Urban Transportation Planning
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Module No. # 07
Lecture No. # 31
Transportation Surveys

This is lecture 31 in urban transportation planning; we will start our discussion on transportation service in this lecture. You may recall that we had a detailed discussion on the four major analytical steps, involved in the transportation planning process; namely trip generation analysis, model split analysis, trip distribution analysis and route assignment analysis. On completion of the four analytical steps, now we are clear about the variables involved in the analysis process at each stage, in each of the four steps, and having known the variables or the influencing factors, we should be in a position now to know what is our data requirement to develop the models that we discussed in the four different steps.

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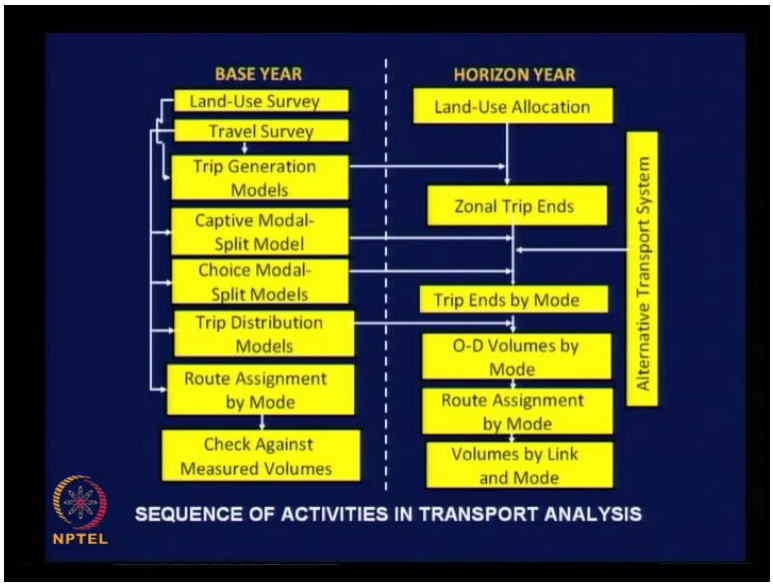

Let us just have a look at the master flow chart that we refer frequently, and you can see on the left hand side, we have completed discussion on the subject matter related to all the boxes, except the first two boxes; land use survey and travel survey. So, collection of information about land use and travel is what we call as transportation service. So, unless

we have this data in hand, we will not be able to do all the analysis that we have been discussing so far, and what really is the data requirement for each step is the question, that is first take trip production models under trip generation analysis. What are the factors that were considered to be influencing trip production, anybody, factors influencing trip production. These factors are related to socio economic characteristics of households, household size, vehicle ownership, number of employed persons, number of students and so on.

We derived independent variables from these factors, the dependent variable being the number of trips produced by the households. So, this implies that we need to collect data with regard to trips made by the households, as well as all aspects related to socio economic characteristics of households, unless we collect data related to these aspects, we will not be able to develop trip production models. If you consider trip attraction model, what are the factors that normally influenced trip attraction, any response. All the factors are related to land use characteristics, the factors are related to the type and intensity of land use, in that context only we identified the variables as floor area in retail trade, floor area in manufacturing and wholesale and so on, as well as number of employment opportunities in manufacturing, wholesale, retail trade, school or college enrolment, all these things were discussed as the independent variables influencing trip attraction.

The dependent variable being the number of trips attracted by each of the traffic zones. This implies again we need to collect all these information through transportation service, different types of land uses, their extent intensity and so on as well as trip attraction zone wise covering the whole of the urban area. So, this is the data requirement with regard to trip generation analysis. Then in mode choice analysis, we understood that the factors influencing mode choice of travelers are related to the socio economic characteristics of travelers, and the characteristics of transportation system, technical and level of service characteristics of transportation system. So, we derived independent variables influencing mode choice related to socio economic characteristics of travelers and characteristics of transportation system. Socio economic characteristics again related to individuals income, age, sex and the nature of work like students or employed person and so on. And transport system characteristics are mainly related to travel time, travel cost, if possible comfort, convenience, level of safety and so on. Again this implies that

we need to collect information on all these factors through transportation service. So, that is why I prefer to discuss the analytical aspects first, before taking up transportation service, so that we know really what we want.

Then trip distribution analysis, we know that the factors that influence trip distribution are mainly p i, a j and d i j expressed in terms of travel time normally. So, we would have collected this information while collecting data for the previous step. In fact there is no exclusive data needed for trip distribution analysis, because the data already collected for the previous step, can be made use of for trip distribution analysis. The only additional information that you need if you want to make use of is, zone to zone, special separation, expressed either in terms of distance or in terms of travel time, for different modes of travel.

Then finally, route assignment analysis, what is the data requirement for route assignment analysis, mainly related to travel time between zonal pass, and all the characteristics related to the links in the transport system network. We need to have information about the length of each of the links involved in the network, capacity of each of the links and the speed one can maintain on each of these links, and the related travel time implication for different modes, as well as we need to have the possible delay at all the nodal points, nodal points are road intersections, these intersections could be either signalized or grade separated or sometimes uncontrolled intersections. We need to have information about possible delay at each of intersections; otherwise we will not be able to work out the cumulative travel time implication along a particular route, for travel from one zone centroid to another zone centroid. So, this is our data need or data requirement with this in mind let us look at the details of transportation survey.

