Urban Transportation Systems Planning
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Lecture - 58
Urban Goods Movement – IV

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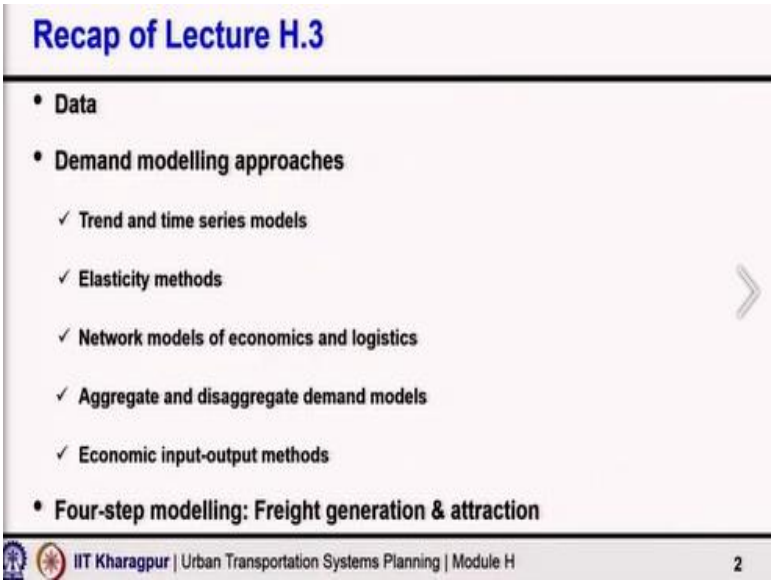

Welcome to module H, Lecture 4. In Lecture 3 we discussed about the difficulty in terms of getting the data which are required for doing goods transport demand modelling. Then we discussed about various demand modelling approaches namely the Trend and time series models, Elasticity method, Network models of economics and logistics. Then the general classification or general categories of model like Aggregate models and disaggregate models.

And also, about this Economic input output methods. Then we said that it is possible to use the knowledge of four stage demand modeling as you have learned during the travel demand modeling for passenger transport. The same framework may be applicable for also modelling the goods transport demand. But goods transport are very very different from passenger transport in so many ways, we discussed at length.

So, all those are to be kept in mind and directly we cannot just apply those models with the same factor same method here. But suitable modification and due consideration to the unique features

and various characteristics that are required when we are trying to map the Four step modelling. And we started our discussion about the freight trip generations and productions and attractions.

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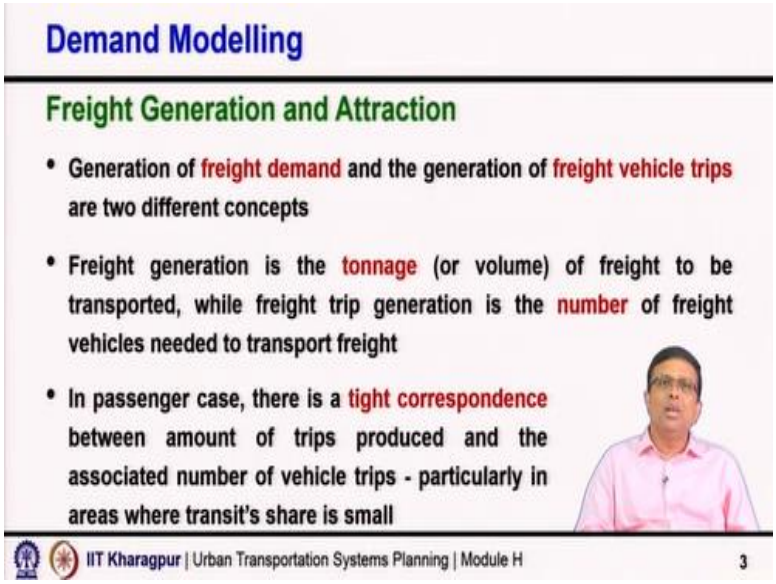

So, freight generation and attraction although have written it here for generation and attraction, I would generally say that let us consider it freight generation. Generation includes both production and attraction. So, we should not ideally use freight generation and attraction but should tell only freight generation. Now the generation of freight demand we said that is different from generation of freight vehicle trips, because those are two different concepts.

While freight generation is generally expressed in terms of tonnage of freight, how many tonnages or how much tonnage are generated or produced? Freight trip generation is normally expressed in terms of number of freight vehicles in the context of freight transport. And as we said that the when we are talking about the passenger transport that how many people want to travel and how many vehicles will be there, they are generally there is a tight correspondence.

I give an example that if there are public transport is not so prominent or not so much developed. And if we consider people travel by personalized vehicle like cars then during the work trip the average occupancy will be normally 1.1 or 1.2 or 1.3. So, you can directly get how many people and then the corresponding how many vehicles or how many cars on road. But here the freight has got unique requirements different types of goods have their own transport requirements.

And the relationship between the amount of freight in tonnage. And in terms of the actual number they are not same.

