**Urban Transportation Systems Planning**
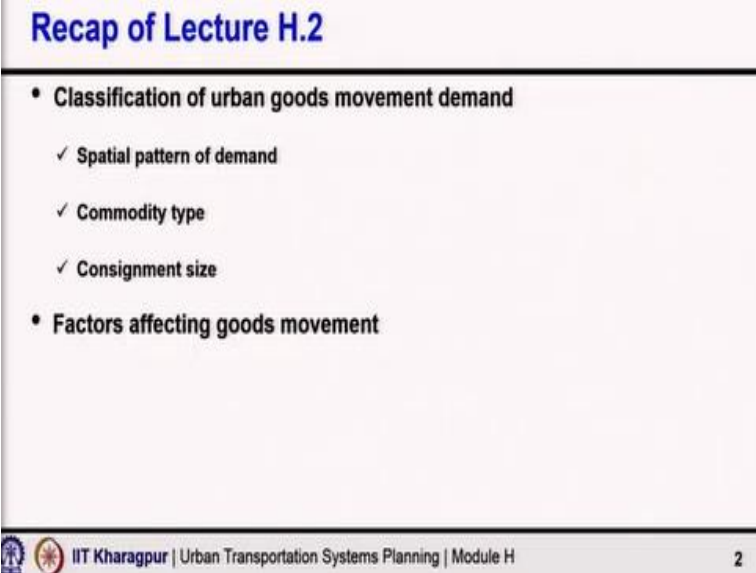**Prof. Bhargab Maitra**
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**Lecture - 57**
**Urban Goods Movement – III**

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Welcome to Module H, Lecture 3. In lecture 2, we discussed about the Classification of urban goods movement demand. We said that the primary classification could be based on the spatial pattern of demand external or internal. Then based on the type of commodity a wide range of commodity needs to be transported. So, we can classify goods movement demand as per the commodity. The third is based on the size of the consignment.

And each economic unit have their own spatial pattern of goods transportation demand, type of the community they want to transport at the required to transport and the size of the consignment. And the transport requirements also will get influenced by these factors. Then we discussed various factors which affect the goods movement.

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## Data

- **Availability** of data about freight movements is the **biggest issue** for freight planners to use for planning activities
- Data collection is **expensive** and **resource-intensive**
- Data on freight movements are held closely by shippers and carriers to maintain their **competitive advantage**
- Planners often **select** analysis techniques based on the **available data** instead of determining the **best techniques** and acquiring the necessary data to support those techniques

In continuation to our discussion, first we shall talk about the data requirement or the data related issues when we are thinking of goods transport demand modelling. Because demand estimation is a basic requirement, whether it is for freight transport, whether it is for passenger transport in the whole transportation sector the demand modelling or demand estimation demand projection is very very important.

Now the data availability of data is always a problem for countries like India. Wherever we work even for passenger transport demand modelling, then also getting the data is extremely difficult. The data availability is very poor and lot of efforts are actually we need to put for collecting the data. Whereas in many other countries such kind of data, specially the secondary database is almost readily available.

And therefore, the it is up to the modeler that how best they can model that demand using different available data and also probably based on collection of additional data as per the necessity. But availability of data about freight movements is the biggest issue for freight planners to use for planning activities. Simply the data is not available. So, whenever we talk about modelling approaches, there are many things possible.

Many advanced or sophisticated models may be developed but ultimately this all these models are to be calibrated. So, it is not the approach is not just sufficient. All these following this

approach is the models are to be developed there to be calibrated and unless we have the data, we cannot use model. Data collection is any how very expensive and resource-intensive. And from my own experience limited, of course.

I should drill that the collection of the data regarding the goods transport, goods movement, goods transport is extremely challenging. Passenger transport data is much easily available, when we have to collect the data the data, collection itself is much easier. We can go and interview commuters they have their own problems. So, sometimes if they are convinced that the kind of data what we are looking for would help eventually the larger society they are willing to provide data.

And they are waiting at the bus stops or sometimes when they are traveling on both also, we do the survey office-based survey household base survey. So, many variety of techniques are available. But freight transport data collection is very very tedious and it sometimes simply even after a lot of efforts putting lot of energy put lot of financial resource time resource still you may not be able to get the data.

Because one major problem is data on freight trip movements are held closely by shippers and carriers. And they normally do not want to disclose the data. If you ask them, we need to understand probably how frequently they need to transport goods but kind of goods they are producing how they are, you know, what is the price that they are or the cost incurring for transport and all such kind of things.

