Urban Transportation Systems Planning
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Lecture-12
Trip Classifications and Factors Affecting Trip Generation

Welcome to module C, lecture 2. In this lecture, we shall discuss about trip classification and also try to identify factors which affect trip generation.

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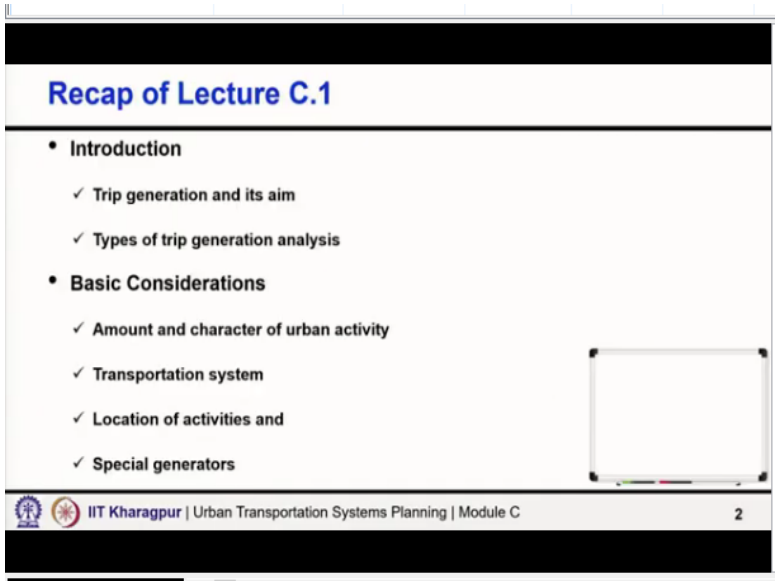

In lecture C.1 we said what we try to do, when we are going for trip generation basically converting activities into number of trips or number of trip ends, then, we said that every trip has got an origin and a destination similarly, every trip has got a point of production and the point of attraction, how we identify the end which is production, what will be the other end or the attraction.

Then, we also discussed about the various basic considerations say when you are talking about trip generation then both amount and character of urban activities are important. The transport system again the influence the trip generation, but we said that for generally we do not consider this, but that effect or impact is there very much then we talked and about influence of location of urban activities on trip generation and then also discussed about the role of spatial generators in the context of trip generation.

Say for example, a hospital or airport or a stadium or large scale regional shopping center and so, on. So, how and why we need to consider them separately and their impact on the trip generation?

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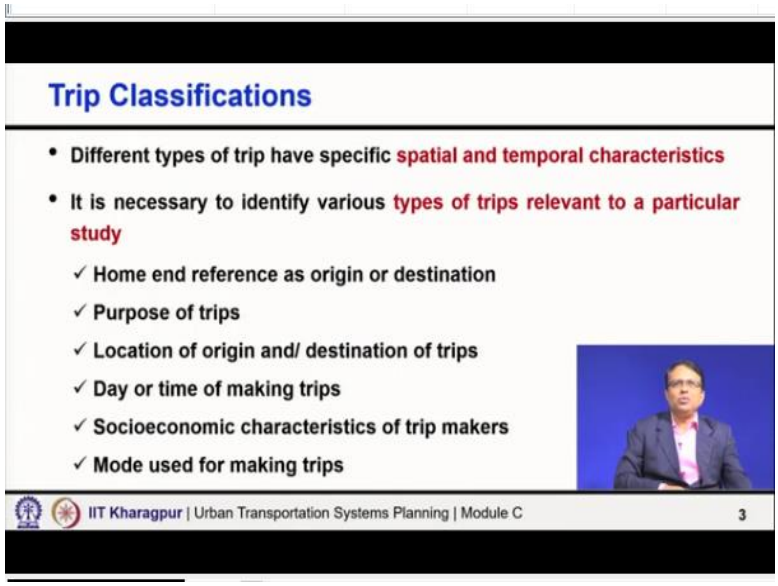

Now, with this background, today, we shall talk about trip classification. Now, why we first of all why we are interested in trip classifications? Very first reason is that different types of trips have specific spatial and temporal characteristics office trips are attracted to office location at certain time. So, the roads which are leading to office areas will obviously get congested when people are making work trips or trips to office.

Similarly, when if there are all schools located in certain areas, then depending on the school timings. So, depending on the school timings people will actually go for drop off and again go for pickup in the afternoon. So, those are the times when the roads which are leading to school will all get congested. So, every different types of trip have got different spatial and temporal characteristics.

So, it is necessary to identify various types of trip which are relevant to a particular study. Any study is carried out with some objectives in mind, some problems maybe we are interested to carry out transportation study, because we want to ease the traffic condition during the peak hour which are typically due to work trip or maybe we want to improve the traffic circulation on roads around the schools in urban area or maybe somewhere the weekend recreational trips so, many people come and create so much of congestion and pollution and all those problems we want to address those.

So, depending on what are my key objectives for taking up a particular study. Accordingly we need to identify the trips and classify trips because different trips have different spatial and temporal characteristics. So, here are again as I have indicated in the slides, that there are different ways we can classify the trips.