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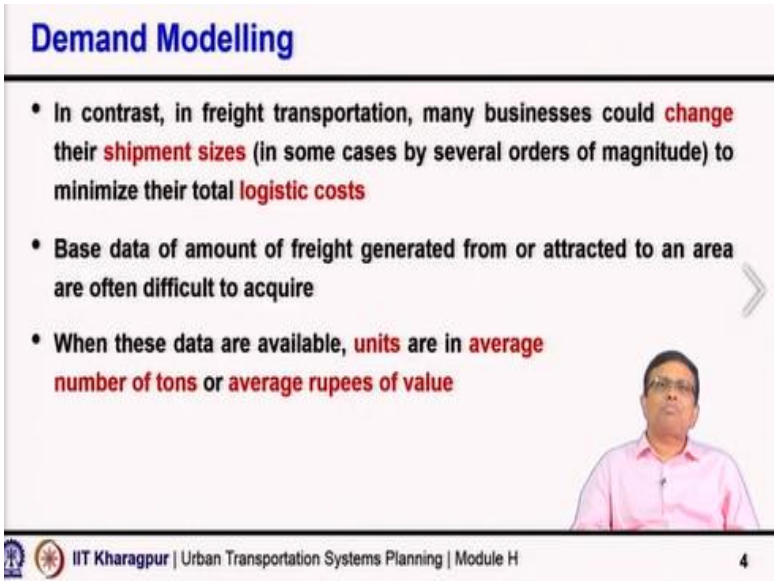

And that is why in contrast to passenger movement in freight transportation many businesses could change their shipment size. In some cases, even by several orders of magnitude to minimize their total logistic cost, the cost of transport is a major major consideration. And then we said about the data difficulties as well. And then said that whenever these data are available generally, we express it in terms of average number of tons per unit.

You know whatever appropriate unit as per the context. Or if we want, we can sometimes express it in terms of the actual value, how many rupees how much rupees or how much dollar whatever is the currency accordingly we can express it.

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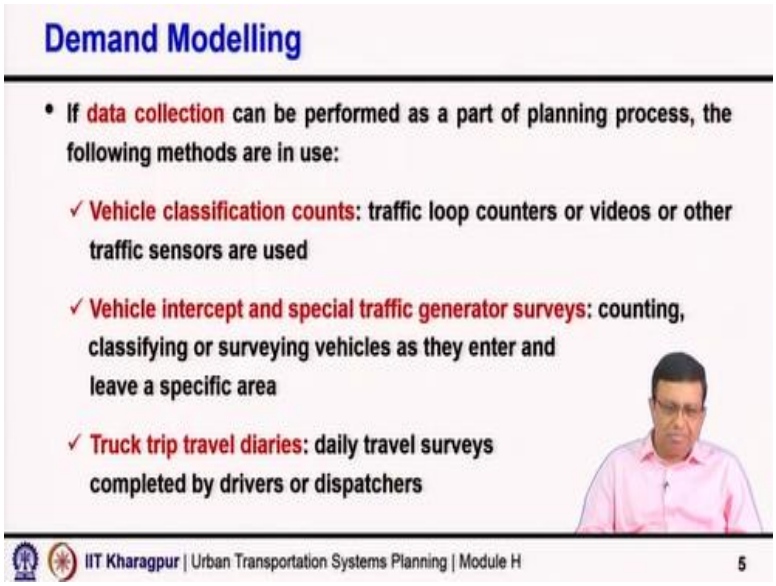

Now if we have to collect data for the demand modelling in the trip generation context and try to understand the overall freight movement what is really happening now. Then that can be performed in the following methods using the following methods. First may be Vehicle classification count. So, we can use traffic loop counters, detectors or some kind of video graphic technique or other kinds of traffic sensor to identify how many goods vehicle are travelling.

And you know what kind of configurations those vehicles have the classified vehicle volume count we can do and from that we can estimate, that how much freight movement is really happening. Second is through vehicle intercept and special traffic generator surveys. We can do the counting we can classify it or surveying vehicles as the entire or leave specific areas. So, you know in a particular area how many vehicles are coming from outside.

We can simply measure it at all the all the you know counter points basically. You can also carry out truck trip travel diaries as we do it even for the passenger also, we do it passenger transport travel diary surveys, so same kind of truck trip travel diaries can be collected. So, which include basically daily travel surveys completed by drivers or it could be dispatcher also, dispatcher knows how many vehicles they are dispatching every day.

And what kind of consignment they are taking where these vehicles are going. So, it is getting about all related data as we collect the data for four stage planning process. So, initially overall

understanding we want to develop. Similarly, this kind of data can be collected using the truck trip travel diaries.

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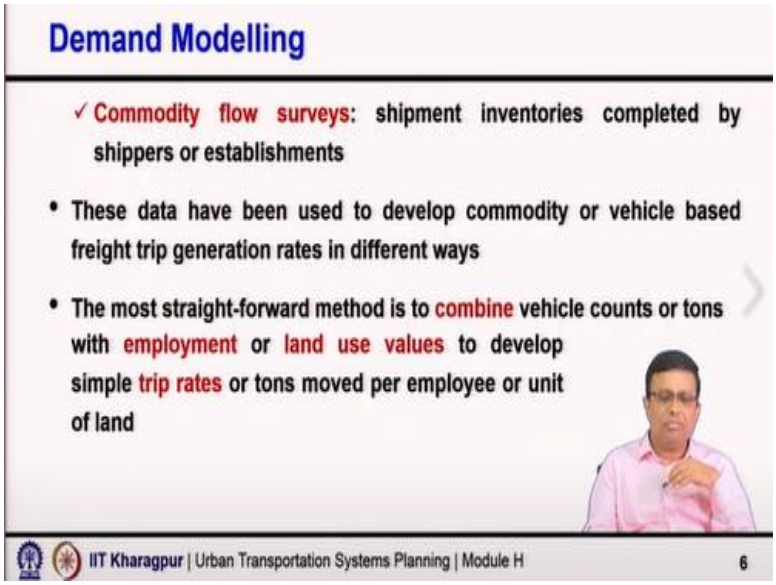

One can also carry out commodity flow surveys, that is also adopted or accepted practice shipment inventories completed by the shippers or establishments, through that we can get the commodity flow data and we know how the movements are happening. Now these data have been used to develop commodity or vehicle-based freight generation trip rates in so many different ways, different types of analysis are possible.