This are generally not interested to disclose such data to maintain competitive advantage. That is a big but they can challenge to get really good data for goods transportation demand model development. Planners as a result left with practically very limited options and completely depend on the available data whatever data is available, they have to work with that. So, planners often select analysis technique not going by the merit of the technique.
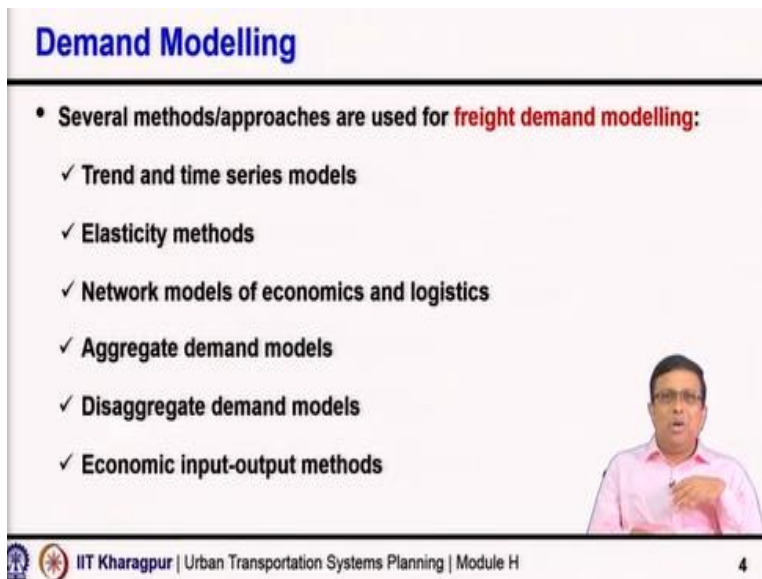
But more getting guided by the available data. So, the available data what data is available what data could be available made available that will dominate. And that will determine what kind of

analysis we can do rather than determining the base techniques and according acquiring the necessary data to support those techniques. Because as I said, sometimes just impossible. And even if it is possible.

It is very very expensive very so intensive in terms of energy in terms of effort in terms of financial resource in terms of time resource and even after that also you may not be really be able to get good amount of data. So, one has to keep these constraints in mind regarding the data and then as I said that depending on the available data, whatever best can be done the modelling technique is selected accordingly.

Rather than selecting a superior modelling technique in the stand-alone manner. Because it does not make sense end of the day whatever modelling approach you take the model has to be calibrated.

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Finally set so still it is important for all of us to understand what are different modelling approaches or methods or techniques that are normally used or that have been used by modular for freight demand modelling. Again, as I say starting from very simple approach to sophisticated approach a lot of techniques have been used or are available for use. Say, for example, simple trend analysis and also more advanced version could be time series models.

Because we want to forecast so we can use the time series data if we know historically what has happened then we can simply project it. Elasticity methods planners are used elasticity methods, network models of economics and logistics, that have also been used. Aggregate demand models, this is slightly I am looking at it from a different perspective, aggregate demand models or disaggregate demand models.

Say for example the time series model elasticity all these are also aggregate models. But there are other kinds of aggregate models which are also possible and you have studied fou r stage transportation planning with respect to passenger transport. And you know what I mean by aggregate models and disaggregate model. Also say approach like economic input output methods.

So, all such kind of approaches techniques are available. And you have to select the suitable technique as for the availability of the data. Now because of the limitation of time it is not really possible for us to go and discuss each of these approaches in details. That we can known to. But we shall discuss it briefly, some level of understanding that I want to give you. And maybe some of you might be familiar with also with some of these techniques.

And if you are not familiar, but you want to use then you can study independently based on this preliminary understanding. And then you should be able to develop the model and apply it in the context of good transport demand modelling.

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Trend analysis is often done in various contexts starting from population forecasts to vehicle growth forecast. So, many ways so many reasons actually are application areas we use trend analysis. So, simply we know that how it has happened in the past in x axis time y axis may be the variable which you are trying to project or trying to get the trend. And then you simply say how over time what has been the growth rate and what growth rate so.

And you calculate and then you project it with the same trend. It could be just simply extrapolation as I said a past historical trends using simple growth factor model for average growth rate you calculate and do it. You can also use several approaches which are well established well known. And which are related to the time series analysis. See the time series data is available. Then you can use a variety of time series models, there are so many models are available.

