Sustainable Transportation Systems
Professor. Bhola Ram Gurjar
Department of Civil Engineering
Indian Institute of Technology, Roorkee
Lecture No. 30
Sustainable Transport Planning and Approaches- I
The traditional Transport Planning Process

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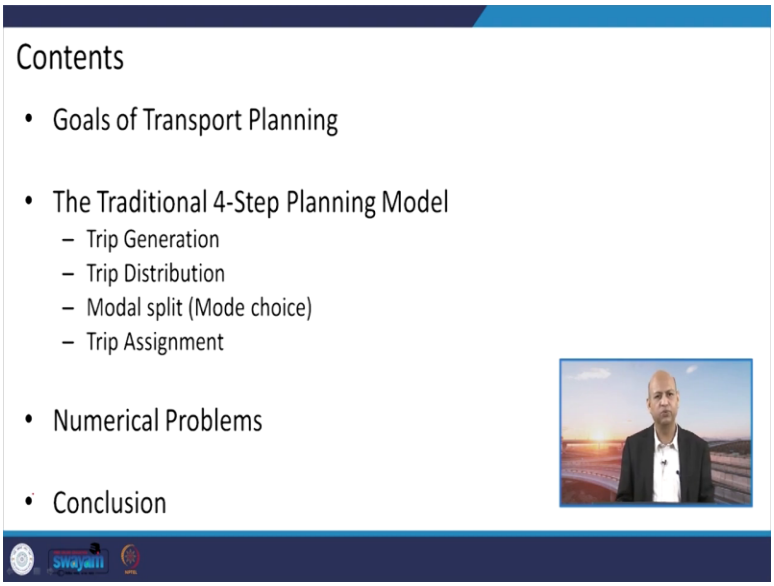

Hello friends, so, in the line of sustainable transport planning and approaches, today we will discuss about traditional four step planning model. So, these will be the contents like goals of the transport planning though we have covered it in the last lecture a little bit, but we will again discuss about it and then how to do the trip generation and trip distribution or modal split mode, different kinds of transport modes choices, decision making, and trip assigning and then to practice it, how to do it, we will have certain very easy numerical problems and then we will be concluding.

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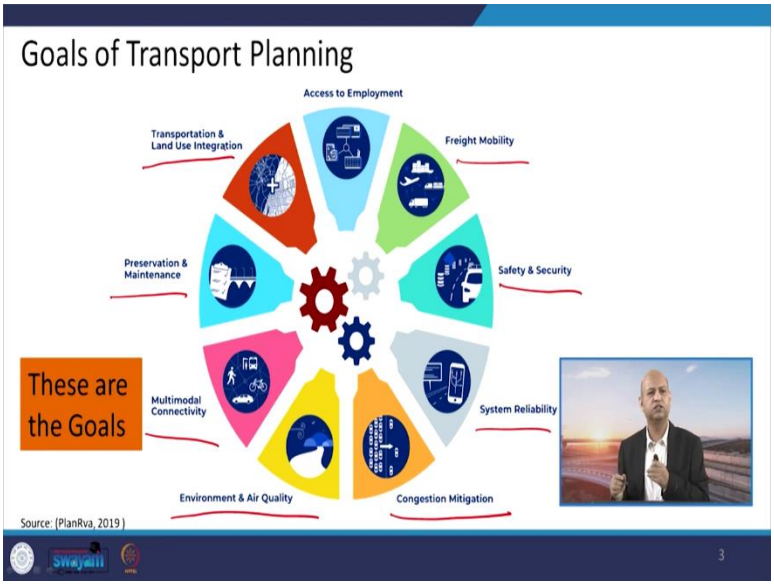

So, the goals of the transport planning as you know, the first of all, the people should have accessibility whether for employment, for education, for any other activity, the transport mode should be of that nature that is accessible to all, that is very important, it should not segregate or discriminate between different social segments. Well, freight mobility is also one aspect because goods and services are exchanged by people. So, the transportation is one important mode for freight transportation or the mobility.

Safety and security is also one important aspect because you want to do your journey safely and with security, because if there are chances of accidents etc., then it is not a good transportation mode. So, planning should take care of all these things. And then the system's reliability, if something some mode of transport is helping you to reach the destination at certain point of time, then that promise should be met means that mode should take you to the destination at that particular time.

And also reliability in the sense that it will not break down somewhere else or there will not be any congestion, transportation or mobility will be quite smooth those kinds of things. So, congestion mitigation must be there, there should not be any chances of congestion or traffic jam, environment and air quality related aspects should be met properly.

That is why we have discussed in detail about the EIA including several case studies related to various transport modes, then multimodal connectivity, because it is not necessary that we will

travel only through one kind of mode, we will have different kinds of modes like highways, railways, airways, etc. And even non motorized kind of transportation or transport. So, all those multimodal connectivity should be proper and efficient.

Then preservation and maintenance of like heritage sites or even the system's preservation and maintenance must be timely, properly, transportation and land use integration that should again in a holistic way, it should not like for some people to not access the proper transport related facilities and others reach there in an easy way. So, the land use integration should be taken with care. So, these are the all goals which should be part of planning means, whenever we plan the transport system, then these are the main goals which should we met properly and in detail.

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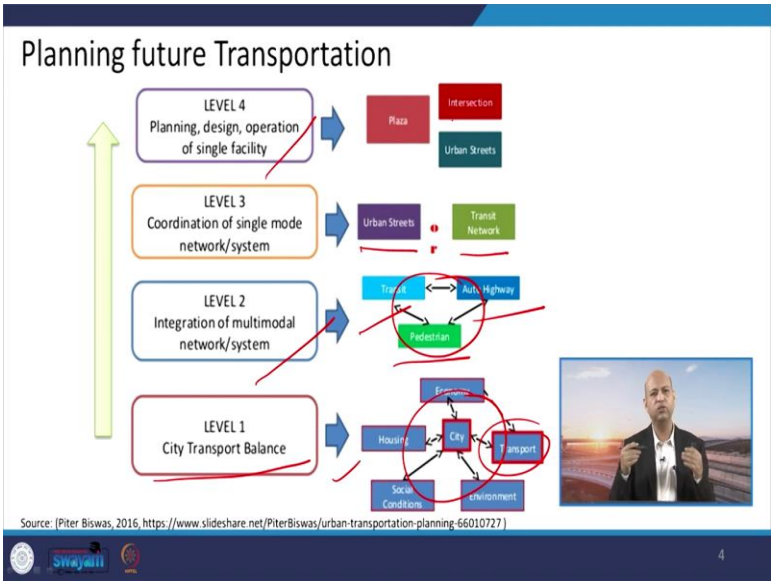

Well, so, there are different levels of achieving this planning of transportation. So, first of all we do city transport balance within the city like the residential area and the economics of the transport, transport related infrastructure, the environment, social conditions, all these aspects related to the city they should be properly met. So, at the city level we do. Then the level two is multimodal network systems. So, like transit, auto highway, pedestrians, these should be properly integrated otherwise, you would not be able to reach from one transport mode to other one in an efficient way.