Trip rates are you are familiar when we discussed about the trip generation modelling approaches, we say that we could use multiple linear regression or go for the cross classification of the category analysis. In category analysis we use different trip rates. So, here the similar kind of thing the trip rates trip generation rates by land use by commodity you know as appropriate we can actually calculate.

The most straightforward method is to combine vehicle counts or tons of goods with employment or land use values, that means per unit area of land or per unit employee the rate we are actually trying to establish the rate. So, rates could be as you know in so many ways you can calculate per unit area of land per unit area of the economic units. That also we can say or per employment.

So, per unit resource basically how much tons are of goods are produced or what value of goods are produced that way we can put it. So, that is what we say land use values to develop simple trip rates or tons moved per employee or per unit of land or per unit of area of the economic units.

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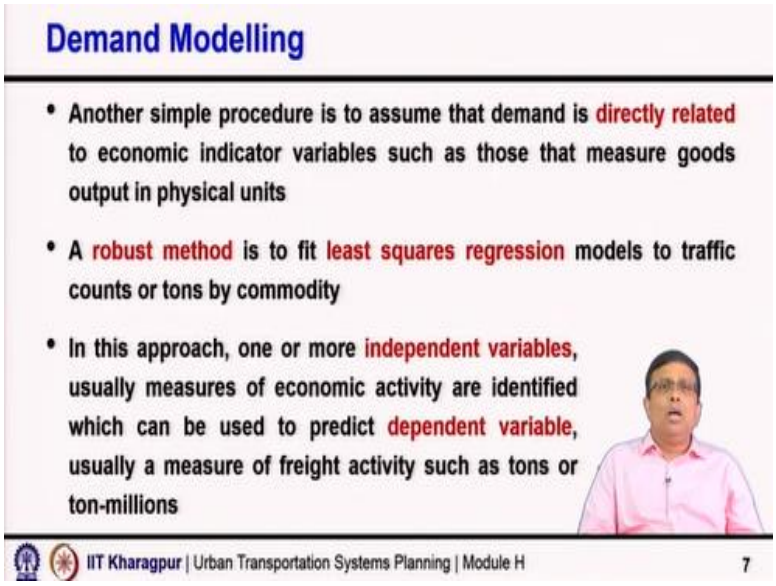

Another simple procedure is to assume that the demand is directly related to the economic indicator variables such as those that measures goods output in physical units. And a robust method is as usual is to fit least square regression model. This is also again approach wise very similar to what we discussed earlier in the context of passenger travel demand models, specially the trip generation models to similar kind of approach you can use it here.

And in this approach as you know one or more independent variables, usually measures of economic activity are identified and which can be used to predict the dependent variable, usually it is a measure of freight activity such as how many tons or how many million tons goods are produced. So, the causal variables are taken and the dependent variable is also taken. And then we try to map the relationship using least square regression model.

So, that is also there. So, through that we calculate that per unit area how much you know goods are produced.

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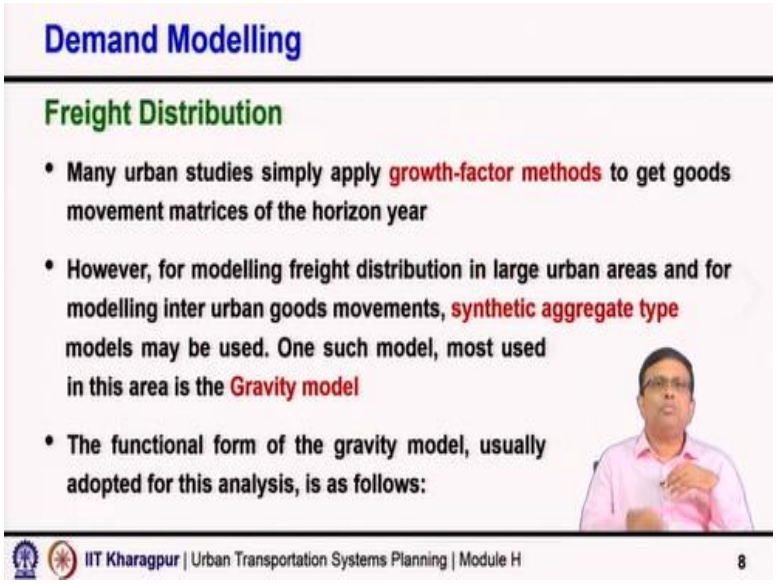

So, like cross classification or category analysis somewhat we are able to map. And also, the regression model that also we are able to map. But the factors are very different so we need to consider appropriate factors. The technique wise or approach wise it may be same. So, the same framework is applicable here also when you develop a regression model, you will see whether the coefficients are statistically significant.

What is the goodness of feed of the model but the variables have to be the real variables or the factors we have discussed already which influence the freight trip generation. The next step is basically the distribution. Now many urban studies simply apply growth factor methods again not different in passenger transport context also we discuss several growths factor-based methods or models.

So, similar kinds of growth factor-based methods are used, so you have the current measurements and then you apply certain growth factor to get the future values. So, the base year or the current year the quantities or the demand is known, I mean how much point to simple like the O-D survey at the corner and volume count and O-D survey also we can do and we can map the distribution.

And then apply it, apply the growth factor on that. And any of the known methods which you have already studied and you know you can apply them. However, for modelling freight distribution in large urban areas and for modelling the interurban goods movement, one can also use or one may use more suitably synthetic aggregate type models. And the model what you have you have of goods learned so many different types of model.

But what you can apply here easily is the Gravity model. The same kind of basic understanding can also be mapped for the goods movement, how the distribution is happening? Distribution depends on like the production like the attraction and also the special separation or some factor of special separation between the zones.