One of them is autoregressive integrated moving average method. There are so many other methods which are available and you can use them and even if you really have the good data one can even use some of the machine learning techniques to get it. Most cases we use simpler method. Because as I said that if you are really ambitious and you may be disappointed because getting the data is really big challenge in our Indian context specifically.

But the good thing with the trend analysis or this kind of times you will see these models is they

are simple to implement. And not so data it is simple data also sometimes only a few data points are available still you should be able to probably calculate the average growth either using very simple method or little bit better approach or technique. And you will be able to get a result. Their usually aggregate model as I said, so when I talked about different approaches, I said aggregate demand model I mentioned as one separate approach.

But many of the approach which are mentioned earlier like the trend analysis or time series model. They are also aggregate model but aggregate models also could be of other kinds. There are so many other kinds of aggregate model which are available. We have discussed we have discussed in details about the four stages transportation planning, in the context of passenger transport demand modelling.

And there we have discussed so many models which are all basically aggregate type model. So, this is an aggregate and therefore this model specifically their aggregated type models. So, we have got all limitations, whatever aggregate models have all those limitations are there for this kind of analysis. And they do not explicitly incorporate important explanatory variables. For example, you are saying the growth of freight demand.

But the growth of freight demand does not happen on which is on. There are certain factors certain reasons why that growth is happening. So, we do not consider those reasons or those explanatory variables when we are trying to modulate. So, that is the kind of limitation with trend or time series model in general.

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So, the next approach Elasticity model. This method we in this method we try to overcome this limitation what I just mentioned. So, we consider in a way some influencing variables logical manner, we try to consider them. And then we try to see the sensitivity of demand to an influencing variable, may be the model cost. Whatever mode you are choosing what is the cost of choosing or using that mode.

So, per how the demand is sensitive to those selected variables. And how we measure it? We measure it by the elasticity, if you know the concept of elasticity it is fine, I also teach this elasticity in some other course. There are different ways you can measure the elasticity generally percentage change in demand by percentage in the influencing variable. So, per 1% change in whatever variable you take 1% change in that value.

Because of that how much percent change in demand is going to happen. So, typically probably the cost goes up by a particular mode of transport naturally the demand will come down or demand may come down. So, among several elasticity measures there are different ways you can measure elasticity. Elasticity the concept is very interesting and simple but you can quantify it using may be different methods like shrinkage ratio you can use, you can use the arc elasticity midpoint arc elasticity.

You can take log and then also calculate the elasticity the midpoint arc elasticity generally very

well approximate the elasticity what you can get by taking the log. So, there are different measures different ways you can quantify the elasticity. And the appropriateness of a particular measure depends on what data is available to you, you know because what kind of elasticity, elasticity with respect to what?

That depends on what kind of data you have with you. And of course, what is the specific application context? Any modelling whether it is passenger demand modelling goods demand modelling, it is always very context specific. What is the context? What I am trying to solve? Please remember my discussion in the very initial class of this course urban transportation systems planning.

Where I said the objective scope of the objective then you know, within objective I said problem definition constraints inputs outputs. So, the context has to be known very clearly. And whatever you are trying to do your trying to find out elasticity you want to use elasticity, but you have to keep in mind why you are trying to develop such models. So, what is the specific application context and it should make sense as per the context.

Elasticity method is again simple to use not really complicated and you are considering the influencing variables. But has its own limitation as well, one thing may be not accounting for multiple factors simultaneously. That also highlighted by many researchers.

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**Demand Modelling**

**Network Models of Economics and Logistics**

- Network models of logistics focus on modelling of shipper and carrier behaviour, thereby capturing both demand and supply relationships that drive freight movements

- Network models of logistics hold great promise for modelling intercity freight flows

- Because of the complexity to implement and more intensive data requirements, implementation of these models may be a viable long-term strategy for state-wide freight demand forecasting

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Then coming to the next type of model what is called Network Models of Economics and Logistics. Now network models of logistics focus on modelling of shipper as well as carrier behaviour, both we are considering. So, in a way we are capturing both demand and supply relationships indirectly. And these are very very important because they actually try the freight movement. It is all basically demand supply interaction.