Level three talks about coordination of single mode network systems. So, within one system like urban streets or transit networks, so, that should be properly integrated in network must be

established and in detail then we should go for planning design operation of single facility like plaza or urban streets and intersections all this should be part of the detailed planning process.

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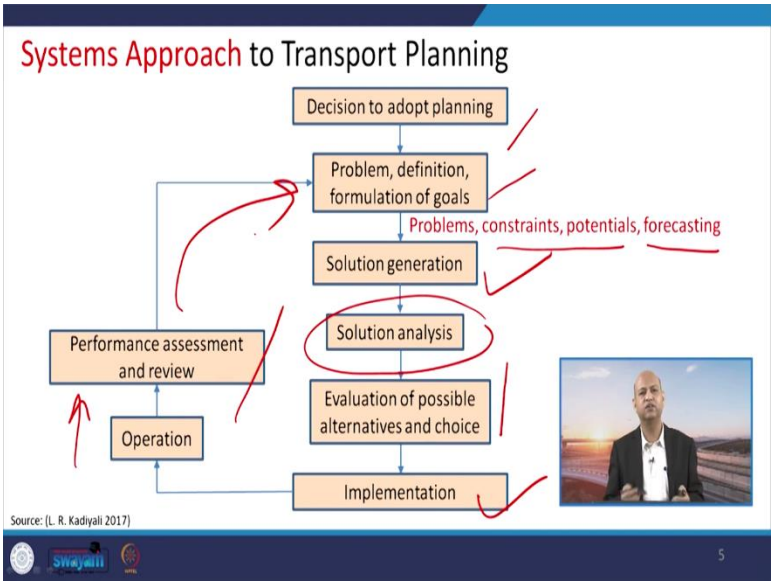

Well, this is the flowchart which gives us an insight about the systems approach, systems approach is necessary because it integrates all components all aspects, all parts of the system. So, this helps us to go for a holistic approach or integrated approach. So, decision to adopt a planning is to be taken by certain committee, problems, definitions, formulation of goals, all these constraints or potential forecasting these should be taken care of at this stage and this it will lead us to solution generation, what kind of planning we want to achieve or we want to implement.

So, the analysis is done based on data which is coming from surveys etcetera and then we evaluate the possible alternatives or choices so, that we can go for the best possible transport mode implementation later comes then during implementation also we get certain feedbacks, if suppose, in theoretical analysis, there was some parameter which was not considered giving proper weightage, then in operational stage or in implementation stage there will be some feedback that should be taken care of during operation we will get feedback.

So, the performance assessment and review should be carried out and that feedback should go to again enhance the better planning. So, that way it is a cyclic process you can say.

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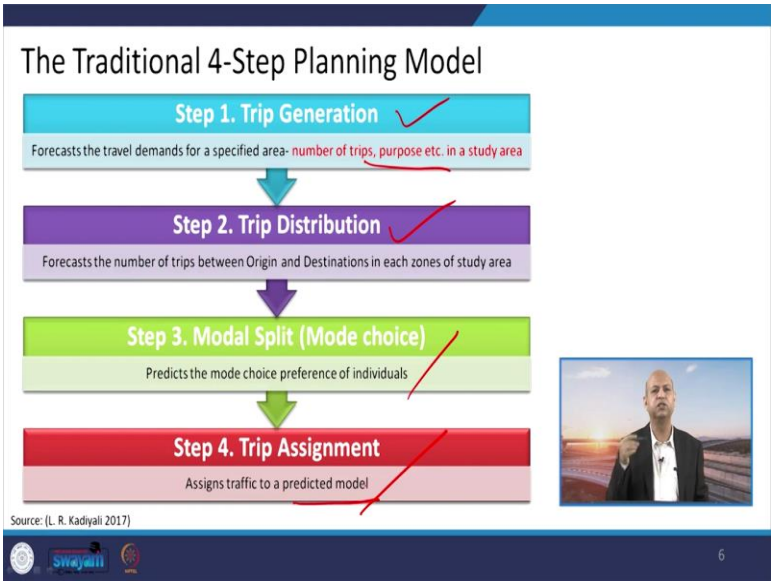

Well, these are the traditional four step planning model, which is central theme for today's lecture. So, the first of all, based on the survey, we go for trip generation or like how many people will travel to a particular destination, how many times they will go So, different kinds of trips and different for different purposes within the study area, that trip generation has to be properly counted, then trip has to be distributed within that particular zone so that like within big area, there are certain zones, so, for this zone ABC, this generated trip is to be segregated or distributed.

After that the modal split that is based on the choices of the people, some people will travel through bus, some people will take taxi, some auto, some two wheelers like that, so, which kind of modes they will be choosing according to that modal split has to be achieved and then we assign the trip for the complete database. So, that goes for assigning traffic for a predicted model. So, that will kind of theoretically meet our, the travel demand in that sense.

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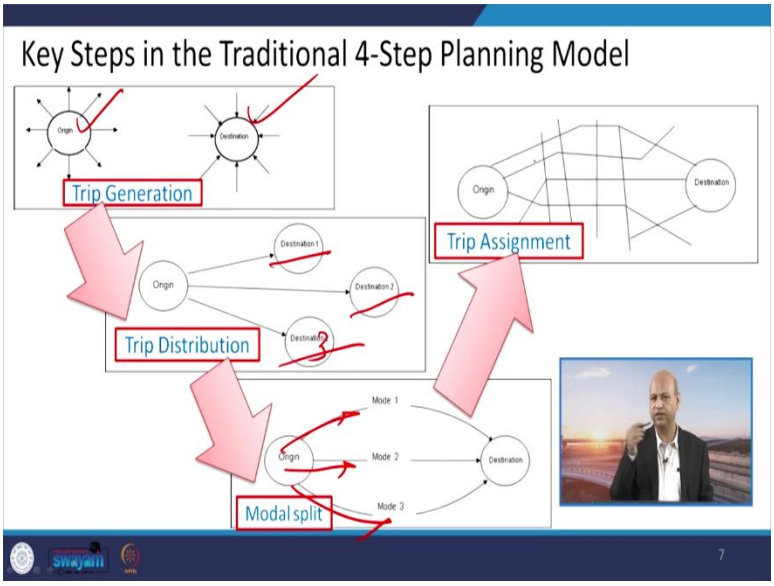

So, in pictorial representation this is given like this is the trip generation from the origin to the destination. So, based on that survey, then within the origin and the different zones, this trip distribution will be done like destination 1, destination 2, destination 3, those kinds of things. Then modal split like some people will take railways, some people will take buses, some people will take auto, taxi for the same destination. And then the trip assignment ultimately for different kinds of roads, different kinds of modes, that is done at the last stage.