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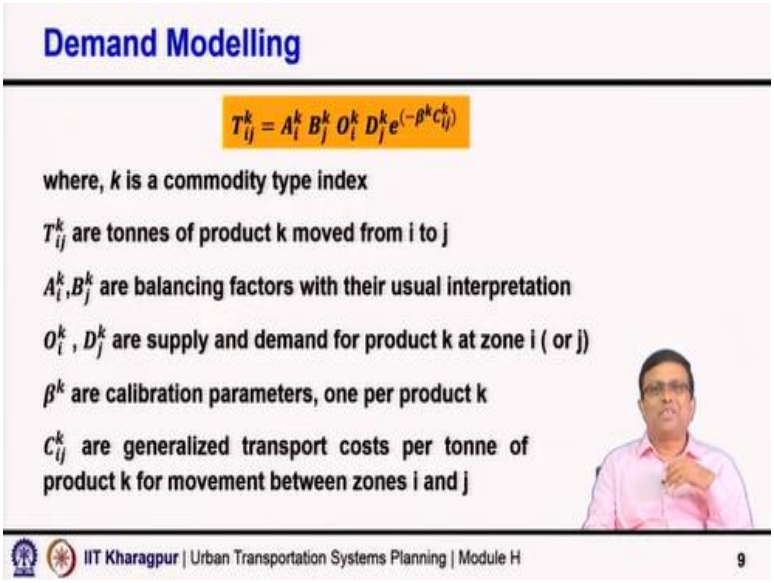

So, the functional form of the gravity model usually adopted for this analysis is as shown in the slide. Are you familiar with this model or model form? Yes, you are familiar. We have discussed this is very similar to what you have studied in the trip distribution part when we talked about the passenger travel demand models. This is doubly constraint gravity model, people also call it some special separation model or some other names also are there in literature.

They all essentially similar kind of things they indicate and here as I said that the k indicates the commodity type index. And T ij k are the tonnes of product k which move from i to j. A i, B j are the balancing factors very very similar to what we studied earlier, y and D j are the supply and

demand for products at of product k. The k indicates the type of product we say that for goods, so many different goods.

So, the distribution also cannot be same or the deterrence also cannot work in the same manner for all the products or all types of goods. So, the case a particular commodity type index. Otherwise this is again what is the production and attraction similar kind of things are used here. And beta are calibration parameters as I say to the power minus beta C ij. So, beta is the calibration parameter and k beta k means for product k.

So, product specific beta value. C ij is as usual is the generalized cost per tonne of product k movement for between zone i and zone k.

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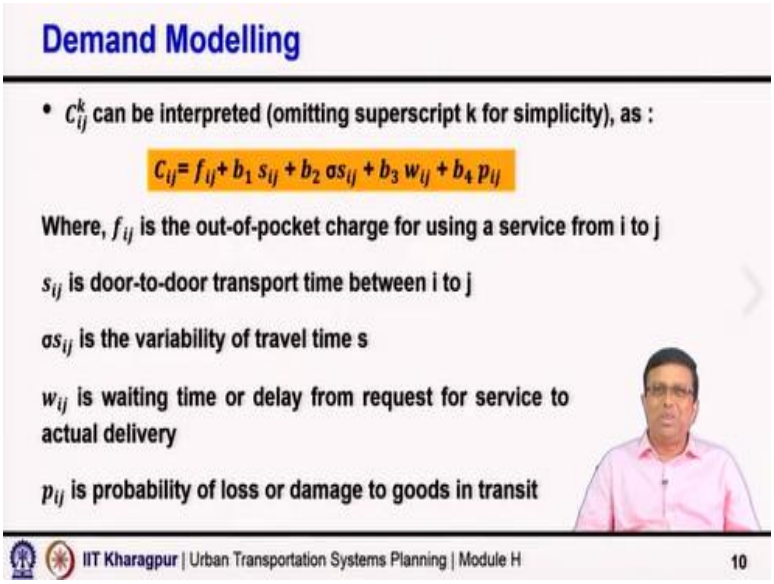

Now the cost is here the way we calculate the cost for goods movement, that is very very robust I should say. Generally, if we just remove the commodity type part, then we can generally say express C ij as I have shown here with so many components. So, it includes basically door to door transport time if you consider time, then the other factors are the variability in the travel time then the waiting time or the delay from this request for service to actual delivery.

That secondly taken the days or the waiting time is taken. Then the probability of loss or damage of good in transit these are all very unique to goods transport. So, the conceptually we are still

taking a gravity model, we are applying it also. But the way the cost is defined, this is very specific to goods movement. And this cost depiction is very very different from what we have done or what we have used earlier for the passenger transport.

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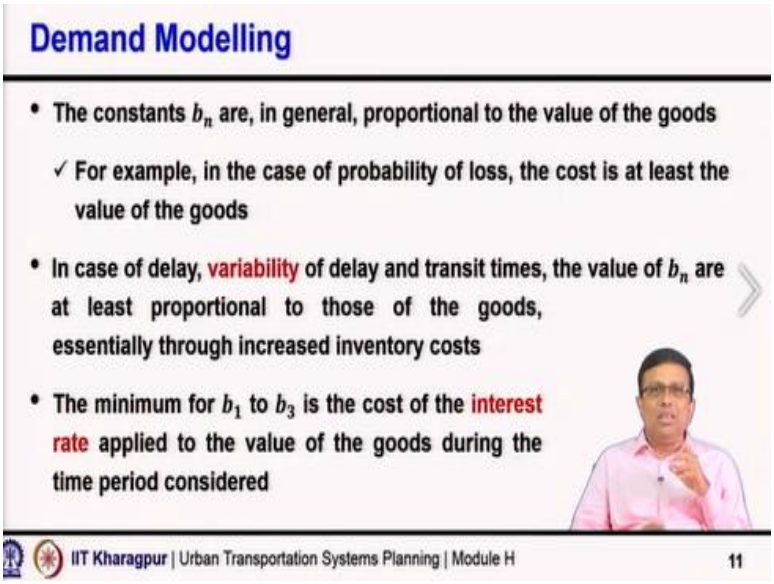