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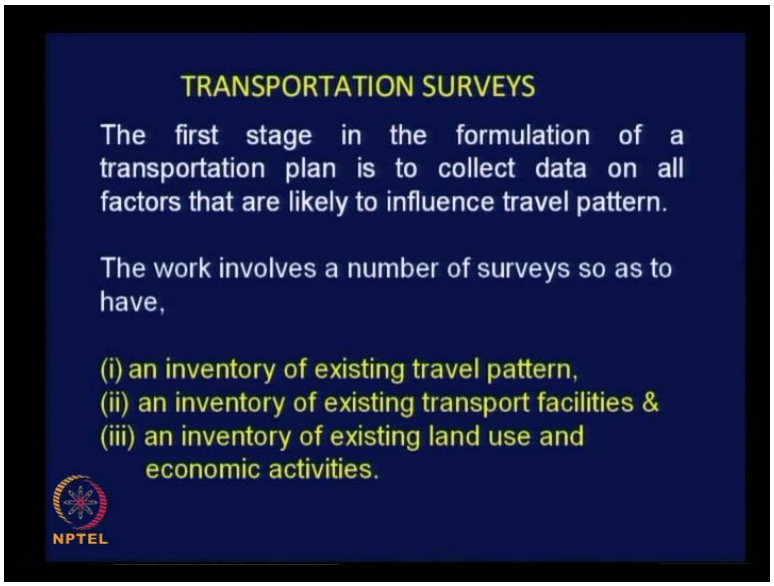

And in essence we need to collect all the information, as indicated here. The first stage in the formulation of a transportation plan is to collect data on all factors that are likely to influence travel pattern. It is made very clear in one sentence; you need to collect information on all factors that are likely to influence the travel pattern in the urban area. The data collection work involves a number of surveys, so as to have or at the end of the survey, you must have these three inventories; number one an inventory of existing travel pattern, you should know how people are travelling, what do you understand by travel pattern. Travel pattern means getting information about characteristics of each and every trip made in an urban area.

What are the trip characteristics, if you take a single trip the related characteristics of trip origin, trip destination, trip purpose, mode used for travel, exact time of start, exact time of finish these are all trip characteristics, unless you have this information you will not be able to get a clear picture of the travel pattern in the whole of the area. So, that is what is meant by this single sentence, an inventory of existing travel pattern, even though it is just one sentence, it is heavily loaded sentence, it implies collection of a lot of information. Then an inventory of existing transport facilities, what do you understand by existing transport facilities, as I used to mention quite often transport system facilities, include all the four major components, starting from the way, the vehicle, the terminal and the control.

All, information related to these components are to be collected in respect of all the modes of transportation. And third an inventory of existing land use and economic activities, there are two aspects here inventory of existing land use, inventory means identification of the type of the land use, and then intensity of usage of that particular land use, and then economic characteristics of the urban area at aggregate level. And to collect this information we need to know the boundary for our study area or planning area, so we need to define the study area first.

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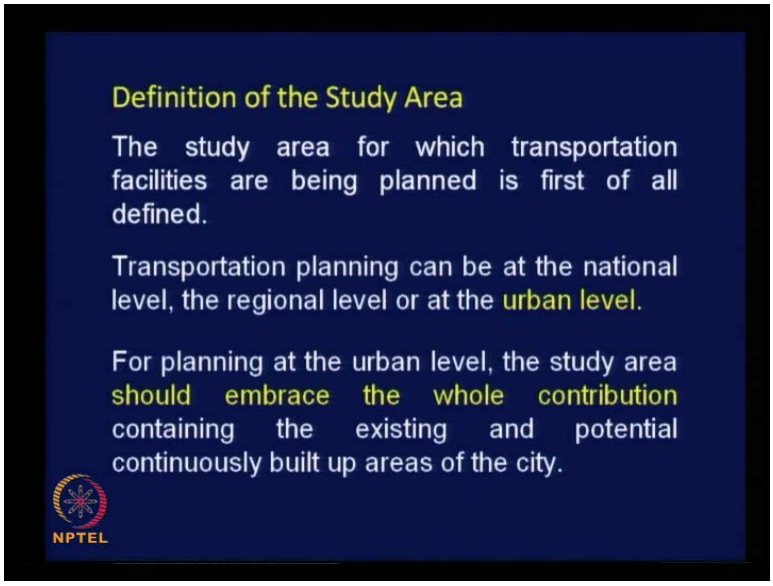

The study area for which transportation facilities are being planned is first of all defined clearly, and transportation planning can be at the national level, the regional level or at the urban level. of course, the principle involved in the planning process is same, whether it is national, regional or urban level, and in the case of urban transportation planning. For planning at the urban level the study area should embrace the whole contribution, containing the existing and potential continuously built up areas of the city. That is very important, because your planning area should be decided based on the potential for growth of the urban area for the next two decades. We should not just look at the current built up pattern and then fix the boundary. So, you should identify the areas where there is a likelihood of development, building up of the urban infrastructure, the whole area should be covered.

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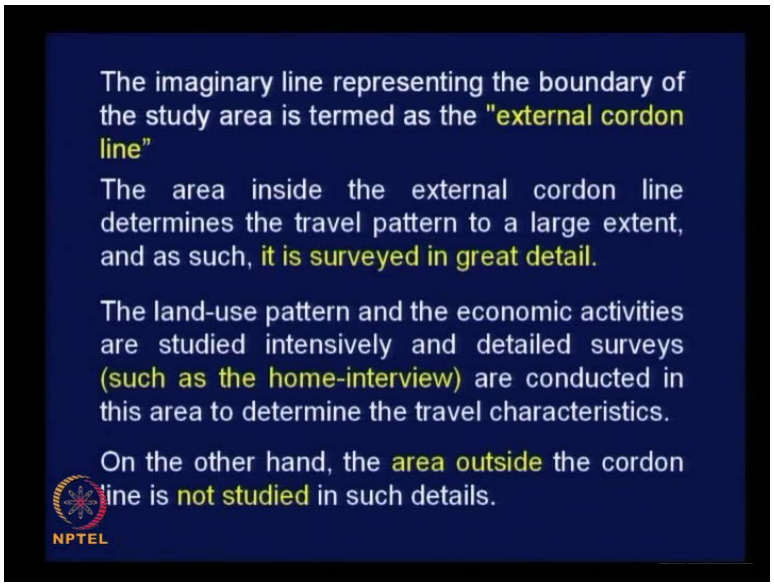

Then the imaginary line representing the boundary of the study area is termed as the external cordon line, or sometimes outer cordon line; both are same, external cordon line. So, we need to really fix this line, even though this line is going to be an imaginary line, which will be just delineating on the map. This is going to delineate or give boundary for you to work with, for the purpose of planning. The area inside the external cordon line determines the travel pattern to a large extent, and as such it is surveyed in great detail, once you fix a boundary do details surveys within the boundary, covering the whole of the area. The land use pattern and the economic activities are studied intensively and detailed surveys such as the home interview survey are conducted in this area to determine the travel characteristics.