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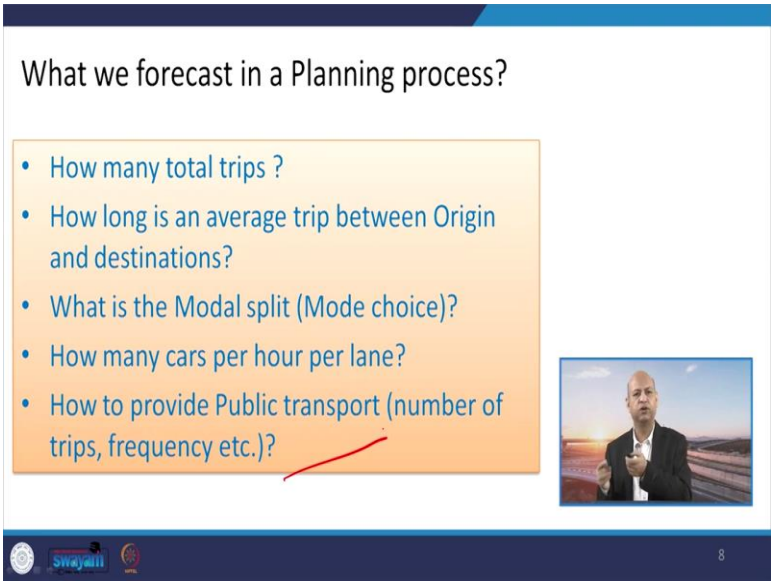

So, these are the basic questions, which are the part of the planning process like how many total trips are there, these are the things which have to be answered during this planning process. So, what will be the total trips volume, then how long is an average trip between origin and destination right, in terms of distance as well as in terms of time taken, what is the modal split mode of choice, with how many people are choosing for let us say public transportation system, how many people are going with the help of their own transportation modes.

Then how many cars per hour per lane these kinds of things, these are examples not only car but two wheeler and all those modes, we have to take care, how to provide the public transport, number of trips frequency etcetera can we shift the people from privately owned vehicles to the public transportation system, all these issues are there.

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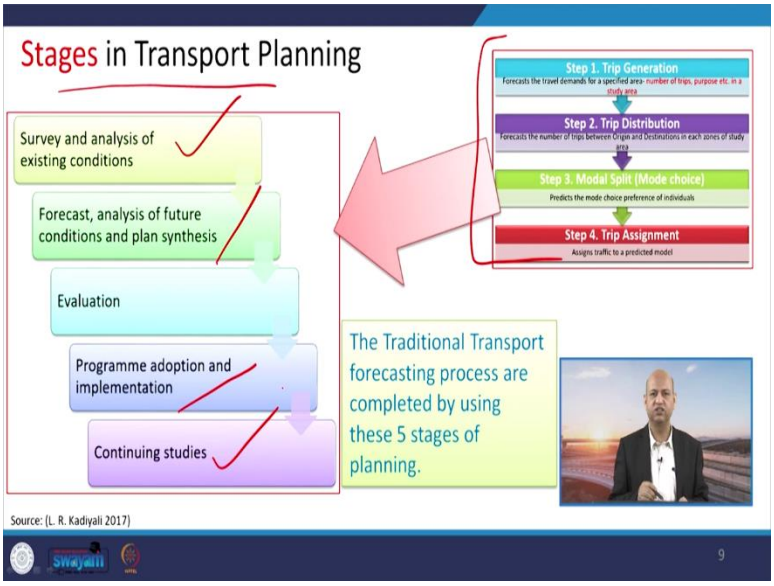

And all these four traditional steps are to be met through these 5 stages in transportation planning, which are known as like survey and analysis of the existing conditions. So, baseline data has to be collected with the help of questionnaire based survey and then forecast and analysis of the future conditions and this plan synthesis is done based on that data which was collected in the first stage.

Then, the next stage is for evaluation. So, the all results are evaluated properly. And the program adoption and implementation means whatever program have been conceived, how to implement that in real ground level and the continuing studies because the feedback should be continuous so

that we can continuously improve the system. So, these are the things which are the five stages for meeting these five steps of the traditional planning.

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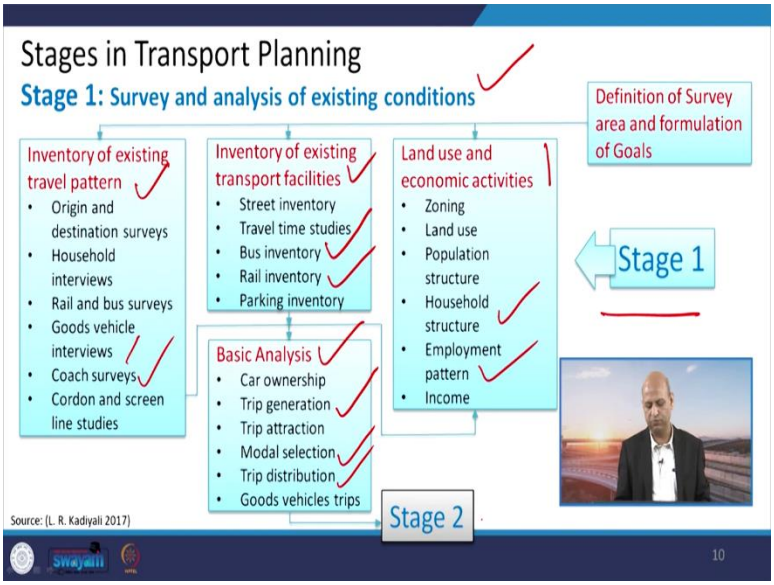

Now, we go one by one these stages in detail. So, the first stage that is survey and analysis of existing conditions, they are part of inventory of existing travel patterns, and inventory of existing transport facilities and land use and economic activities all these things to be met. So, this is the part of stage one, you can see in detail like origin and destination surveys, household interviews or goods and vehicle related interviews, coach surveys, those kinds of survey related activities are taken in the field.

Then, inventory of the transport facilities what kind of facilities are existing at that particular time like bus, how many verses are available and the rules of the buses, the railway inventory or parking inventory, whatever infrastructure facilities there related to the transport that inventory we should prepare as the baseline data, then land use and economic activities like different zoning, industrial zone, commercial, residential, okay, household structure, employment patterns, because that will help us to design proper transportation to the required destination.

Then, the basic analysis related to the vehicle ownership like car, how many cars in the family how many people are having cars, so, the density of the automobile then trip generation, trip attraction, generation means people are going, attraction means that origin is a kind of destination for other

origins, it will attract also, then model selection and the trip distribution which we have just discussed, and the goods vehicles trips will lead to the stage two.