So, that demands supply relationships are captured in a manner. Network models of logistics hold great promise. I should say for modeling especially the intercity freight flow. But because of the complexity to implement and more intensive data requirement, obviously if you want to develop certain kind of models, you need much more data as compared to the previous methods. Implementation of this models may be a viable long-term strategy for statewide freight demand forecasting.

So, in larger perspective when we are doing this freight demand modelling because you want to use it for statewide freight demand forecasting, then such kind of methods can be useful.

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Then coming to general classification of models or generally variety of categories of models which we can use as I said that, grossly we can look at this modelling approaches with a different, you know perspective. One is whether we are doing the aggregate models or whether we are trying to develop disaggregate models. Now aggregate demand models estimate commodity flow volumes instead of you know.

It is at them as you understand we have discussed it in the contextual specifically on mode choice models we said that, you know, aggregate models to disaggregate models the trip generation models, we said earlier that is again aggregate based model. But mode choice model, disaggregate model, we discussed that is where you got introduced to disaggregate modelling. So, disaggregate models in freight sector are those that have close parallels to four step passenger travel demand modelling approaches.

You try to see the mode choice behaviour, how the mode choice is made, how the route choice is made? But at the disaggregate level, so the whatever you have studied actually in the context of passenger travel demand modelling. All those concepts are useful but you have to apply it suitably. Remember that many disaggregate models have focused on mode choice behaviour and estimation of modal split.

But it has to match with the context not that everything what you have applied or used in the

context of passenger travel demand models. You can apply it exactly in the same manner for the goods transport. Because the factors of the different the complexities are different the considerations are very different and very unique, I have mentioned it in the earlier occasion also.

So, as an approach the disaggregate demand models have got lot of promise and both for passenger demand and also for modeling the freight demands. Disaggregate models have got really lot of promise and that is what is going to dominate the future applications with has and the data availability part is sorted out and over time things are going to change. So, I would expect rather more and more application of disaggregate models even in the context of modelling of freight travel demand.
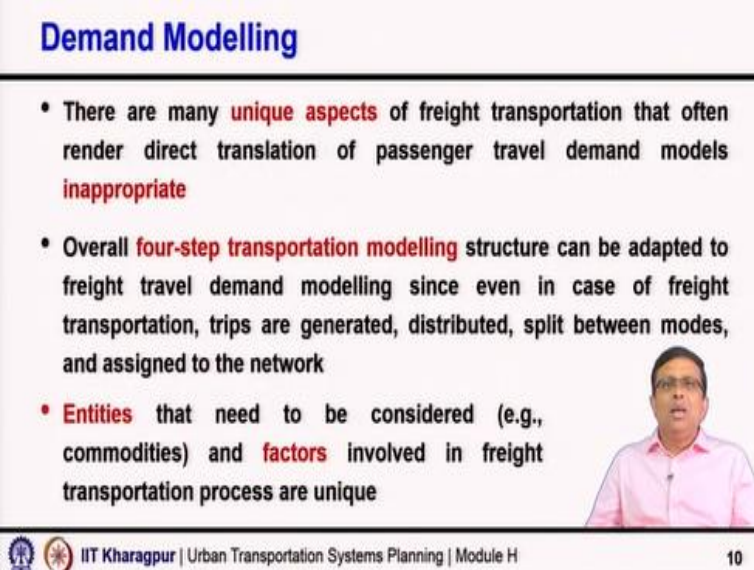
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Then Economic Input-Output Method. Input output, this is again a different kind of analysis which involves the use of economic inputs and output indicators to determine the level of economic activity that drive freight transportation demand. Just to give you very simple example, we cannot assess we cannot discuss in details, but let us take an example. So, typical such inputs may be taken economic unit. So, what are the inputs?

The typical inputs are capital, the typical inputs are labour, land. So, these are the inputs, that can add value through economic activity. And then these are fed through an input output analysis

matrix to determine various outputs such as the quantity of goods, services that are produced from this economic activity units, by type, by geographical location, by temporal frame. So, basically it is basically mapping the economic input and the outputs.

That process how that relationship is happening. So, then based on that understanding the further works can be done in the perspective of demand modelling.

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There are many unique aspects of freight transportation that often render direct translation of passenger travel demand models inappropriate. I mentioned this in a slightly different form in my earlier slide. But overall since you are familiar with the four-stage planning process and since I have discussed in details about the four-stage transportation planning throughout my course on major part of the course was actually devoted for that.