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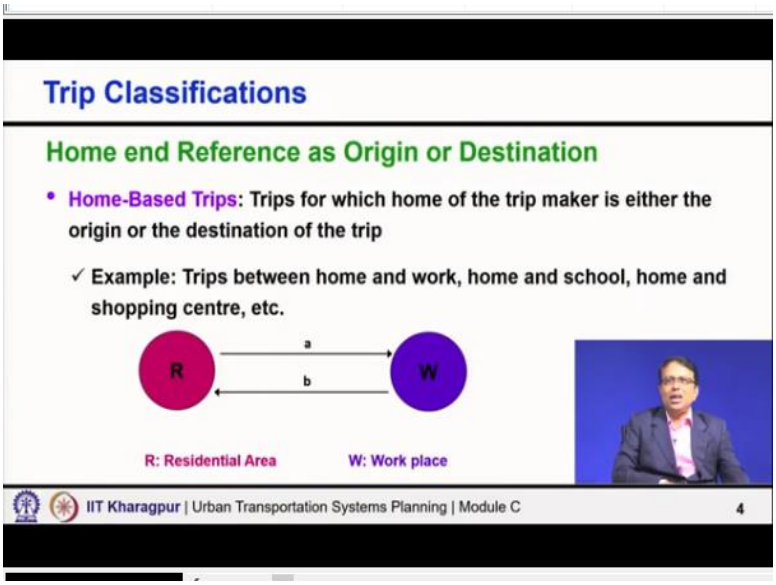

Let us go one by one and try to understand them. One way of classifying trips is based on the home end reference as origin or destination. As I said home end is there one end is home. So, obviously always that trip production happens at the home end, that home end maybe origin maybe distribution. So, if we consider these then we can classify trip like home based trip, non home based a simple classification.

That means, for one way of classifying looking at the trip is home base trips and non home based. In home base trips, home of the trip picker is either the origin or the destination of the trip. For example, trips between home to work, trips between home to school, between home and school, between home and work, home and shopping center. So, either person going from home to work or work to home or home to school or school to home, home to shopping areas or shopping centers and shopping centers to home. All are home based trip because either the origin or the destination includes home.

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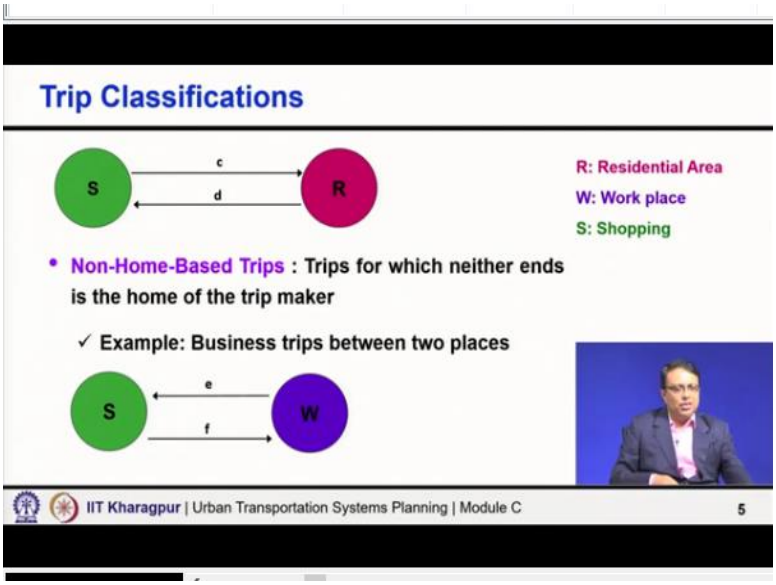

The second is non home base trips, that means, in this care neither the origin nor the destination includes home end. So, that is non home based trip. So, business trips between 2 places maybe somebody is going to the corporate office and from corporate office going to the manufacturing units and coming back or from corporate you go to the office and from office you go to bank and come back.

So, the trip what happened neither in is actually home end. So, they are all non home based. So, maybe we depending on the context of the study, we are interested to know how many are home based strips and how many non home based trips? And maybe that is the most appropriate classification for the work.

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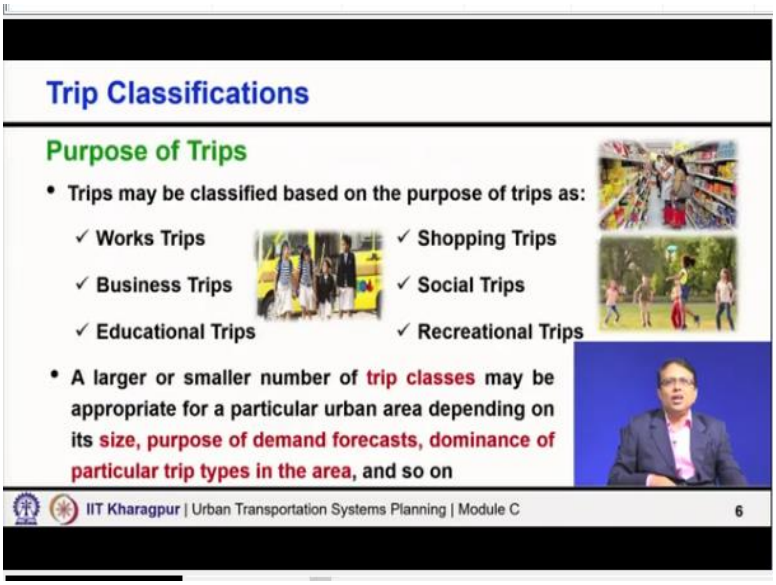

Similarly, another way of looking at it may be based on purpose. The purpose may be contextual depending on the study. As I said, maybe the objective is to understand improve the traffic circulation around schools, during the school opening and closing hours. So, I want to find out how many actually educational trips are happening? School, college, all these.