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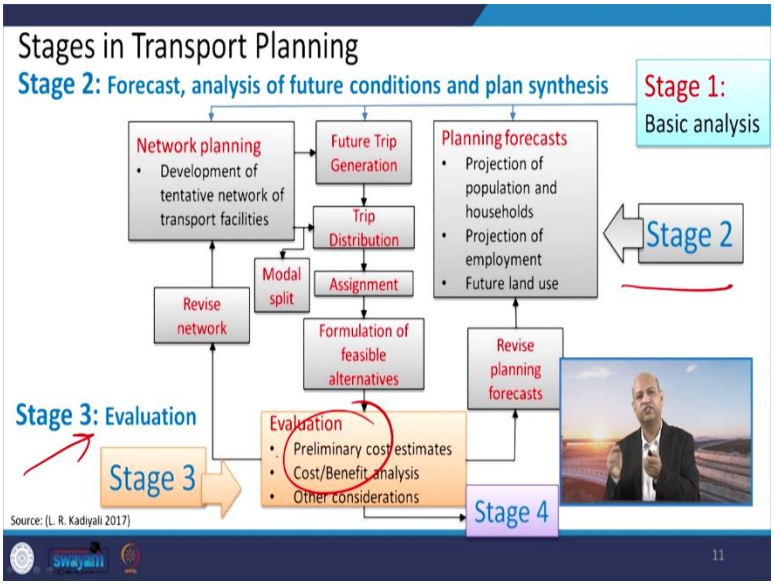

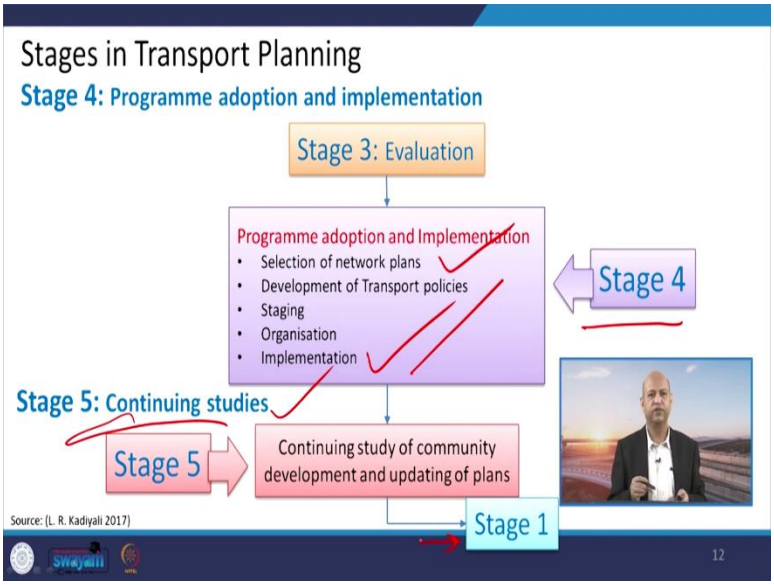

And the stage two is this one, like forecast, analysis of future conditions and plan the synthesis of all these data which have been estimated. So, this is the part of stage two and that will go towards the stage three of the evaluation. So, within the stage two we have to do network planning, future trip generation, planning forecasts and the modal split, revise network because of feedback from the evaluation stage which is the part of stage 3.

So, these are in fact related to each other. It is not in isolation, every stage gives feedback to the other stage. Then the next stage from stage three to we go for a stage four, which is related to program, adoption and implementation. So, in these we select the network plans, we do differently staging organization related issues, development of transport policies and implementation related whatever plans we have to do, and then continuing the studies when we are implementing, so, we need to do feedback related studies so that we can get the data in continuous mode and will give the feedback to the stage one. So, this is a cyclic process okay stage 1 to 2, 3, 4 and then that to stage one.

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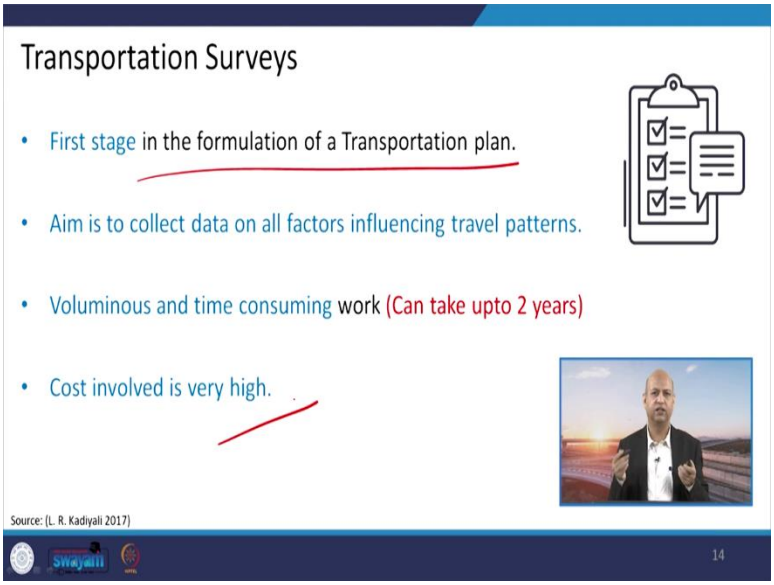

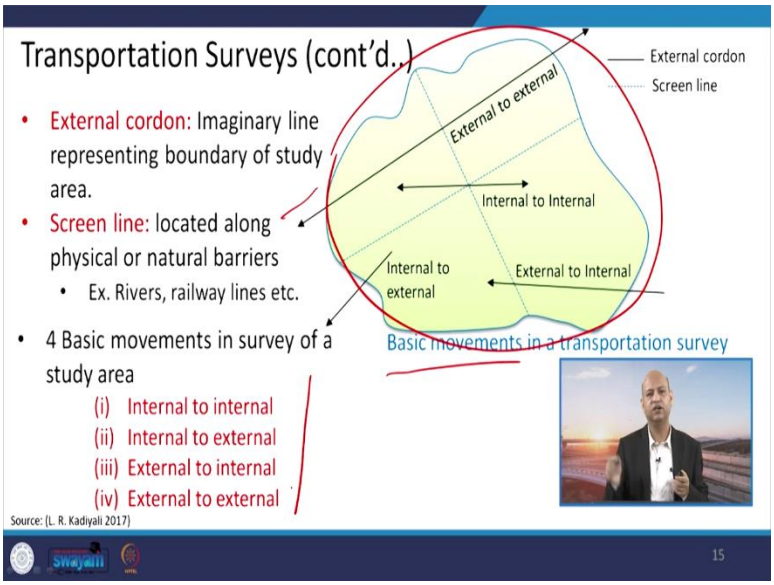

Well, when we talk about transportation planning then there are certain factors which are to be considered properly and these are the factors in detail like car sharing are there, carpooling is there or not or ride sharing is happening or not bike sharing, active transportation modes or autonomous vehicles are there or not, what is the demand management okay, and then the truck platooning or aging in place, so all these factors are to be considered because only then we will be having the holistic planning otherwise, if some segments of the society or infrastructure are left out, then there will be a gap and the planning will not be proper.

Well, the surveys so, first stage the formulation of transportation plan and it aimed to collect the data, on all factors which are discussed or which will be discussed in later on. So, which will influence the travel patterns. So, the total planning or networking and this data is voluminous and it takes time, sometimes 1 or 2 years are taken for conducting the detailed field survey, because household survey or cost related survey, all these surveys are there.

Then cost involved is also very high because time is taken, experts involvements are there, we need to hire a skilled people. So, that survey is conducted properly, nobody do shortcut and the data must be reliable and proper. This is like the transportation survey and this kind of basic movements of the transportation within that imaginary area. So, this is the kind of area we are talking about to do transportation planning.

So, in this we will first of all see how much traffic is coming from the external and it is going externally means that is not being part of the this area as a destination like in Delhi outer ring road

is taken or nowadays this periphery expressway, peripheral expressway is there. So, who are you know want to go from Rajasthan to Haryana they do not need to go to Delhi they can go directly by that Expressway.