The constants in general are proportional to the value of goods whatever all the coefficients you have used here. This coefficient values are like b 1 b 2 b 3 b 4. So, like that in general I am saying the constant b n, if there are n number of variables then b n. And in general, are proportional to the value of goods, higher value means higher will be the cost also. So, for example in case of probability of loss thus cost is at least the value of the goods that would be the minimum.

And in case of delay variability of delay and transit times the value of b n are at least proportional to those of the goods essentially through increased inventory cost. And what could be the minimum value of b 1 to b 3 is, b 1 to b 3 you can see that what are the b 1 b 1 is associated with S ij which is due to do transport time, b 2 is associated with the variability in time.

And W ij b 3 is associated with the waiting time. For b 1 to b 3 the cost the minimum values are the cost of the interest rate applied to the value of the goods during the time period consider. Because these are very very logical very logical it is not complicated in a sense. But what one

has to be careful that I am taking things which are which makes sense in the context of goods transport and which are goods transport specific and meaningful components.

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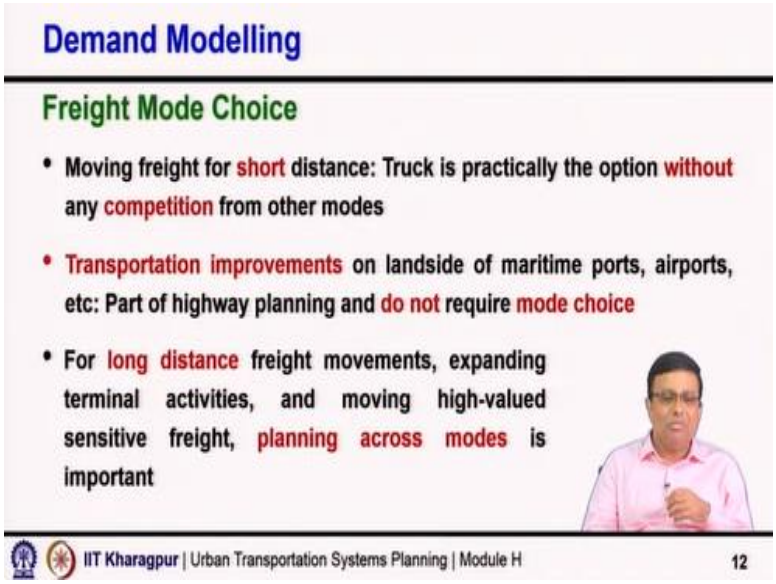

Then coming to the mode choice. That is the third stage that was there for the mode choice. Now if you want to move freight for short distance, so within urban area just one point to another point and that is assuming that is a short distance. Urban area also one point to another point could be not necessarily is always short. But if you take short distance then track is truck is the practically the only option.

You cannot you know take any other mode, so without any competition from other mode. So, in this case there is practically no more choice, we do not need to do more choice analysis. Because whenever you are thinking that you want to transport some commodity from point i to point j that time itself the decision is made. That we want to transport it from point i to point j using truck.

And depending on what is the consignment size depending on other factors requirement of the specific goods specific requirement you decide the type of truck you want to use. So, if you want to move freight for short distance as truck is the only option and the decision is already taken. So, there is actually there is no other option and so there is no competition and no context or more choice.

Similarly, if we are doing some kind of transportation improvement on land side of maritime ports, airports. So, you have already airport you have a maritime port and you are doing the transportation improvement on the land site of maritime ports and airports. Then it is essentially what we are doing is it comes under part of highway planning. So, it is actually you know a port or airport cannot work in isolation without the road infrastructure.

So, you are basically doing the transportation improvement. Here also again we do not require the more choice. So, in such situation it is not again a more choice because goods will still use the many time ports still probably use airports. But then the land transportation part you are improving. So, it is basically the transportation improvement or comes under highway planning kind of work, so the more choice is again not applicable.

But then there is some context where the more choice is also important. For long distance freight movement expanding terminal activities and moving high valued sensitive freight planning across mode is very important. So, the more choice also comes into picture.

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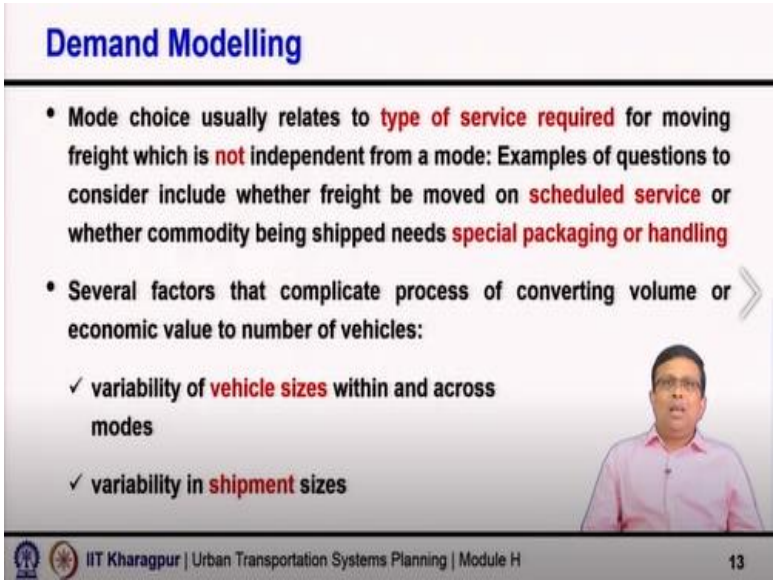

Mode choice usually relates to the type of service required. I am trying to indicate that when you decide a mode you actually bearing in mind what kind of service is required for that commodity. So, more choice usually relates to the type of service required for moving freight, which is not

independent from a mode. So, the service requirement type of service required is linked with the type of mode.