Because my focus may be that one or if I want to know that there is the large shopping areas and the roads leading to that shopping center or shopping area is at all these roads, the congestion is a problem and you want to solve it. So, you may try to identify how many shopping trips are happening that may be of interest for that study. So, I have indicated here that how we can classify trips based on the purpose of the trip?

Maybe work trips, business trips, educational trips, shopping trips, social trips, recreational trips, a larger classification or a smaller classification, right more number or less number of groups or category we can make again depending on the requirement of the project or requirement of the work, but I have tried to indicate here that these are all different way based on the purpose we can actually classify trips.

And then what kind of classification will be appropriate for a particular project that you have to apply your judgment, you may not use all these 6 types of trip in every project, may not be necessary. Maybe I can simply do it work and non work or educational and other trips depending on what is my focus? What is my objective of doing this day? So, I have said here, a larger or smaller number of trip classes may be appropriate for a particular urban area, depending on its size, how much is the contribution?

I do not want to classify trips separately. If that contribution of the trip in overall number of trips is really very insignificant, then there is no point in making a separate classification, because the idea is to find out contributions which are actually reasonable and contributing significantly to the transportation problems. So, purpose of demand forecast, why we are doing? What problem we are trying to solve?

What are the dominance of particular trips in that area? Depending on the land use, if you know the schools are not located in that area, then school trips may not be really prominent there. So, there is no point in making a separate classification and if there is there is no

recreational facilities in that zone. So, there is no point for me to either classify separately create a category of like recreational trips, which will hardly have any contribution there.

So, all these are to be considered, but remember that, there are different ways very interesting ways we can look at the trips. So, one way of looking at is as I said earlier, whether the home is there in one end either origin or destination. So, that is one way home, non home and also here based on the purpose.

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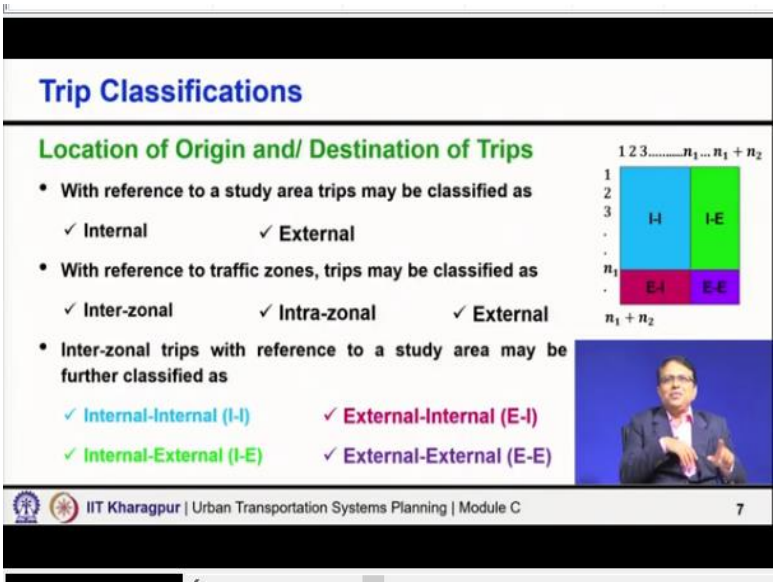

Then, based on the location of origin and destination of trips and or destination of trips, with reference to a study area the trips may be internal or external. But, what do you mean by that? We say that there is a cordon line. Cordon line is demarcating the study area. So, the cordon line is demarcating the study area. So, with reference to cordon line, I can say anything which is happening here within the study area that is internal.

And outside the study area, anything is happening that is external. Similarly, with the reference to a zone boundary also what is happening within the zone is internal, anything happening outside is external, that is a simple way, internal, external. We can also look at it when we look with reference to traffic zones, then trips may be classified as inter-zonal, intra-zonal and external.

What do you mean by that? Intra-zonal means, trips are happening within that zone itself, trip produced in zone I and terminating also in zone I. So, nothing is going outside zone I, all within that zone, that is intra-zonal within the zone. Inter-zonal one zone to another zone,

getting produced in zone 2 going to zone 3 outside zone 2, or outside the zone where it is actually produced, that is inter-zonal.

The other is external where nothing is happening within this zone. So, any 3 features maybe you can also consider the bigger boundary if I consider the zone boundary. So, any trips, which has nothing to do with this study area is external. Inter-zonal trips with reference to study area may further be classified as not all these trips I would say why only international trips**.**

Inter-zonal, intra-zonal external, all can be classified further into this 4 groups, internal-internal, internal-external, external-internal and external-external. Let me explain you very clearly. Let us say we have n 1 number of zones, we are considering within the study area that means I have actually demarcated my study area using a cordon line. So, within that cordon line boundary we have the study area or the city area which is I am considering for my study.