So, similarly, there will be some traffic, then some traffic will be like internal to internal that means, within that area from one zone to another zone or within that zone, so, that traffic will be there, then some traffic will be from external to internal like people coming from Gurgaon to Delhi or from Ghaziabad to Delhi.

So, external to internal or going from Uttarakhand to Delhi, something like that, internal to external means, some people will go also outside is not necessary that everyone will be there. So, that will be the traffic from internal to external. So, all these basic movements are taken at various functions. So, this data is to be generated by field survey or basic field survey.

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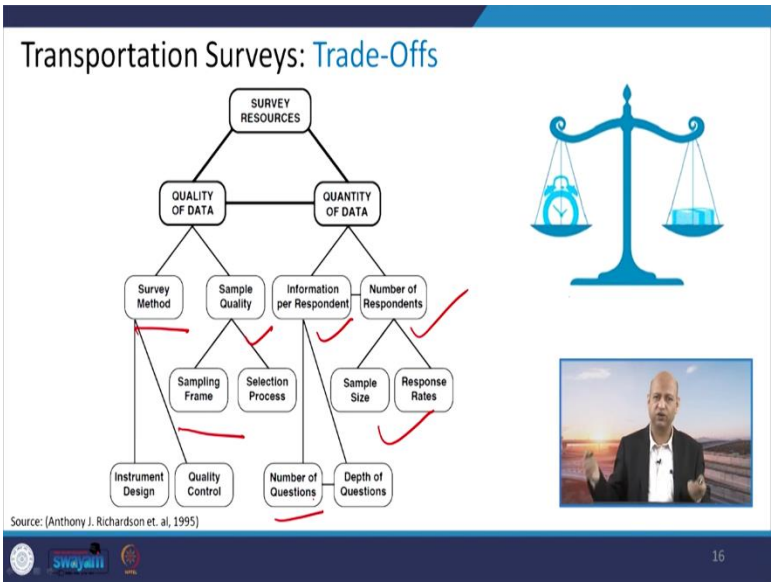

Then there are trade-offs because, it is not necessary that you have to do at all locations, there will be some sampling stations kind of thing. And then there are various assumptions, you cannot go for, endless survey at endless stations, because this needs a lot of resources and time consuming. So, there is a trade-off between quality of the data and quantity of data, we have to make some balance, it is not necessary that just go and go and you are generating data, you have to stop somewhere, you have to draw some boundary line.

So, the based on that balancing, that these kind of particular points are there, where data can be generated, and those data can be representative to that particular cities transport related needs. So, according to that, we have to do, then survey methods, sample quality, information per respondent, how much information is received, number of respondents, you cannot go for each and every dweller or the city resident to ask the survey related questions, it is not possible.

So, some sample population has to be surveyed only. So, those kind of things we have to do, and then the sampling frame, selection process and sample size, as I said, so, statistically, that should be representative and according to this survey has to be conducted and the questions should also be limited, otherwise people sometimes do not cooperate, if you are going to ask again and again, and depth of the questions will be framed in that way, that whatever information you are needing, that can be easily taken from the person whom you are serving.

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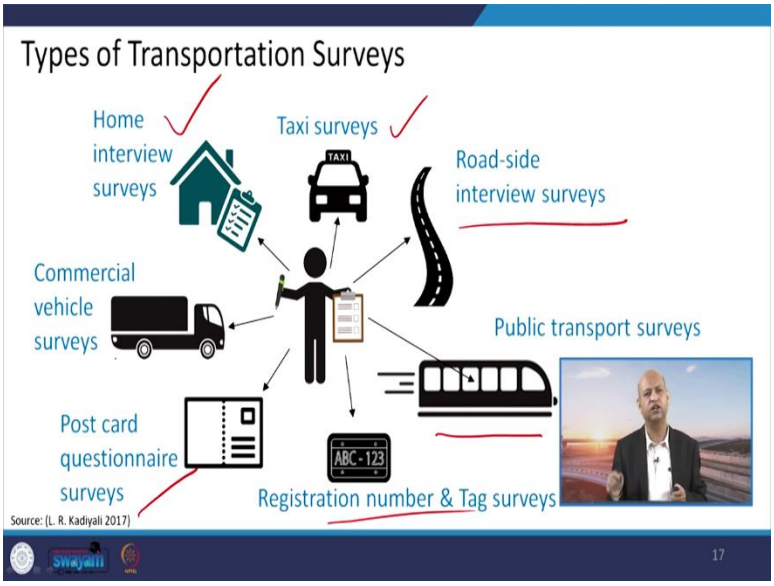

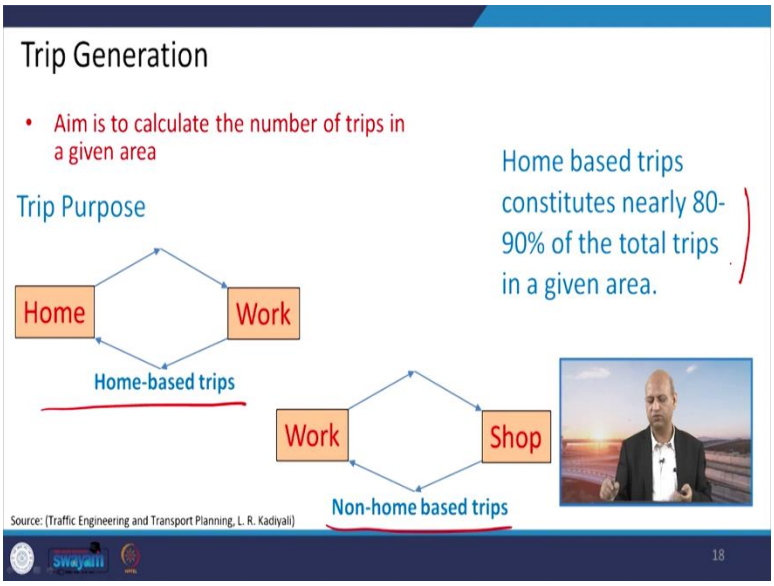

Well, these are the different kinds of transportation related surveys which we do like home interviews, so, door to door survey, you can say, taxi surveys means with the taxi drivers also roadside interview, you are extending somewhere and people are coming, you just ask them to answer your questions, those kinds of things, then public transport survey. And registration number and tax survey that you can get the data from even IT office also, postcard questions surveys, commercial vehicle related surveys, all these kind of different modes simulated surveys are conducted.

Then, we come to the trip generation as this traditional planning method. So, this was the first step for that, like home based trips, means, from home we are going to work or we are going to for hospital or education or whatever this is just one example, for the work there will be some trips non home based means, like from hospital you are going like buying medicines or from your workplace you go for some in a lunchtime you go outside and you buy from commercial area, those kind of things may be there and 80 to 90 percent trips are home based, this is one aspect of those surveys.