On the other hand, the area outside the cordon line is also studied, but not in such details, why should we study the area outside the cordon line also. As I indicated to you earlier trips emanating from outside your cordon line also might influence the travel pattern inside the city, and as I said earlier there could be external to internal trips and internal to external trips. External here means the area outside your external cordon line is termed as external area. So you need to have some information about the likely origin of the trip that come into your study area as well as likely destination trip that is going out of your study area, that should also be recorded.

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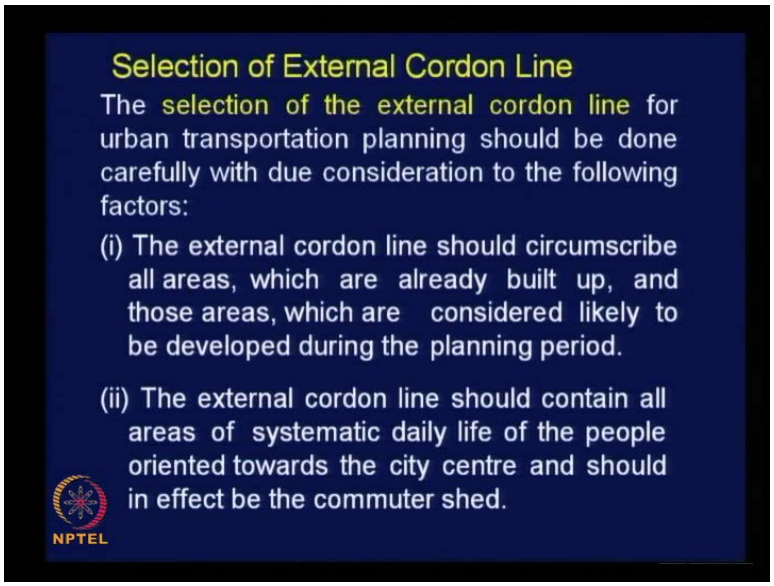

Now, how to select the external cordon line, relevant question unless we answer this question, we will not be able to fix the boundary, what is a basis. The selection of the external cordon line for urban transportation planning should be done carefully with due consideration to the following factors. There are four important factors to be considered while selecting or delineating your study area, by fixing the external cordon line. The first point is this, the cordon line should circumscribe all areas which are already built up and those areas which are considered likely to be developed during the planning period, what is the planning period, that 10 years in which we will be doing them. It is the time gap between the base year and the horizon year. If, you are fixing a horizon year to be twentieth year then planning period is twenty years, two decades. So, what is said here is that you should not just look at the present development alone, include all the areas which are likely to develop in the future during the planning period.

And the second important point, the external cordon line should contain all areas of systematic daily life of the people, oriented towards the city centre and should in effect be the commuter shed. It should include all areas that contribute for a systematic daily life of an urban area. If there are people commuting on a regular basis from a small sub urban pocket, even though it is isolated from your main city boundary, that sub urban pocket should be included in your planning area, because that pocket is contributing regularly on a regular basis to the travel pattern of your urban area. Conduct sample surveys have detail observations and find out how people travel, where from they are

coming, or they coming regularly on daily basis and so on, and then try to include all such areas within your outer cordon line or external cordon line.

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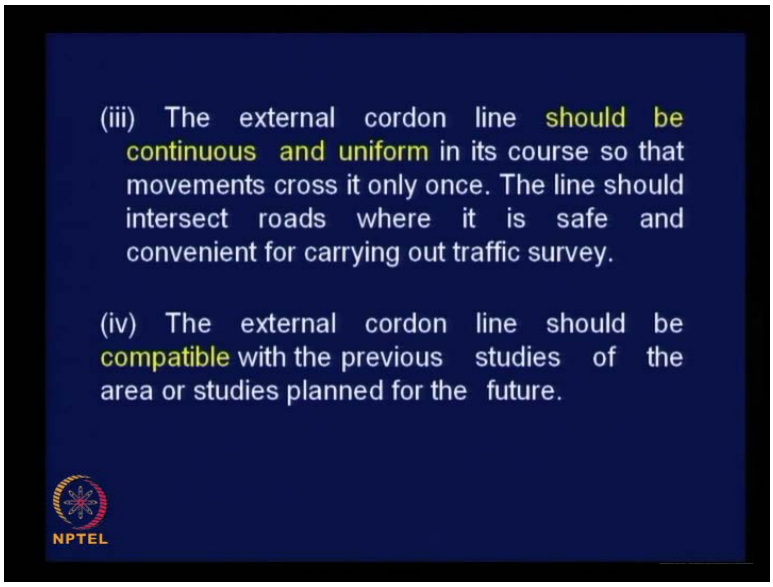

Third point is this, the external cordon line should be continuous and uniform in its course, so that movements cross it only once, movements along the radiating roads, should cross the external cordon line only at one location, later on I will show you a picture to explain the same point. The line should intersect roads where it is safe and convenient for carrying out traffic surveys, because we are going to conduct traffic surveys, at the points of intersections of radiating roads and the external cordon line, and we must see that the roads intersect external cordon lines at safe and convenient locations, so that we can use that location for conducting traffic survey.

The external cordon line should be compatible with the previous studies of the area or studies planned for the future, why it should be compatible, what do you understand by compatibility here, any suggestion. Previous studies could be studies related to census operation, population, and census. How do they conduct census operation, how do they delineate areas for counting population figures, it will be municipalities, panchayats, town panchayats and so on. The revenue boundaries will be the boundaries for census operation taluk, district, because the information statistics that is to be given finally, at the national level, will be based on. Of course, the whole of the country and then whole

of each of the states, and then broken down to districts and then urban areas talks and so on.

Revenue boundaries are going to be the guidelines for most of the studies. This means your external cordon line, preferably should match with the revenue boundary which is adjacent to your delineated alignment of the external cordon line. You cannot simply draw a nice circle covering the area and call it as external cordon line. You should follow the revenue boundary even though it is not that convenient to shape. The reason is, what could be the possible reason for this particular aspect of matching your external cordon line, which the boundaries considered for previous studies or studies planned for the future. Data available based on those studies can be used for comparison, cross checking. It is not that we need not have to collect the data, we have to collect whatever data is required for our purpose and if the same information is available through other sources pertaining to this area, it will be easy for us to cross check for the correctness of our work; that is idea.