And let us say I have divided it into n 1 number of zones. So, I have 1 2 3 4 5 6 up to n 1 number of zones. So, all these n 1 zones are internal with respect to the study area boundary, because they are all within my study area. So, any movement that is happening within the zones or in between zones within the study area is internal-internal. That means, trip is getting produced in any one of these n 1 zones.

And getting attracted also to any one of these n 1 zones. So, that means that trip is not at all going outside, everything is within that cordon boundary. So, this blue portion what I have shown here that shows that segment internal-internal I have n 1 number of zone. So, n 1 by n 1 matrix represents n by n matrix representing the zones within the study area and any movement that is happening within that, it is basically I can call it internal-internal with reference to my cordon boundary or study area bounded.

Then, some trips are getting produced within this n 1 zone, but actually going outside. So, trips produced within the study area, any one of these n 1 zones, but going outside this cordon line. Now, external also there are some zones, number of zones we can consider externally. So, let us say I have n 2 number of zones which are external. So, total my zone number of zone is n 1 + n 2, n 1 internal zones within the study area.

And n 2 zones which are external. So, total number of zones I am considering in my work is n 1 + n 2. So, look at this green segment, this portion, what is really happening? I have written as I-E. Here, the trip is produced, how I can interpret a cell in this one I-J produced in I getting attracted to zone J, TIJ. So, produced in any one of these n 1 zones, but getting attracted to these n 2 zones, any one of these n 2 zones.

So, that is internal-external, getting produced internally, getting attracted outside internal-external. Similarly, it may happen, that trips are getting produced in one of these n 2 zones, one of these n 2 zones, external zones, but getting attracted to this study area, that we are getting attracted to any one of the zones within the study area, that means any one zone within this n 1 number of zones.

That is shown here as E-I. This is the segment produced external to study area getting attracted internally. The last bit of this representation is external-external, that means, produced in one of these n 2 zones external zones getting attracted also to this one of these n 2 external zones. Nothing, neither the production is within the study area not the trips getting attracted within the study area.

Finally, production is also happening in one of these n 2 external zones, attraction is also happening to this one of these n 2 external zones. So, we can call it as external-external. And that is what I said in some other context earlier. That is the typical segment which we should consider if we are thinking of a bypass for a town, if that external-external is significant, that means, they are all getting captured at external cordons why.

Because the road is passing through the city, but the traffic has nothing to do with the city. So, if that external-external is really significant, then it makes sense probably to investigate if a bypass is physical, so that you do not allow this traffic to go inside the city and create congestion, create emission, you create a bypass. So, outside the city only they get connected, they do not come inside the city.

This is again one way of looking at my trips. So, again you can see here we are not looking at the purpose or anything, here is basically the location of origin or destination of the trips, that becomes important.

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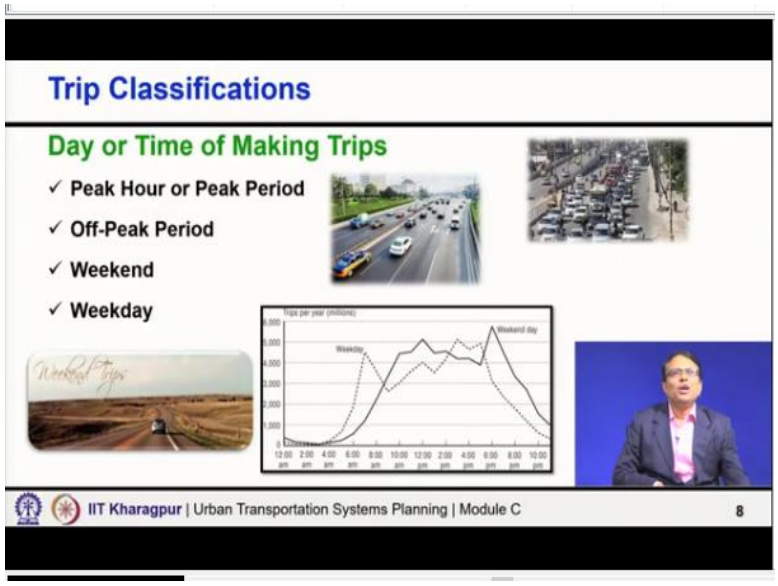

We can also think the classification of trips based on day or time of making trips. Again, another dimension of the trip just see, how many dimensions we have for a trip? How many ways we can look at the trips? And all this will give you some kind of insight, that in what work, what kind of what way I should look at the trip, maybe in one project, I look at the trip based on purpose.

In another way I look at the trip an external-external, in another project, maybe I look at the trip from the day or time of picking trips, when the trip is being made? Peak hour, peak period, or peak period in the weekend, typical weekday, they will mean entirely different thing. So, this is again one way because you will see the congestion, most urban area congestion is due to peak hour trips.

So, if you see the total number a road capacity is fixed, every hour a road can handle so many vehicles or so much of traffic. So, road capacity may be fixed per hour. And if you say in most urban area, the total daily demand is less than the capacity of the road into 24 that value significantly lower. So, if I consider daily theoretically, how many vehicles this road can take. So, whatever is the road capacity per hour into 24.