That is what I am saying this that overall four stage transportation modelling structure like the trip generation to distribution, mode choice traffic assignment can be adopted to freight travel modelling them also. Since even in this case of freight transportation trips are generated, trips are also distributed, split between split among different alternative modes and finally assigned to network.
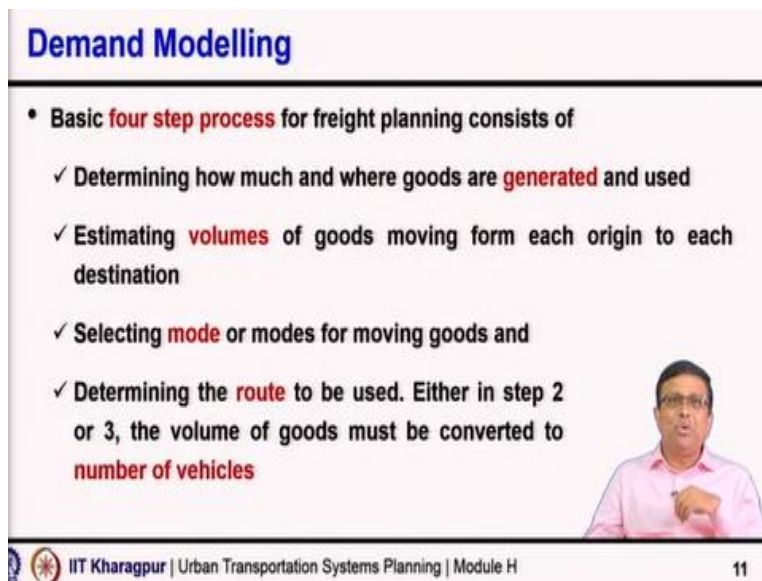
So, fundamentally all this also do happen for freight transport as all these things happen for the

passenger transport. So, conceptually you know, you can manage it nicely. But one has to remember that entities that you need to be considered for example type of commodities and then I say the size of the consignment, light requirement, whether you want to transport liquid or you want to transport perishable goods or even to transport other kinds of consumer goods.

And the factors involved on fair transportation process, we have discussed those also in details. There are very unique and they are much different from what we do or what we consider in the case of passenger travel demand forecasting models. So, you can apply although the four-stage transportation model can be applied can be met but not that everything can be borrowed directly because here the context is very different.

The factors influencing the freight demands are very different from the factors which influence the passenger travel demand on the decision-making process is also somewhat different. So, you can apply the broad four stage transport planning framework but taking care of the differences.

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So, the basic four stage freight transportation planning as I said consists of determining how much and where goods are generated and used. It is transported from one point to another point that again is same like passenger demand estimating volume of goods moving from each origin to its destination. Then selecting mode or a set of modes for moving goods and finally determining the route to be used.

And somewhere in between either in state two or in step three steps are you can see I have do not have not written steps but I have written it like tick. So, the second or third tick you can consider the volume of goods must be converted into vehicle as we say the passenger demands get converted into vehicle at demand either distribution stage or definite you know mode choice stage.

Either you know, either before after distribution or before distribution as I said that the mode choice and the distribution, we assume that there happening just in sequence but they can even alter the place.

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So, as I said that goods transport demand is very different and unique and complex as compared to the passenger transport demand. I would like to begin summarize with a slightly different angle using a slightly different angle or a slightly different perspective that how they are different. The different in terms of units of measurement in passenger transport demand, it is very easy, how many persons want to travel.

But freight is measured in different units. You can measure it in terms of by weight by value by volume. So, it is again complex and different from passenger transport demand. Second is the value of time is very different. Passenger transport context the value of time and the freight

transport context value of time the considerations are very different. And here it may vary a lot say for example your value of time could be very different or much higher.

Much much higher, when you are transporting a fish or vegetables or any perishable goods. But whereas if you are transporting some other kinds of good saving of 10 minus 15 minutes or half an hour time may not really matter. So, the value of time is actually very much a function of what kind of commodity you are transporting, whereas in the passenger transport context. It depends probably on the purpose of the trip.

If I am going to the office, I have to reach to the office on time. So, the value of travel time for what trips could be much higher. The higher the income probably the value of time will be higher. Generally expected to be higher. So, it depends on you know, socio-economic characteristics, it depends on the trip purpose. But here the value of time predominantly get dominated some cases the value of travel time could be very negligible.