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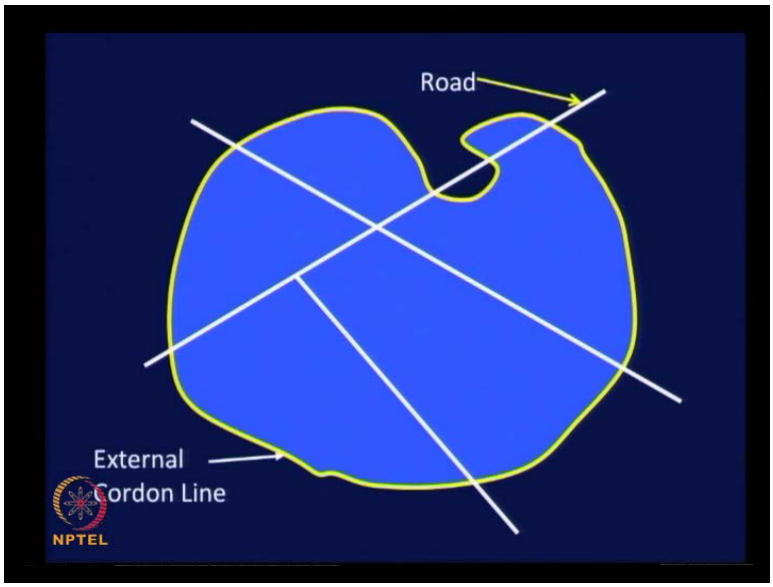

This is what I said external radiating roads crossing the external cordon line at only one point. You see for example, this road is crossing the external cordon line at 1, 2, 3 locations. So, it is going out of your study area then coming in to your study area, even though to satisfy the condition of matching your boundary with the existing study boundaries, may warrant this kind of configuration, still you can modify in such cases to

avoid crossing of radiating roads at several points. You can just connect your boundary line here, so that the crossing point is only one, such minor modifications can always be done to suit our convenience.

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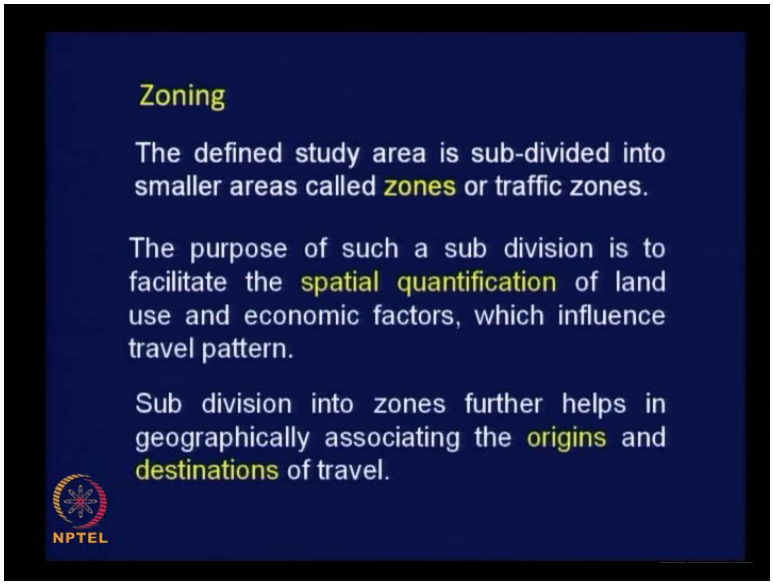

Then once you delineate the boundary for your study area, we have to divide the whole of the area into smaller land use parcels, or you must divide the area into small traffic zones and this process is called zoning, zoning of the planning area. The defined study area is sub divided into smaller areas called zones or traffic zones. The purpose of such a sub division is to facilitate the special quantification of land use and economic factors, what do you understand by special quantification of land use and economic factors. You must cordon of some space some area and then study the socio economic characteristics of that area, so that is taken as an attractive force or trip producing force, unless you divide the whole area into smaller land uses, this kind of quantification cannot be done, that is purpose one.

Second, these zones will influence travel pattern or these factors will influence the travel pattern that is why we want to quantify zone wise. This is another advantage sub division into zones further helps in geographically associating the origins and destinations of travel; this is what we discussed it in the detail. For analysis purpose we need to fix the trip origins and destinations, and we have fixed those points as zone centroids, unless we

have zones we will not be able to fix the centroid, so that is the purpose of dividing the whole of the study area into smaller traffic zones.

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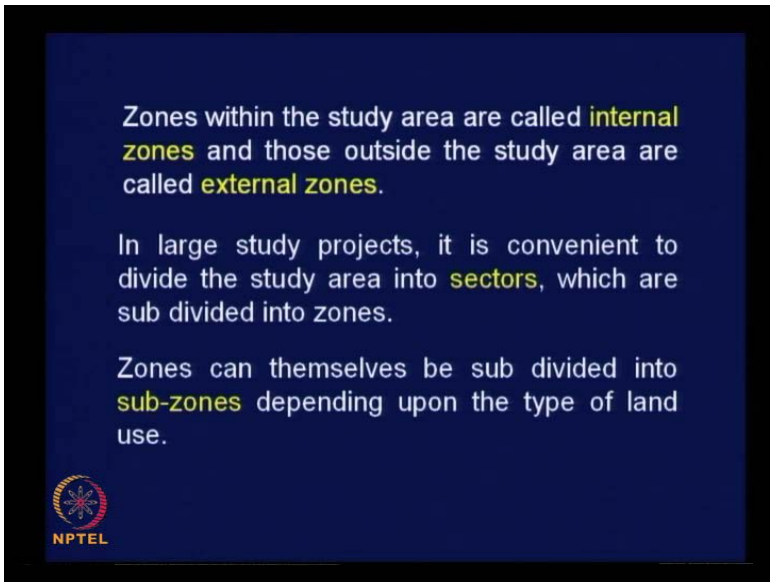

And zones within the study area are called internal zones, or zones within your external cordon line are called internal zones, and those outside the study area are called external zone. This implies that there are going to be zones outside your external cordon line also. In large study projects, it is convenient to divide the study area into sectors first, which are subdivided into zones. You may end up with hundreds of traffic zones in an urban area if the area is larger, instead of simply dividing the whole of the area into smaller land use parcels, namely traffic zones starting from one end. You first broadly divide this area, on some basis into say nine or ten divisions, which are named as sectors, then divide each sector into traffic zones that will be more convenient and later on I will show you how division of the urban area under sectors is very convenient to handle the data.