That is the theoretically I can consider the capacity. So, if you look at the demand, the demand will go higher near that value. But still why this condition happens, because most of the trips are a larger number of trips or larger share of trips happened only during the peak

hour or peak period. So, maybe, if peak hour congestion is my focus, I am only interested to know how much peak hour demand is there?

What is the peak hour travel? So, my simple classification of trips could be peak and off peak or peak and other than peak, whatever you say. So, that way I would like to classify, sometimes the weekday you go to some area, no problem, some recreational center, you go to that area in the Saturday evening with a lot of restaurants, a lot of other recreational facility, the area is totally congested.

So, do you want to know you are interested that in a typical weekend, what is happening, not in the weekday? So, again, it depends on what is subjective, what you are trying to solve.

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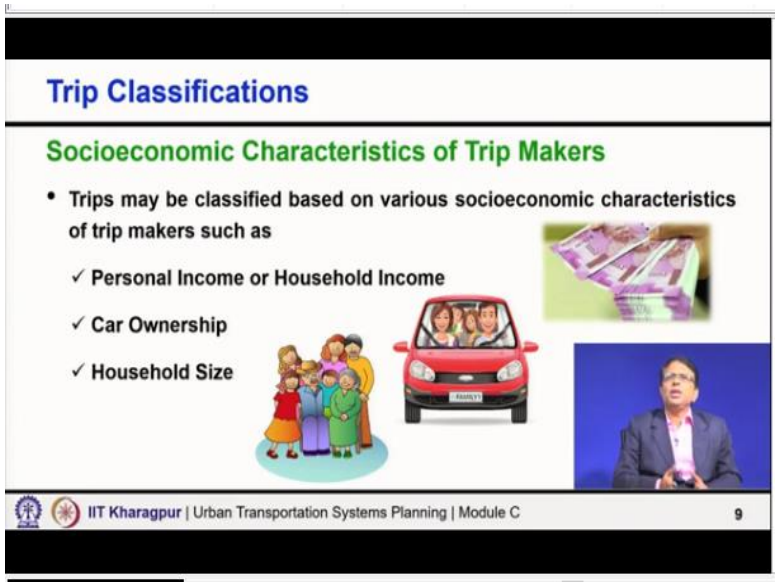

We can also look at the trips based on the socio economic characteristics of the trip maker. How many trips are being made? I can classify them based on the income, how many high income group people how many trips are making, low income group trip, how many are making, because the requirements will be different, requirements of different socio economic segments are different.

A high income person and a low income persons requirement in terms of the trip, in terms of expectation, even the bus service most urban areas we are failing to attract because our service is not as per the expectation of the choice riders, choice riders means those who have access to private vehicle. If you have a vehicle of your own, you are a choice rider to public transport.

Because public transport is a matter of choice for you, you may go, you may not go, even if you do not go to public transport you have your vehicle you can travel. So, you are choice riders, if I do not have the car, then I am not a choice rider why because I have to use only public transport. So, the trips may be classified in terms of personnel income or household income, maybe car ownership, we want to know car owners and others, those who do not have car maybe I can classify it based on the household size, I discussed this to some extent earlier also.

So, the socio economic characteristics of trip makers, I can look at the trips from that specs. I am looking at the trips, how different socio economic segments are making trips, car owner, non car owner, high income, low income and so on so, forth.

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Then also the whole trips I can try to classify better mode used for trip making ultimately how in urban area especially biggest cities there are multiple options for transport. Some people use cars, some people use taxi, some people use public transport or bus, even non motorized mode, very important. Actually, we are forgetting the more and more we are going for motorization.

And going more and more trips we are making using motorized transport, we are inviting more and more problem for all of us in terms of congestion, in terms of degrading the air quality. Look at the air quality in urban areas, especially the big cities, it is a pity what we

have done? We have really done the development or we are**,** doing something seriously wrong and injustice to us and the future population.

What kind of cities we are living for them for the future generations? So, very important is also there. So, we can even simpler thing, how different modes are being used? I want to make the trip because maybe I want to see then how many people are actually using car and taxi. Can I shift some of them not all, but even if the 5% or 10% if you want if you shift you can make it happen in favor of the bus or the public transport system in general, which may be bus or maybe rail also.

That may make a big difference in the whole urban transport environment. So, maybe my interest could be if I am working on the public transport how to improve public transport, how to bring more people to public transport, if that is what is my key objective, then I will be interested to know that trip mattress are separately that who are the car users? Who are the taxi users? Who are the public transport user?

How many are using non motorized mode or even if I want to promote non motorized mode, it is very important for me to have a trip classification in that manner. So, that is another way of looking at the trips, what kind of mode is used for the trip?