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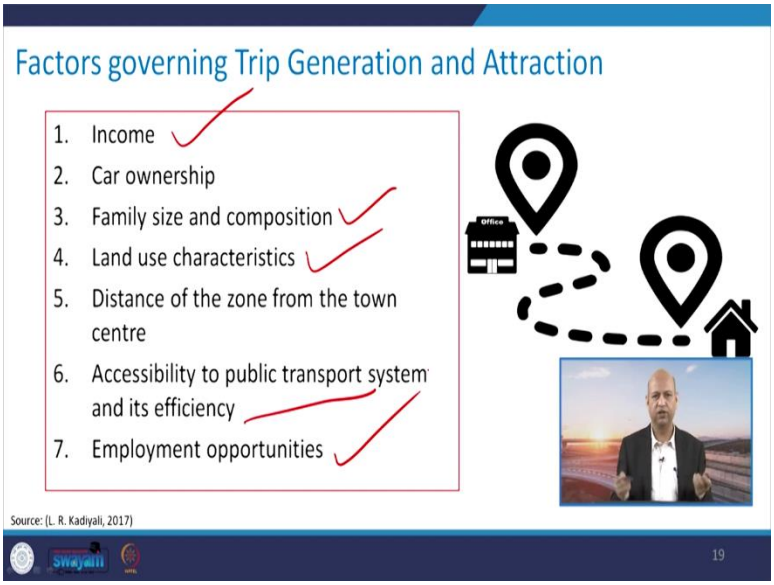

And the factors which are governing the trip generation and the attraction means generation from this, attraction towards this origin. So, these are the factors which influence these generation and attraction of the trips, income, car ownership, because suppose car ownership is more, then people will use the highway and if facilities are proper, otherwise, people will use some public transportation system.

Family size and composition again it will also influence because if you are going for family affair or some kind of activity, so, all people will travel in the car or not depend upon the size so, whether you are taking the transportation, public transportation or you are going through your own vehicle, that will depend upon these factors.

Land use characteristics, distance of the zone from the town center. So, that will also decide if it is nearer you can go walking or you can do bicycling otherwise, if it is far away then either you have to take some automobile or some public transportation system, accessibility to the public transportation system and its efficiency if it is not good, then you will feel discouraged to take the public transportation system, then you will go for taxi or your own vehicle and the employment opportunities that will also decide because if there are more employment opportunities, people will travel more for economic activities.

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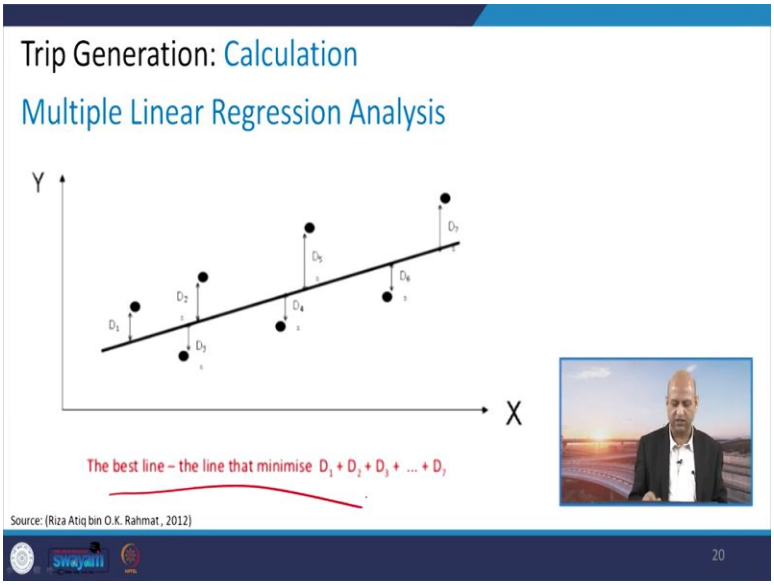

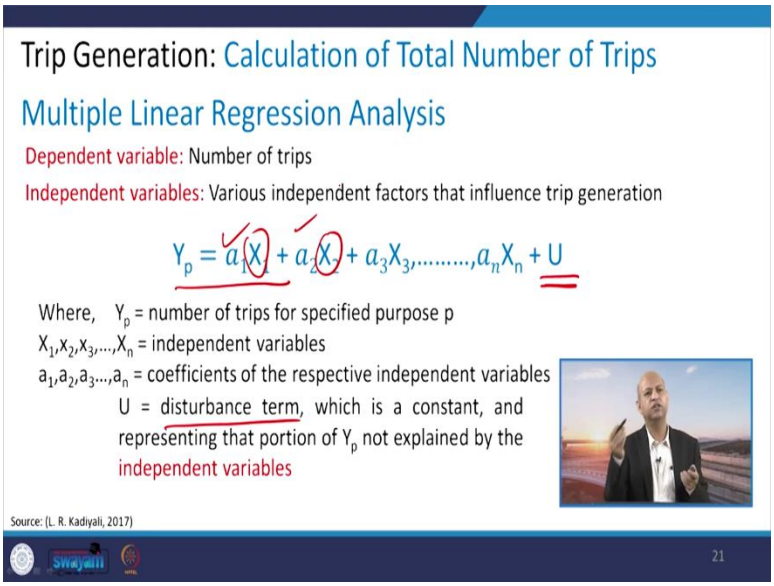

Well, we do then this multiple linear regression analysis, these are different distances. So, the total distance is calculated for the trip generation and this is one simple equation,

$$Y_p = a_1X_1 + a_2X_2 + a_3X_3, \dots\dots\dots\dots, a_nX_n + U$$

which is used for this trip generation calculation purpose. So, you can see like this is the equation, $Y = mX + C$; you can recall or $Y = aX + C$; those kind of equation that particular form of the equation is there.

So, this is the constant, the disturbance term which is a constant kind of representative okay independent variable and these are the independent variables and these are the constants like coefficient a1, a2 so, for particular non data we can use those data to determine the values of a1, a2 etc., and the U and then you can generate the trips and Y value can be calculated.

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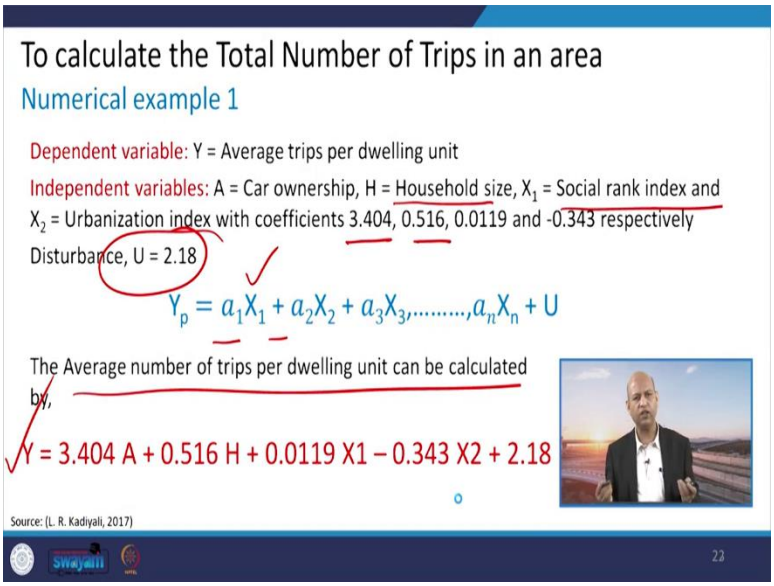

So, this is like one example; for example, these variables were X1, X2 etc., car ownership or household size okay social rank index those things and these values of the a1, a2 these are like 3.4, 0.516 these are the values and U value is given 2.18. So, these values can be used to this average number of trips per dwelling unit can be calculated by this, you can put those values multiply and sum up. So, this value will be calculated by this particular simple equation.