Zones can themselves be sub divided into sub zones if necessary, depending upon the type of land use. So, we can divide the urban area into sectors, sectors into zones and if necessary zones also can be sub divided into sub zones, and sub zones will be the smallest land use parcel and you will be fixing your centroids at each of the sub zones, sub zone centroids will be with trip origins and destinations, if you are dividing zones also into sub zones, otherwise there is no point in dividing zones into sub zones.

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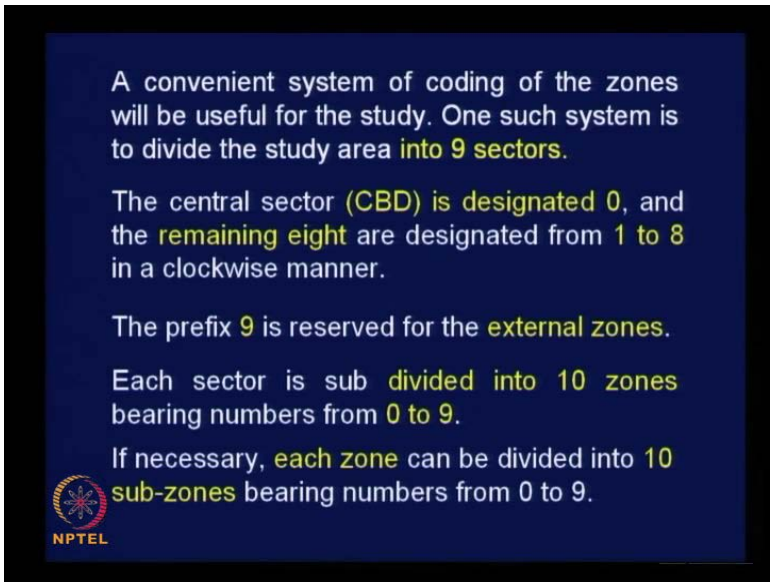

A convenient system of coding of the zones will be useful for the study obviously. One such system is to divide the study area into nine sectors first, divide the study area into nine sectors, numbering the sectors starting from zero to eight within the external cordon line and number nine is reserved for the space outside, the external cordon line. The central sector CBD Central Business Distinct is designated normally with number 0, and the remaining eight sectors are designated form 1 to 8 in a clockwise manner, clockwise is only convention, even if you do it anti clockwise nobody is going to question.

The prefix 9 is reserved for the external zones; the entire area outside your external cordon line is given sector number 9. Each sector is sub divided into 10 traffic zones bearing numbers from 0 to 9. If you start numbering from 0 to 9 you get 10 traffic zones. If, necessary each zone can be divided into 10 sub zones bearing numbers again from 0 to 9. So this kind of coding will help you to understand the database much better and you will be even able to perceive the exact location of a particular sub zone or zone when you look at the number, let us see how, it is going to really help us.

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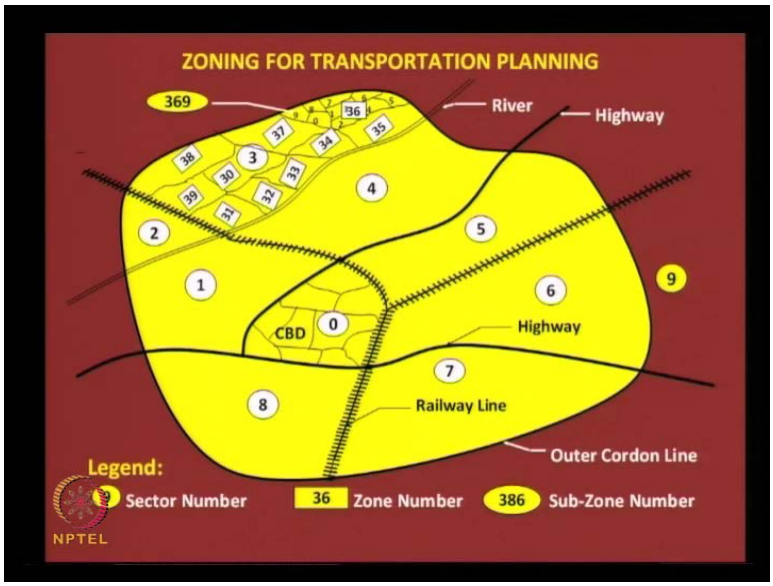

Let us say this is your study area, yellow colored one, planning area considered for the planning purpose, let us say this is the outer cordon line, you have identified the outer cordon line based on the four factors that we have discussed, and there could be a railway line crisscrossing, the urban area. There could be a highway and a river crossing the urban area and more roads, and of course CBD is shown here this particular case. Now, as we discussed we divide the urban area first into sectors, so sector number first CBD is 0, what is the boundary for sector 0, can see boundary line is well defined, there is a major road here, another major road in this path and then railway line. There are clear cut man made barriers in this case defining the sector boundary. Then give numbers for the other sectors, sectors 1, 2, 3, 4, 5 6, 7 and 8, just we have numbered in the clockwise directions starting from 1 and ended with number 8.

Please note, that sectors are not equally dividing the urban area in terms of area thinks like that. Sector division is mainly for our convenience, if you know that a particular zone is from sector number 3 or 4, we can immediately perceive its geographical location, that is the advantage of dividing the urban area into sectors, and the basis is available boundaries; sector 1 for example, has the outer cordon line, external cordon line partly as its boundary, then the river, railway line, road and road. Sector 2; has outer cordon line river and railway line, it is a small sector, but still it is a separate piece of land, divided by river and a railway line, it is better to consider that as a separate sector. So, this is how we need to divide the urban area into different sectors, and as I said sector

number 9 is to indicate any area outside your external cordon line, anywhere around your external cordon line as sector code number 9.