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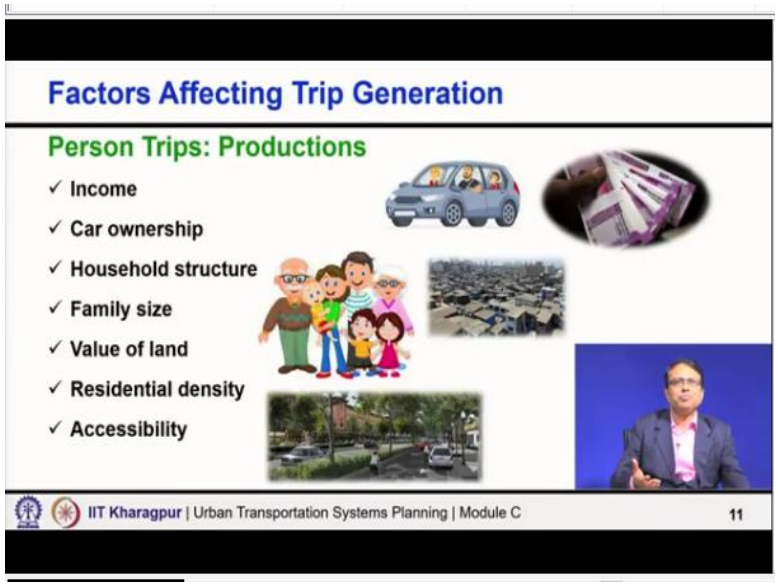

So, that is different ways we can look at the trips and to develop our understanding insights and then adopt the most suitable classification, what is really most appropriate for a given context given work. Now, I want to discuss there are different factors which are affecting trip

generations. What are those factors? These factors I want to discuss separately for person trips and for good strips.

First coming to the person trips. Person trips context you know the productions and attractions are different even for good trips also the productions and attractions are different. So, what are the typical factors that affect trip generation? Generation means trip production specifically, 1 income, 2 car ownership, third household structure, 4 family size, 5 value of land, 6 residential density and 7 accessibility.

So, we have identified here, 7 factors, which are important for trip generation context. Now, if you look at it, income, obviously high income, more trips, car ownership, those who have car, they make more trips than normally households who do not have cars or people who do not have car. Family size bigger or smaller, it is again important, bigger the family size generally per household trips will be higher expected to be higher.

And you can see the first 4 attributes activity typical to household characteristics. So, that means they are very useful if I am developing a model where I am trying to ah model the trip generation trip productions by household. So, how many trips will be produced by household. So, household is my unit for analysis and I am trying to analyze the trip productions by households.

So, then I can use household income, household car ownership, household structure, household family size and so on. Then the value of land and residential density they are fairly meaningful, if you see indirectly where the value of land is higher think of any area of a city big city where high income people live and infrastructure is much better and facilities, amenities are better, there the value of land will be higher.

So, value of land is also an indication that higher the value of land you are may get you will likely or you may get even higher trip productions from that area, but can we use that value of land if we are considering households as our unit we cannot use it. So, the value of land can be used typically, if we are using zonal based model that meant different traffic zones or traffic analysis zones what we say that study area divided into number of zones are in the just a few minutes back I was staying n 1 number of zones within the study area.

So, if we are trying to model the trip generation or trip production by zones, then we can use this one. Same the residential density is a very meaningful indicator, higher the residential density higher will be the trip productions. Obviously, more higher density will produce more trips. But then again residential density we can use only for the zonal based model not household based model.

It does not make sense. So, the first 4 are typically maybe used for household based modeling, if we are taking household as our smallest unit for analysis and model, value of land residential density we can use for zonal base model. Accessibility the last one. It is very much interesting. What we are saying that trip production again as I said actually is elastic to the available transportation system performance.

How your connectivity is there with the public transport is available, if it is available, then what is the level of service that is there. So, higher level of service, better transportation system and resulting better accessibility will make the trip production higher, more trips will get produced. So, it is very meaningful if we can include accessibility in the trip generation model.

But as I said, we normally do not consider the trip generation elastic or influenced by the transportation system or accessibility. So, they are meaningful but generally not considered. So, that is what.

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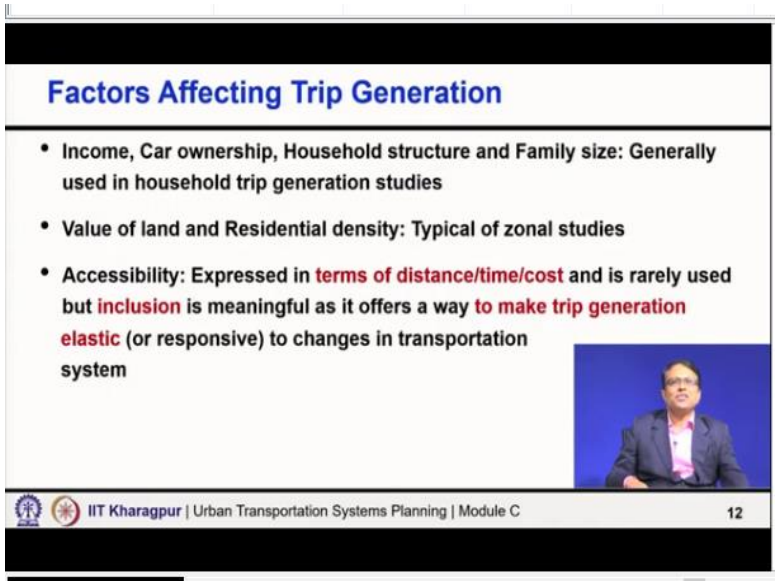

So, if I go back to the next slides here, some explanation I have given. As I said, I have written here probably income, car ownership, household structure and family size that generally used in household trip generation studies, value of land and residential density are typical to zonal studies. When you take traffic analysis zone as your unit, you are trying to model how many trips will get produced from a zone are in the first case, household base, how many trips will be produced by a household, 2 things are different.

