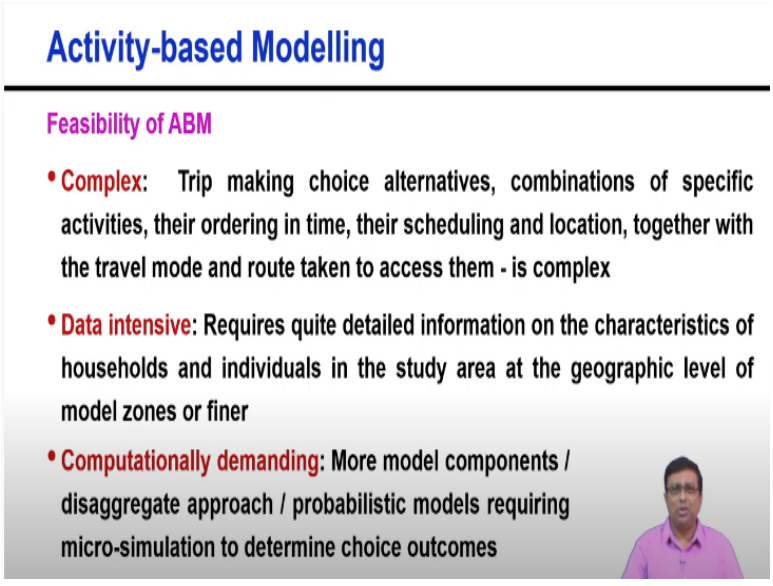

So, if they are quite good but one has to remember that activity models are complex. Because the trip making choice alternatives combines specific activities, their origin, ordering in terms of time, in terms of scheduling, location together with the travel mode and the routes taken make the whole thing a bit more complex obviously as compared to the simple trip based model. And it requires a lot of data because the whole thing, individual travel behaviour is simulated in the whole consideration is there. So, it is very much data intensive. You need a lot of data.

And also it is computational demanding, more modal components basically disaggregate approach you use probabilistic models and use micro simulation to determine the choice outcomes. So, computationally it is more demanding.

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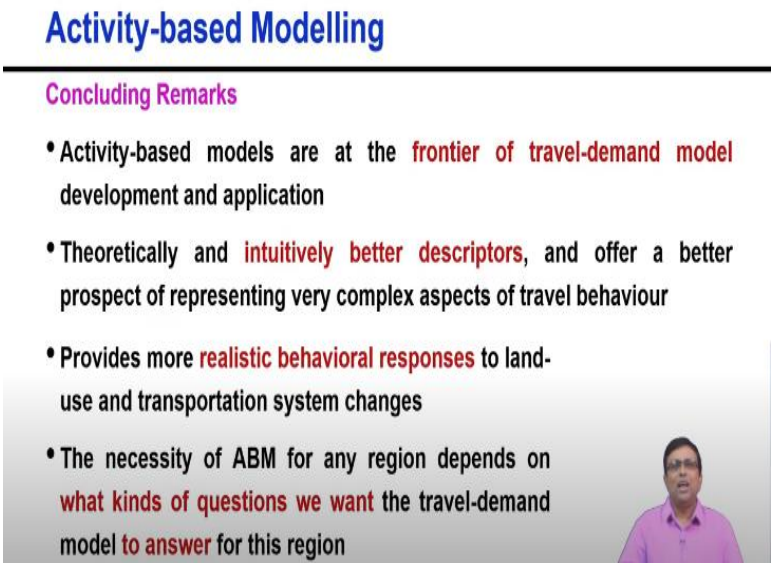

And finally we would like to say that activity based models are really at the frontier of the travel demand model development and application. In the future more and more applications will happen. Theoretically and intuitively better descriptors and offer a better prospect of representing very complex aspects of travel behaviour which other simpler approaches or simpler models cannot consider.

Provides more realistic; behavioural responses to land use and transportation system changes. As I said so many examples we tried to give you. The necessity of course for ABM for a region depends on what kind of questions we want to answer for the travel demand model is expected to

answer. As you know that there are several medicines so if there is a simple fever maybe a Paracetamol will work.

If it is not, it is much more complex then you may have to go for antibiotics and go for other things. So, similar kinds of things all modeling approaches are there. So, if my questions I am trying to answer get answered, if I can get answers with the simple model I will still use a very simple model. It is not that I need to use a very complex activity based model. But if there are certain questions I am trying to get answer which I cannot get answers from the simple trip based model then I will go for the activity based model.

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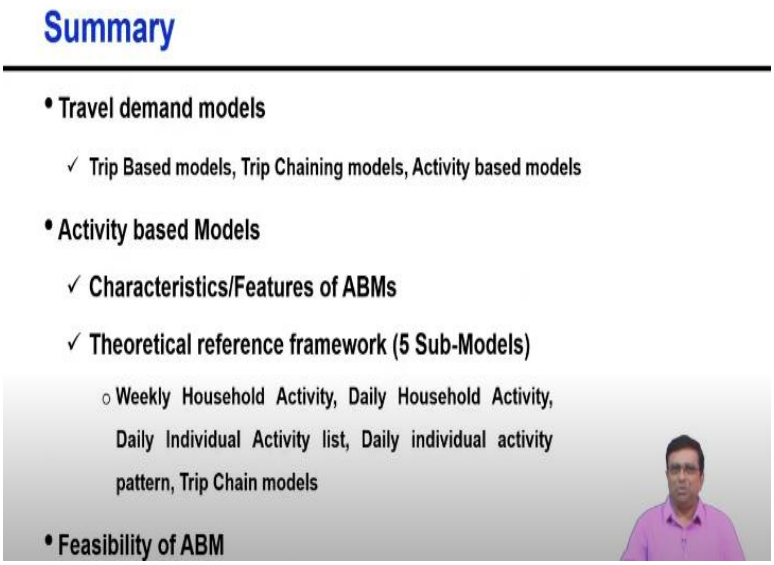

So, we discussed here different types of travel demand models, trip based, trip chaining based and activity based model. Then discussed briefly the characteristics or features of activity based model and gave you a theoretical reference framework 5 sub models starting from weekly household activity to daily household activity then each member activity and then of course the structuring of individual activity pattern and trip chain model.

And then concluded with some remarks regarding the feasibility and where and what, why we should apply activity based models. Thank you so much.