Now, just I am showing division of one sector into traffic zones, sector 3 is divided into different traffic zones, please look at the zone numbers. The first place indicates the sector number and second place indicates the zone number. So when I say the zone number is 3, 9, it automatically indicates that the zone lies in sector 3 first, and then within sector 3 this is zone number 9. And a zone can be divided into sub zones also, I have shown sub division of zone number 36, it again 10 small land use parcels and these sub zones also can be numbered from 0 to 9, can be divided into 10 smaller land use parcels.

Of course the legend is known to you, number 9 for example indicates sector number, 3, 6 indicates zone number, and when you have a number with three digits, it obviously indicates a subzone. For example, this subzone can be numbered as 3, 6, 9, so when you have a subzone numbered 3, 6, 9 it is subzone number 9 lying in zone 6 which lies in sector 3. So, that is how when you just look at the code number itself you will be able to identify the exact location of that particular land use parcel. So, you will be dealing with only these code numbers while you analyze the data. You cannot just have your city map and analyze your data; you will be just dealing with the code numbers, like this.

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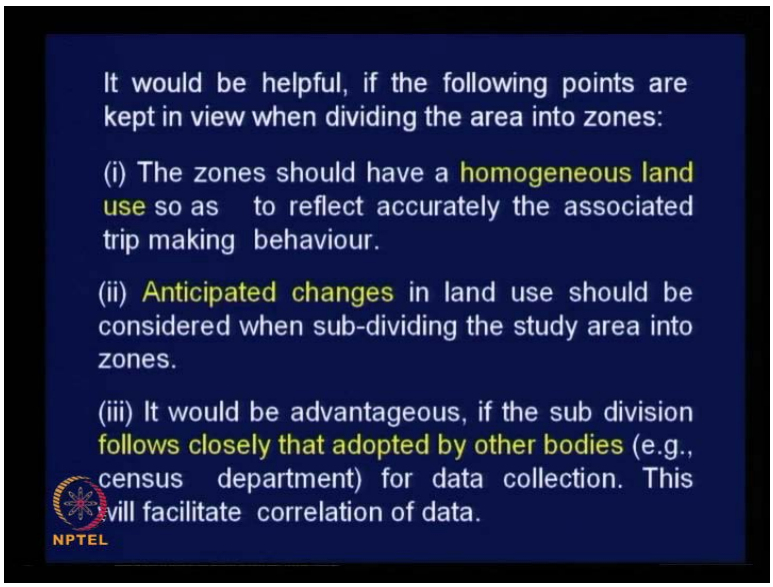

And it would be helpful, if the following points are kept in view when dividing the area into traffic zones, there are guidelines available to divide the urban area into traffic zones. First the zones should have a homogeneous land use, so as to reflect accurately the associated trip making behavior; it is a very important factor why should we have a homogeneous land use, as you may recall we have different types of land uses in urban areas, starting from residential, industrial, institutional, recreational. So, as far as possible if a traffic zone has a particular type of land use, then the trip making behavior can be understood or explained very easily. The zone contains only households' residential area then it is going to be a trip production point, trip producing zone. So that is how as far as possible, see that there is only a kind of homogeneous land use in traffic zones.

Anticipated changes in land use should be considered when sub dividing the study area into zones. Let us say one residential area in the base year is changing very fast into a commercial area, and is partly commercial and there are few residential apartment still in that area, definitely you can include those are residential pockets also in this zone, so that in the near future it is going to be only a commercial land use. So, such changes are to be foreseen, you must have a clear idea about the history of development of an urban area, and fix the boundary for the zones. There could be scattered residential development with open agricultural land in between. Obviously in course of time within five to ten years, all these spaces will be occupied by houses. So, you can enclose the whole of the area as one traffic zone that is how you need to understand this particular point.

It would be advantageous if the sub division follows closely that adopted by other bodies, obviously see local bodies like municipalities, town panchayats, they will have their own bonds for the purpose of elections and other administrative purposes, as far as possible fix your zone boundaries also to match with those boundaries, so that you will have another secondary data source for checking your data that you collect in respect of each of the traffic zones. This will facilitate correlation of data.

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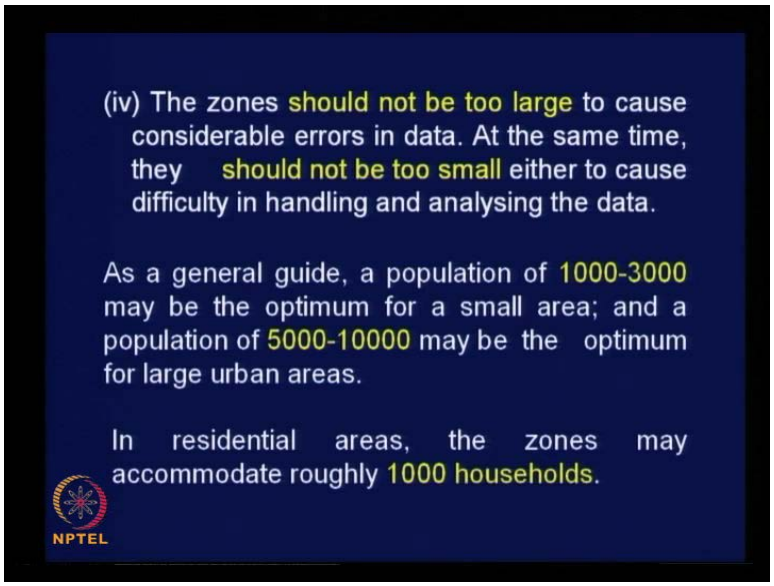

Fourth, the zones should not be too large to cause considerable errors in data, as indicated to you sometime back if it is too large, then it will be erroneous while you do the analysis, it should be of reasonable size, at the same time they should not be too small either to cause difficulty in handling and analyzing the data. They should not be too ambitious and divide your urban area into ten thousand traffic zones. You will be unnecessarily troubling yourself for no net advantage, you have to be careful. As a general guide, a population of one thousand to three thousand, may be the optimum for a small area, small urban area and a population of five thousand to ten thousand may be optimum for large urban areas, and in residential areas the zones may accommodate roughly about one thousand households. Why the population range given is small for smaller urban areas and large for larger urban areas, any suggestion.