Then as I said that accessibility expect in terms of distance, time, cost, but rarely used in the modeling, although inclusion of accessibility is meaningful as it offers a way to make the trip generation elastic or responsive to the changes in the transportation system, actually, it happens like that, actually, it influences. But as I said, then many assumptions we made, many simplification we make in our model and work.

So, this is one of the assumptions and if you ask me personally, I will say yes, it is a compromise, but the effect of transportation system is very high on route choice, on mode choice. And such kind of huge change in the transport network does not happen every day or so frequently in an urban area to impact the trip generation in a big way. It may change, but is it that the whole changes happened, so frequent.

And the impact of transportation system or trip generation is expected to be a little lower on than the impact on choice of mode or choice of routes and other things.

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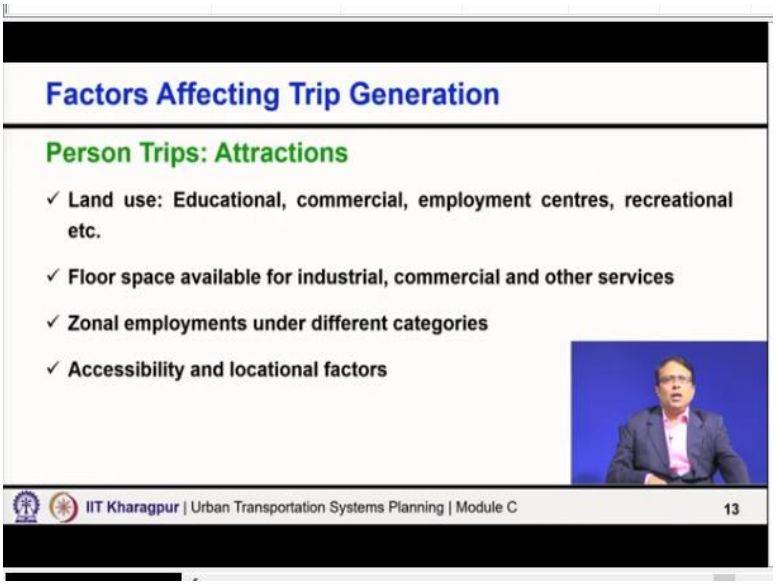

Then, in terms of attraction, when we are doing the modeling the person trip attraction, we should definitely consider different types of land use for educational, commercial employment centers, recreational facilities etc. So, different types of land use we considered. So, categorization of land use too. So, these are different land use may enter into a model as variable.

Similarly, we can use let us say 4 floor space available. This is the first one is basically the characters look at it, first one is basically the character of the activities character of land use, what kind of land use, the second is the amount. How much floor space is available for industrial, for commercial and for other services? So, more of the space higher the number and the first one is basically the characters, character of activity or character of land use, commercial, educational, employment centers, recreational centers and so on so forth.

Zonal employment under different categories, a number of different categories are made from for employment, the economic census data actually indicate the use different classifications. So, all those categories of employment can be utilized total employment you can use, you can use manufacturing employment and like that different categories of employment to see that how they are influencing or explaining that trip attraction to a zone.

Again, here also accessibility and locational factors, we said that earlier discussion in lecture 1, under this module, we said that the locational factors are important, a shopping complex located in the heart of the CBD with wider roads and footpaths and enough parking space, very well planned and in the (()) (39:38) what 2 vehicles cannot go side by side, the attractions are not going to be the same.

So, the locational factors are also important and that is what we have seen, and accessibility means the transport connectivity, transport connectivity or the characteristics of transportation system that is there. So, all these are going to influence or impact the trip attractions.

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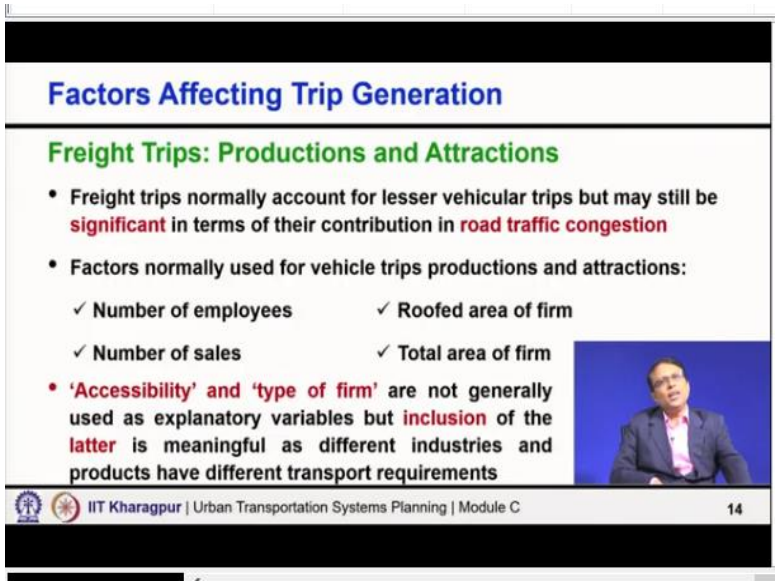

Then freight trips very important in an urban area, very important often we see trucks and commercial vehicles on road and we felt disturbed because they really contributes significantly congestion that we cannot deny. But just imagine even during covid people did not go outside for walk, did not make any other trips but the supply of food or logistics it was very, very important without that people cannot live**.**

So, the goods transport are actually much more important for us, it is ok if people cannot go to office for 2 days or few days, if people cannot go for recreational trips for some months. But people cannot stay without food. So, food, vegetables, all these things essential commodities, groceries, medicines, all are actually coming under freight transport. So, they are very important.