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Trip Rate

- Defined as the ratio of the total number of trips generated per day to the total population of considered area

$$Trip\ rate = \frac{Total\ number\ of\ trips\ generated\ per\ day}{Population\ of\ area\ considered}$$

Source: (L. R. Kadiyali 2017)

Calculation of Trip Rate

Numerical problem 1

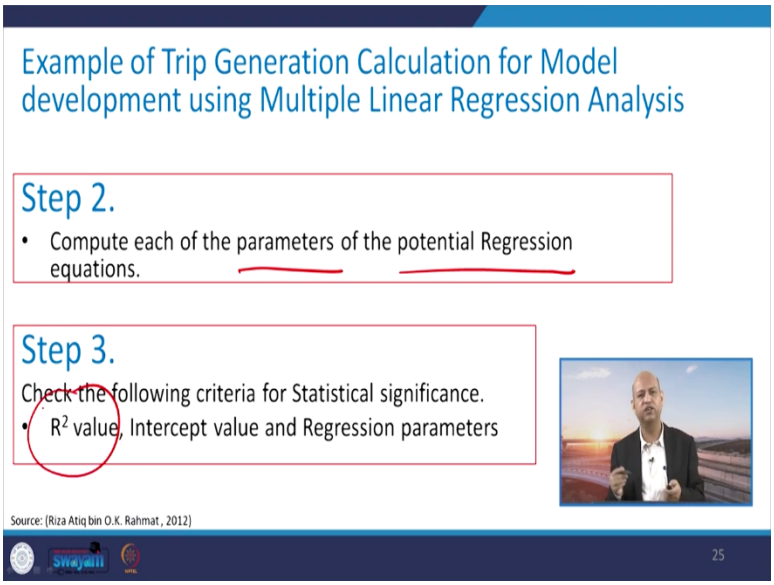
Estimate trip rate for a residential colony with a population of 2744 and 6574 number of trips ?

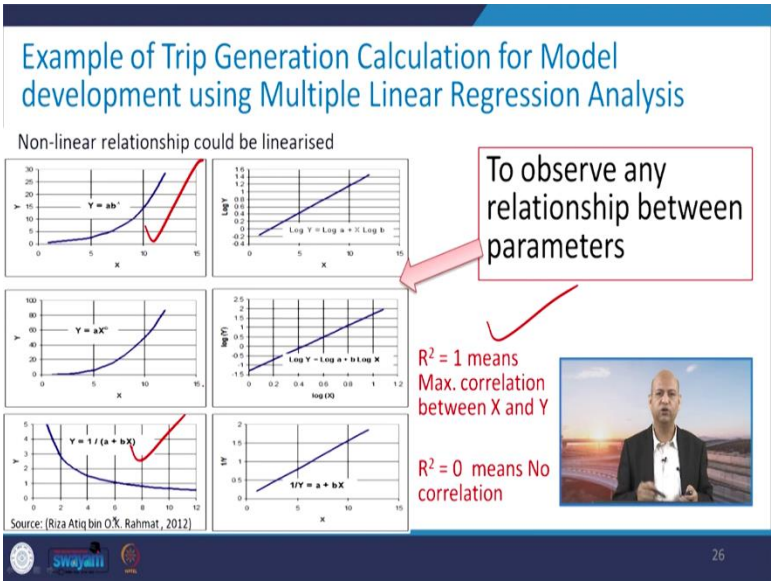
Solution

$$Trip\ rate = \frac{Total\ number\ of\ trips\ generated\ per\ day}{Population\ of\ area\ considered}$$

$$Trip\ rate = \frac{6574}{2744} = 2.39 \approx 2.4$$

Source: (L. R. Kadiyali 2017)





So, the next one is like trip rate, how to calculate the trip rate. So, this is empirical equation which is defined as the ratio of the total number of the trips generated per day and the total population which is generating those trips.

$$Trip\ rate\ = \frac{\text{Total number of trips generated per day}}{\text{Population of area considered}}$$

So, the total number of trips generated per day and the population within that area considered divided by that so that will be the trip rate. So, for example, this is very simple equation based calculation, estimate the trip rate for residential colony with a population of 2744, 2744 people are there and 6574 number of trips are generated.

So, what is the trip rate, so, very simple this is divided by this total population. So, the trip rate is 2.4 that is per person is taking that much trip an average value. So, these are the examples of trip generation and related to each parameter and the potential regression equations, these are used and then the R square values are taken. So, that confidence level can be seen like these are the, its not necessary that always linear relationship occurs.

So, according to the data available by the computer calculations, we can calculate the R squared value depending upon their relationship and we choose whether this is fitting in the curve or not or this one whatever. So, we choose that particular equation and correlation is decided and where correlation is good only that kind of relationship or pattern is chosen.

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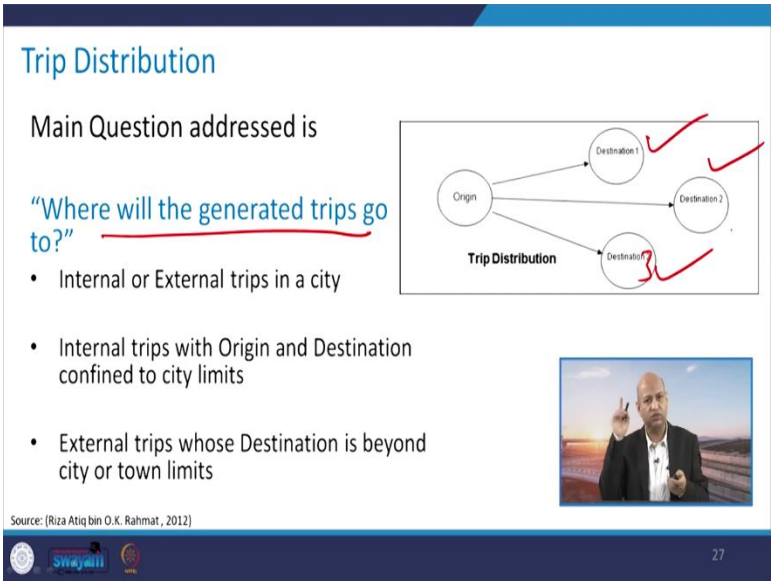