See the range of socio economic characteristics in a country is going to be same as indicated to you earlier, if you consider income range in our country, it varies between say about two thousand rupees to sixty, seventy thousand rupees per month, that variation is going to exist everywhere whether in the town or cities, that you can say small or big, but range is same. To capture that range in a smaller urban area, you must divide the area into number of smaller land use parcels, so that you do not miss out any information within that range. Whereas, in larger areas even if the number of people covered is more, still you will be able to capture the range, because total population is

huge. So, that is how one thousand to three thousand for smaller areas, and five thousand to ten thousand for large urban areas.

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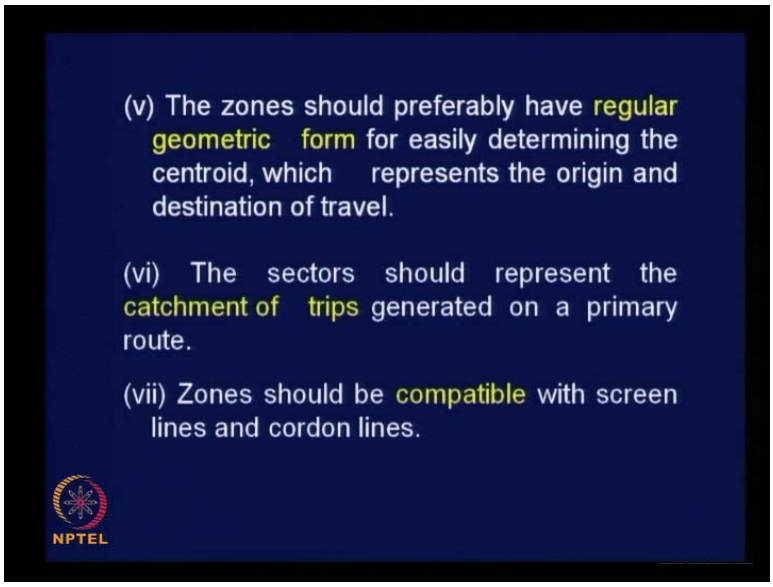

The zones should preferably have regular geometric form, normally in practice never happens, you may not come across very regular geometric forms, it is just given as one point wherever possible you can look for such geometric forms for easily determining the centroid, which represents the origin and destination of travel as you know. The sectors should represent the catchment of trips generated on a primary route, what do you understand by catchment of trips, what do you understand by catchment area for a water body. The area where from water flows into the water body, similarly, if you have an arterial road, if lot of commuters just converge towards that arterial road for commuting from the adjoining area, then the adjoining area becomes a commuter shed for this particular road. What is mentioned here is this, this sectors should represent the catchment of trips generated on a primary route. Once you have sector boundaries as major roads and railway lines, obviously the sectors will be the catchment area.

And then zones should be compatible with screen lines and cordon lines. Cordon lines you are familiar with, when you are dividing your area into zones, the zones which are adjacent to your cordon line will have partly the cordon line itself to serve as zone boundary. So, you should not just try to have another boundary for a zone when it is abutting the external cordon line. Take the cordon line itself as part of your zone

boundary, that is what is mentioned here, and screen lines will be shown to you shortly, I will show you pictorial what is really meant by screen lines. You are familiar with this picture and these are screen lines. I have shown the railway track and river as screen lines, what is a screen and what is then a screen line. Screens will have specified size of openings at specified locations; it will be made as per the design. Similarly, if we have barriers with specified openings at fixed locations, for the traffic to flow through; such barriers are called screen lines.

The alignment of a railway track serves as a screen line, because road vehicles cannot cross railway track at every point, they should pass through fixed locations, either level crossing or underpass or overpass. Similarly, if there is a river, there will be bridge is providing opening for the traffic to cross at fixed intervals; like openings on a screen. So, that is how these barriers where there are fixed locations for traffic to pass through are termed as screen lines, and what is meant earlier is this, your zone boundary, for example zone 39 has its boundary as railway track also, part to the boundary for 39 is screen line itself. So, screen line has to be taken as boundary, you cannot just create, you should not create another boundary adjacent to this screen line, take that itself as your zone boundary. Similarly, for zone 38 part of the boundary is the external cordon lines itself, that is what is meant by compatibility with cordon lines and screen lines.

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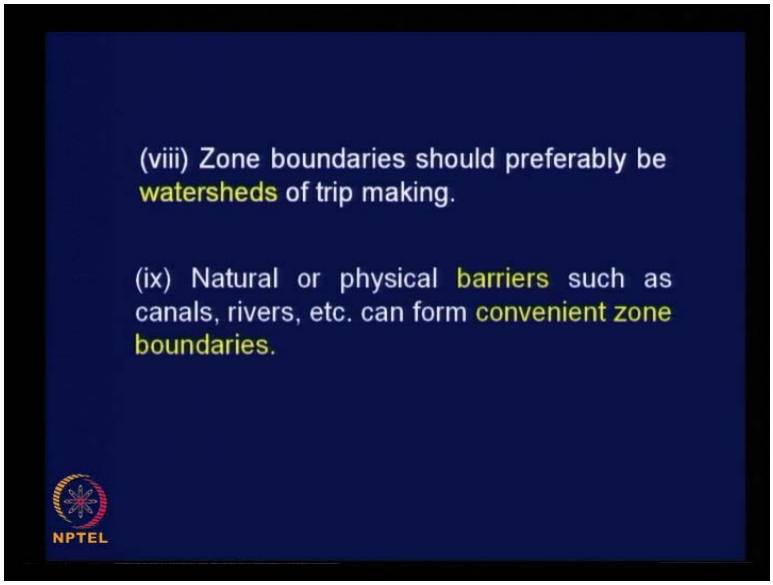

Zone boundaries should preferably be watersheds of trip making, earlier we talked about commuter shed; now it is watershed of trip making. Watershed is nothing, but a water course collecting water from the catchment area. Zone boundaries should preferably be watersheds of trip making, that means the boundaries should preferably be either a road or a railway line, then it will be shed, watershed of trip making. Natural or physical barriers such as canals, rivers, excetra can form convenient zone boundaries as we have seen.