So, by which mode I am transporting the goods the service the type of service I am looking for is getting linked with the mode. So, they are not different decisions, so that is what I said carefully observe this statement. Mode choice analysis usually relates to type of service required for moving freight, which is not independent of a mode. So, it is again that requirement of the type of service is linked with the type of mode I am using.

For example, of questions to consider include whether freight to be moved on scheduled service as usual what we are normally using. Or whether the commodity being shipped needs special packaging or special handling. So, obviously if it requires some special packaging or special handling and special care you want to select mode accordingly where it can get that special care. In general, you know the sensitive goods people do not like to send by rail, although within urban area the scope for using rail is very limited.

But I am just saying in general contest even for long distance freight, people do not like to set sensitive goods which needs to be handled with care and with proper you know extra caution. They do not try to send such kind of goods by rail. Because that perception is there. So, they prefer to send it by road transport. So, several factors that complicate the process of converting volume or economic value to the number of vehicles finally the mode choice is all about getting the number of vehicles.

Some factors which are important in this context are. One variability of the vehicle sizes within and across modes, you talk about one mode to another mode, but within one mode itself you as I said you talk about trucks it is not one type of truck. So, many different possibilities are there and the requirements will depend on what you want to transport. That is the primary factor which will govern.

Then variability in shipment size not every size of consignment can be transported using every type of vehicle.

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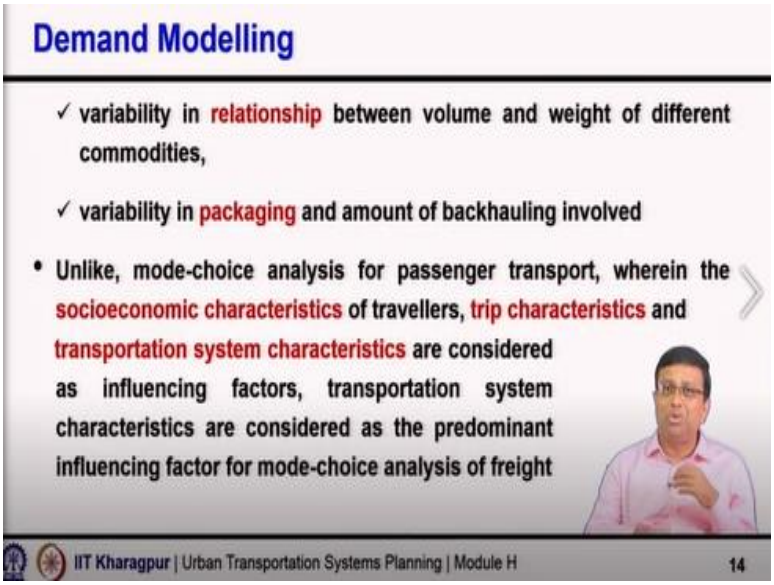

That is again a consideration to decide when you are trying to convert this how many tonnes to how many vehicles or how much value to how many vehicles. Third variability in relationship between vehicle volume between volume and weight of different commodities. Weight and volume are again two different things. Some commodity could be where the volume is really the dominant thing, weight wise it may not have.

But you can only carry certain you know volume. You cannot it not just the weight, weight wise also there is limitation volume wise also there is limitation. And the volume and weight of different commodities are different and there is a variability in relationship between the volume and weight. How much weight will bring, what volume? Or how much volume will break, what weight? This is not same for all commodities.

These are going to vary, last also variability in packaging and amount of backhauling involved, that is again very important. The requirement again commodity specific. Remember here unlike mode-choice analysis for passenger transport, where in the socioeconomic characteristics of traveler, trip characteristics of traveler and transportation system characteristics of the travelers all together are considered to influence the decision.

In the case of goods transport, it is predominantly the transportation system characteristics. That is going to you know the influence the more choice of the freight, not so much on socioeconomic characteristics or trip characteristics. It is basically the transport system characteristics, I am sending by truck or I am sending using certain special kind of vehicle or I need some refrigeration or temperature control facility within the vehicle.

So, that my injections or medicines and vaccines they remain you know effective and usable. So, that will decide. So, the transportation system characteristics as a whole I am considering. Including the vehicle part that is going to dominate not so much on socioeconomic characteristics or not so much means socioeconomic characteristic really does not play any role or trip characteristics.

Of course, trip partially may played a role whether it is you know short trip or you know how long you know it will take to transport that may govern sometime. But predominantly it is transportation system characteristics. That is going to dominant.