So, if you just somebody scanning, so maybe a truck carrying a coal. So, whether to take a toll road or whether to not to take a toll road that decision may be may not be interested even to take a toll road. But if it is the crack is carrying the fish, the fish has to reach to the market right at the at the destination point right at early morning, otherwise the fish cannot go to the local markets in the city on the same day.

And if it cannot go to the local market you cannot use that fish probably or storage will be much more expensive. Similarly, the vegetables, it will be you know wasted. So, the value of travel time could be higher much higher. Third loading unloading, no assistance is required for passenger whereas for freight it requires assistance at both origin and destination of the trip. At both ends the loading analyzing has to happen.

So, the that part needs to be duly considered in the overall demand models overall in the context of mode choice.

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Then types of vehicle, now, as I said, that transport goods transport, very very unique. The requirement is requirements are very very unique requirements. So, passengers only require only sit to become comfortable. If I am traveling in a bus, I just want to sit in the bus, that may be my best requirement-based expectation. But freight requires to wide variety of accommodation from refrigerated container.

As I see if you are carrying some medicine and from vaccines which need to be maintained or transported maintaining certain temperature. That is different requirement to dry bulk hoppers to liquid bulk tankers you are carrying the petroleum product the diesel, petrol is transported from the refinery or the nodal point to different petrol pumps to sometimes you need flat beds, you know, the transport requirement will change in terms.

The type of vehicle is not just one type, not just truck. But within the goods transport within trucks, also there are so many varieties. So, that is very very unique. So, all this actually make the good transportation very different and as you can see much more complex than the passenger transportation part and also accordingly the demand model.

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**Demand Modelling**

**Freight Generation and Attraction**

- Generation of freight demand and the generation of freight vehicle trips are two different concepts

- Freight generation is the tonnage (or volume) of freight to be transported, while freight trip generation is the number of freight vehicles needed to transport freight

- In passenger case, there is a tight correspondence between amount of trips produced and the associated number of vehicle trips - particularly in areas where transit's share is small

So, freight trip generation as I said that fourth stage planning can be applied easily. So, generation of freight demand and generation of freight vehicle trips are two different things. Freight generation is the tonnage or maybe the volume of freight that is to be transported, while freight trip generation is basically the number of freight vehicles or units that are required to transport.

So, two things are different. In passenger cars, there is a tight consequence generally between amount of to produce and the associated number of vehicles, specifically if you consider that the transit shear is small and everybody is traveling by car during office time, you know, that occupancy is going to be 1 or 1.2 or 1.3 not more than that does not very so much. So, the number of persons and number of vehicles straight forward relationship.

But freight it is not so. It is not so, how the freight how much I may not really need a full truck load of goods I made require that multiple such units may be required type of vehicle requirement may be very good if I if the truck is not fully loaded if I am not utilizing the whole capacity my you know, pricing factor will be very very different. So, then you know, the all kinds of you know consideration have to come and which will make it much more a complex phenomenon.

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So, in contrast to freight transportation many businesses could change their shipment sizes. In some cases, maybe several orders of magnitude to minimize their total logistic cost. So, the cost play very vital role and that gets internally as I said. So, the base data of amount of freight generated to and from or attracted to an urban area of open difficult to acquire that significantly, which I have already mentioned in the context of the data.

But I wanted to mention it once again and when such kind of data are available you needs are in average number of tons how many tons of goods you are transporting, we quantified in that case, or maybe sometimes the value of that goods. So, maybe if it is Indian rupees then only simply average rupees per value or average rupees of value. So, either in terms of tons or rupees, if it is converted into value.

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**Summary**

- Data
- Demand modelling approaches
  - ✓ Trend and time series models
  - ✓ Elasticity methods
  - ✓ Network models of economics and logistics
  - ✓ Aggregate and disaggregate demand models
  - ✓ Economic input-output methods
- **Four-step modelling: Freight generation & attraction**

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So, altogether what we discussed here, we discussed the problem and the challenges of in the planners faced when we are going to do the goods transport demand modelling, the kind of problem we face with the data. Data is always the challenge but here it is even more challenge then we discussed about various demand modelling approaches, trend and time series analysis to elasticity method to network models for economics and logistic then aggregate disaggregate approaches for modelling and then economic input output method.

And then we said that four stage demand modelling can be mapped with due consideration to all the characteristics and the requirement of freight related issues and started our little bit introductory discussion about the freight generation and attraction. We shall continue in the next lecture. Thank you so much.