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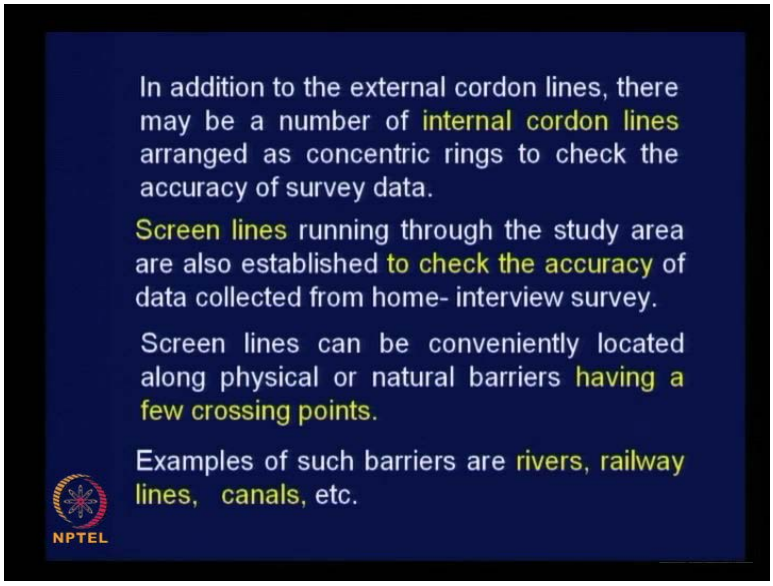

In addition to the external cordon lines, there may be a number of internal cordon lines also, arranged as concentric rings to check the accuracy of survey. See when you have an external cordon line, we are going to differentiate trips made within the cordon line as well as trips made crossing the cordon line from one side to another side, and if you want to have a cross checking of a data within your study area. You have more cordon lines within the external cordon line, one or two more cordon lines and approximately concentric ring form, so that you have two three concentric rings, and it is possible for you to study the flow pattern of traffic crossing each of your rings, wherever necessary you can have more cordon lines also in addition to external cordon lines, the purpose is to check the accuracy of the survey data.

Screen lines running through the study area are also established to check the accuracy of data collected from home interview survey. You know what are screen lines now, and let

us say a railway line is dividing your study area into two halves, then if there are say five crossings across the railway line and the whole stretch, if you count the traffic at all the 5 locations you can get clear information about the crossing traffic from one half of the city to the other half. You would have already collected information on each portion as well as for the whole of the city. So, this cross checking will facilitate to understand or to identify possible errors in your data set; that is the purpose of making use of this kind of screen lines also to cross check your data. Screen lines can be conveniently located along physical or natural barriers as we discussed earlier having a few crossing points like canals, railway lines and so on, examples of such barriers are railway lines, canals etc.

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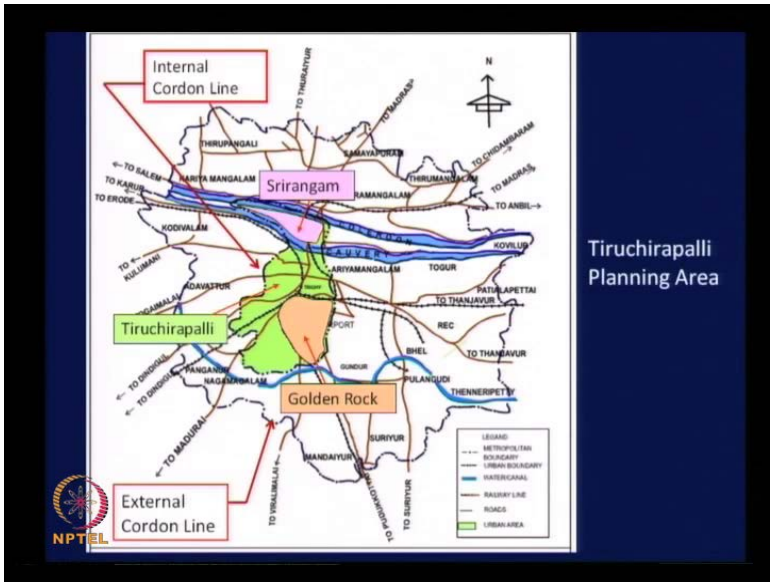

Let us look at how the external cordon line and internal cordon line was fixed for the city about which you are familiar now; Tiruchirapalli city. Can you identify the external cordon line for the city, the outer boundary obviously, this is the external cordon line, and the internal cordon line was also fixed and this was nothing, but the municipal boundary of the combined area of three municipal towns, this was the internal cordon line, and as you may recall this urban area has got three municipal towns; one is Srirangam, other one golden rock and the rest of the area is Tiruchirapalli municipality. So, this is how you need to understand fixing of external and internal cordon lines it is very clear internal cordon line also follows an administrative boundary it is the municipal boundary and the external cordon line is fixed again following the adjoining panchayat boundaries which are revenue boundaries you can see the shape configuration of the

external cordon line it is not very smooth quite odd because we are just trying to match the boundary lines already followed for other studies.

We will stop here and to summarize what we have seen today we started out discussion on transportation service first we tried to understand the data need for transportation analysis by recollecting the data set requirement for the 4 steps involved in the analytical process. Starting from trip generation model split trip distribution and route assignment analysis then we discussed about delineating the study area using external cordon line and we know now that there are guidelines available for fixing external cordon line and the area enclosed by external cordon line we studied in detail to get information about the travel pattern and the related socio economic characteristics.

The area outside the external cordon line also needs to be studied to account for internal to external and external to internal trips and there are a set of guidelines available for dividing the study area into traffic zones and we also know now how to code the urban area for the purpose of zoning first dividing the area into sectors then zones and then subzones and finally, we have seen an example in respect of fixing the external cordon line as well as internal cordon line in respect of Tiruchirapalli city we will see the rest of it in the next class.