So, there are several factors which influence a freight transport production and attraction I would just identify a few here. Before that what I said here I have written the similar thing. Freight trips normally account for lesser vehicular trips, but may still be significant in terms of their contribution in road traffic condition that is I said also exactly the same thing. If there are few trucks or heavily loaded commercial vehicle the whole nature of the traffic stream will change and the congestion will also be very different.

There are factors which normally used for vehicle trip productions and attractions. Say for example number of employees, number of sales, roofed area for firm, total area for firm, all these are extremely important. Then accessibility and type of firm again 2 variables which are

very meaningful variables, I would say, but again generally not used as explanatory variables for freight modeling productions and attractions modeling.

But if we include them they are meaningful specially the type of firm, actually the goods transport is extremely complex and the type of firm has really got a big role to play in terms of the trip productions and attractions. Different commodity have got different transport requirements. So, if you are considering using type of firm as a variable in our trip generation modeling for freight trips.

That will mean by different industries and productions have different transport requirements and that actually will get captured in the modeling**.** So, the accessibility is again an important how will the places are connected. So, as it is important for the passenger trips it is also for the goods trip. So, here are the factors and as I said that the accessibility and type of firm are the 2 variables which are extremely meaningful if we can include them there is a different meaning for that. So, it is all very much important.

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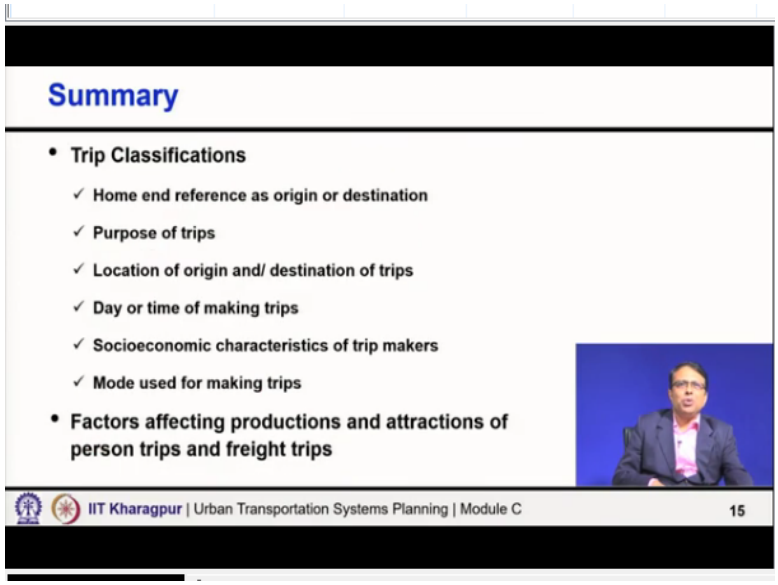

So, if I have to summarize this lecture I would say that there are different ways we can look at the trips. There are really so many characteristics of trips and so many ways one can look at this same trips which are happening in the urban area, it depends on the context which way it is meaningful to look or to classify trips that directly relates to the what is the objective, end of the day what we are trying to achieve?

So, we may classify trips in terms of based on home end reference as origin or destination. So, home based, non home based, that was the fundamental classification. Then we say based on purpose of the trips and I explain clearly that why we this is meaningful the work trip, education trips, social trips, recreational trips and so on so forth. Then with reference to location of origin or destination of trips internal, external, internal-external, internal-internal.

External-internal, external-external and (()) (45:01) what type of classification would be really appropriate. Also classifying trip based on when it is happening, is it happening in the peak hour, or peak period it is in the week day, it is in the weekends. So, day and time making trips. Based on the socioeconomic characteristic of the trip maker high income, low income and so on so forth.

There are different characteristics which are important, then also looking at the trip based on mode used for trip makings, car trips, taxi trips, public transport trips, NMT non motorized transport trips. So, different mode wise we try to model the trip productions and attractions. That also very interesting and may be meaningful in some cases. So, with that kind of over view about with the trip classification then we identify the major factors which affect the productions and attractions of person trips and freight trips.

Initially talk about the factors which influence the person trips, production, then we said that several factors which are meaningful for household base model, and some factors which are typically for zonal base model and then we say talk about accessibility or the role of transportation that actually it influences but may be most cases we do not consider that. Then talked about the factors which are may be used for modeling of trip attractions, person trip attraction.

And then finally we discuss various factors which are import for goods trips productions and attractions. So, with this I close this lecture, thank you so much.