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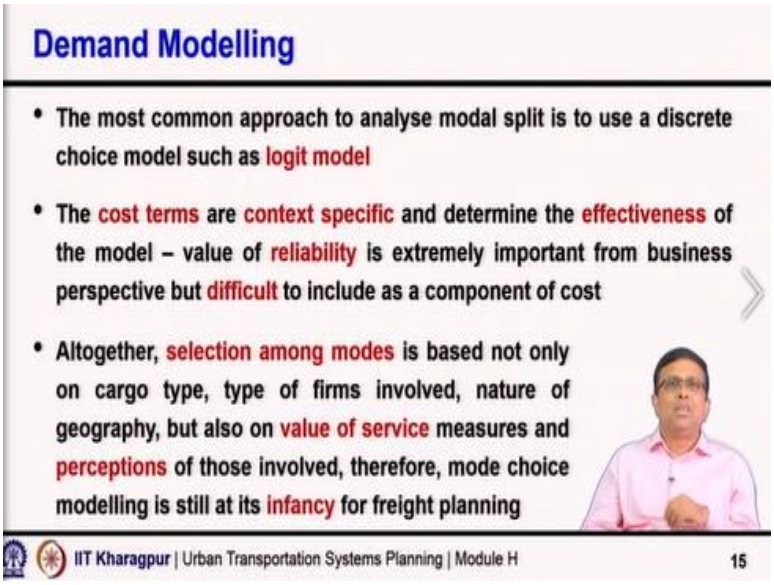

The most common approach is to analyze model split is to use a discrete choice model such as choice logit model. As I said the future is descriptors or disaggregate model and the logit model variety of logit model is used. So, for passenger transport for goods transport both cases the logit

model or behavioral based model are going to be used extensively. The cost terms are context specific and determine the effectiveness of the model.

How you are considering the cost, that very important. It depends on the cost but how you are considering the cost what are all components you are including how you are getting that cost function. And here one thing is very interesting and important that the value of reliability is extremely important from business perspective. That influence that that controls the decision. If I have to transport something the reliability sometimes is very very important.

But it is equally difficult to include this value of reliability in the as a component of the overall cost or generalized cost. So, it is important, it is a necessity because reliability really is an important factor business perspective point of view or from business perspective. And it is but it is difficult also to include it as a component of cost. All together selection among modes is based not only on the cargo type or type of form involved or nature of geography all these do influence.

But also, on value of service measures, as I said indicated the reliability. And such kind of factors value of service measures and the perception of those involved, as I said that normally, if sensitive goods which need little bit special care or so people are not interested to send by rail, because the perception is very different. Therefore, more choice planning because of these complexities for goods transport or goods demand is still at it is infancy for freight planning.

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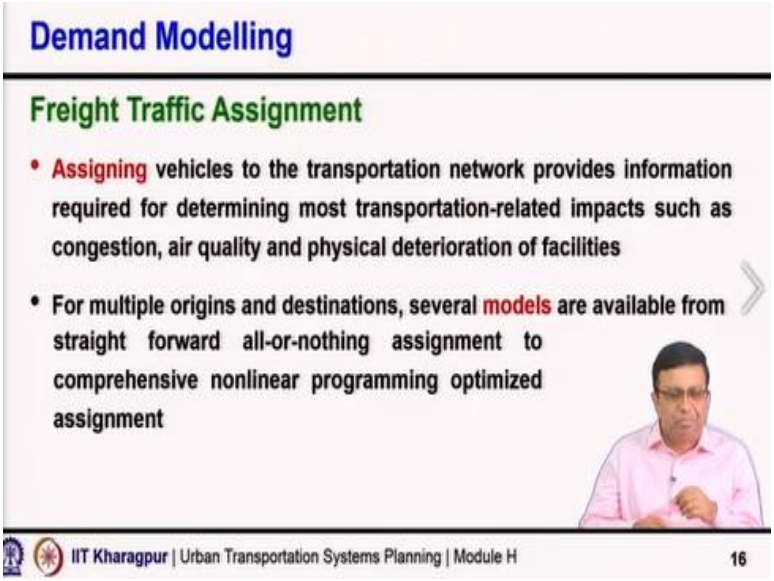

Now coming to the Assignment. Assigning vehicles to the transportation networks provide information required for determining the most transportation related impacts such as it depends on what will be the impact in terms of congestion in terms of air quality in terms of physical deterioration of facilities. Because most cases urban areas the congestion is a serious problem the air quality is a big issue, I have mentioned it right in the beginning of my course.

Also, when I started talking about this goods transportation there itself, I mentioned it, again I would like to remind you the for-root assignment or the traffic assignment part. That is again an important consideration. And physical deterioration of facilities not all types of road can handle freight traffic. Because your pavement design considerations have to be there, you remember the way we design the highways village road we do not design in the same manner.

We do not expect them to carry so much load. Similarly, in the urban area also not all roads are designed to carry heavy traffic. Maybe the major arterials fine but not all roads. So, physical deterioration that will happen on facilities what will be the impact on pavement altogether what will be the impact on air quality what will be the impact of congestion all these are important. For multiple origin destinations several models are available;

Starting from whatever you have learnt you starting from the simplest one like all-or-nothing assignment to different advanced assignment technique, even the non-linear programming optimized assignment large number of possibilities are there.

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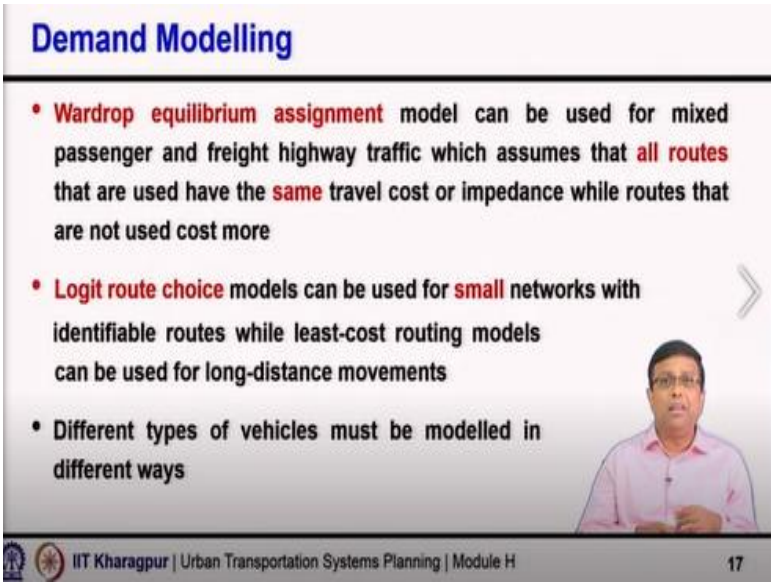

But again, it depends on what is most suitable for a given context. One can use Wardrop of equilibrium assignment user optimal assignment model. That can be used for mixed passenger and freight highway traffic where together we are assigning traffic, which assumes that you know it that all routes that are used have the same travel cost or impedance while routes that are not used have either same or higher cost.

That is the typical user equilibrium you are all familiar with this one we have discussed at length about this equilibrium assignment. And various considerations in the context of traffic assignments again, you can use also logit route choice models for small networks with identifiable routes. And for why least cost routine models can be more suitable for long distance movements. Small networks multiple paths are there.

So, all paths are likely but for long distance obviously the freight assignments when we are doing because the again the philosophy is slightly different. So, here it is more appropriate to consider the you know least cost routing models for long distance movement. Different types of vehicles

must be models in different ways, where their characteristics are different their requirements are different when they are in the traffic or along the routes.

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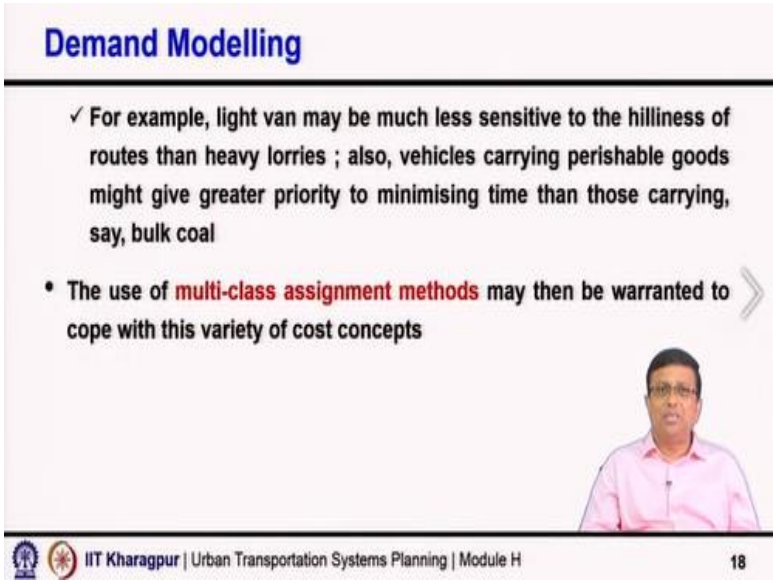

For example, the light van may be much less sensitive to the hilliness of the route. It can easily negotiate a small goods vehicle like the light commercial vehicle what you say. But heavy lorries you have to take care you have to consider that what is the gradient along that road whether my heavy vehicles can negotiate that or not. Also, vehicle scaling perishable goods might give greater priority to minimizing time.

Than those which are carrying may be other kinds of good where the time value is very less practically nil. So, bulk coal is getting transported. One-hour two-hour time considering the overall hauling distance it may not matter much. But if the perishable goods if it is medicine if it is other kinds of you know very special value goods then that it is a different bulk in them different consideration.

So, the use of multi class assignment technique may be warranted to cope up with the variety of cost concepts because they are actually different class. So, it comes under multi class assignment techniques I have not I did not get an opportunity to really discuss in details about the multi class assignment techniques. But if you are interested and whatever you have understood and learnt in this course about the traffic assignment.

You can easily learn such you know new techniques, because the base or the basic understanding we have given in this course.

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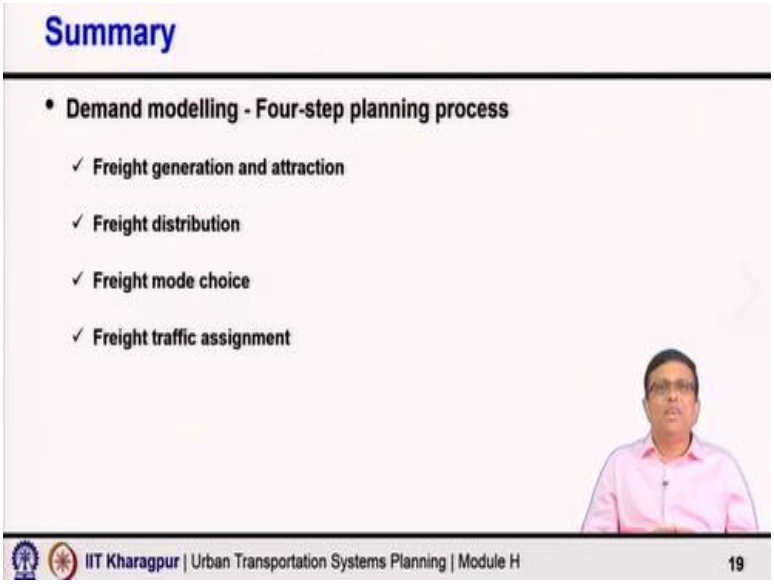

So, to summarize here we discussed about the how the Four stage transportation planning or travel demand modeling how you can map it, you know in the context of goods travel demand modelling. So, freight generations then distribution then more choice and then the traffic assignment. So, with this I close this module. Thank you so much.