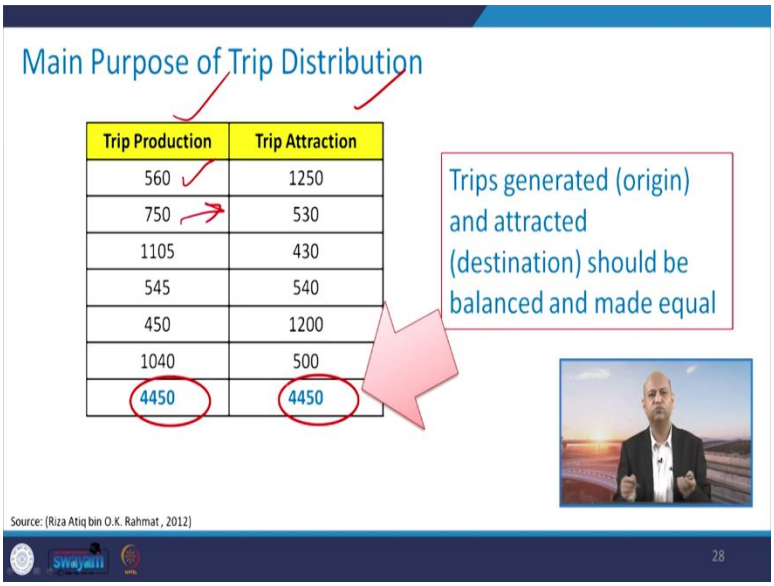

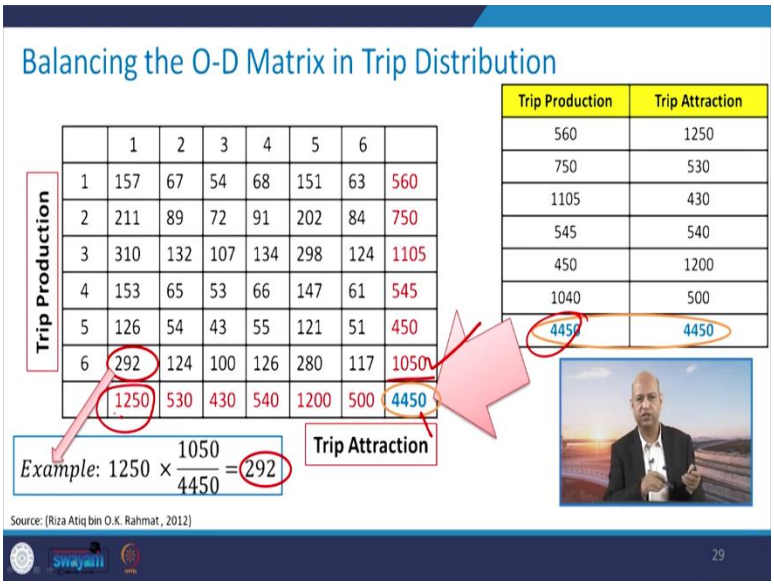

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2	211	89	72	91	202	84	750
3	310	132	107	134	298	124	1105
4	153	65	53	66	147	61	545
5	126	54	43	55	121	51	450
6	292	124	100	126	280	117	1050
	1250	530	430	540	1200	500	4450

Trip Production	Trip Attraction
560	1250
750	530
1105	430
545	540
450	1200
1040	500
4450	4450

Then we go for trip distribution when we have generated the trips, we got the trip rate etcetera Then we have the data for distribution that trips within that particular area in different zones like you can see where will these generated trip go so, internal to external or external to internal all those. So, the origin to destination 1, destination 2, destination 3 these kinds of trips are distributed means total trips are there, then you need to distribute these trips according to different kinds of destinations.

Because everyone is not going to a single destination, there are several destinations right. This is one theoretical assumption based kind of metrics you can see trip production and trip attraction. So, the total sum is balanced basically this is ideal condition this does not happen, but the trip production and the trip attraction for a particular point and from this point going 750, coming 530. So, total it is assumed that it is balanced, and but its not necessary.

Anyway to explain this one for example, trip produced is 4450 and trip attraction is also the same theoretically. So, when you are distributing, how to distribute, you can see in one particular trip attraction related 1050 and this is 1250 when production related data is there. So, the when we want to distribute at this particular location, we want to get this value.

$$\frac{1050}{4450} \times 1250 = 292$$

So, 1050 divided by the total and multiplied by this particular production like trip production or trip generation related value. So, that we can fill complete matrix and we know how much trip is being generated or attracted from this origin and at this destination.

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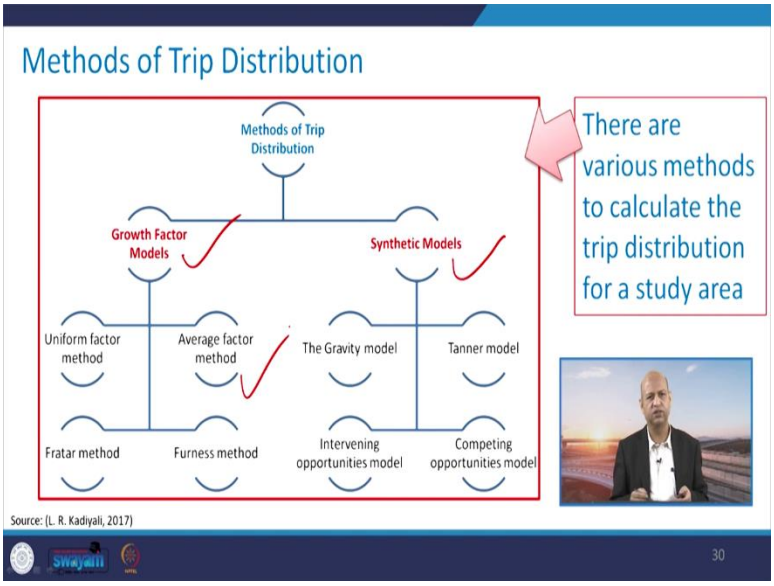

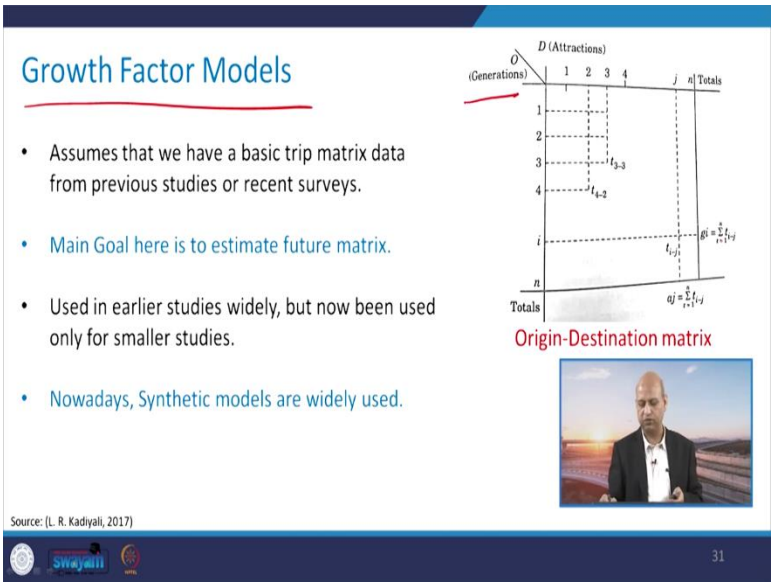

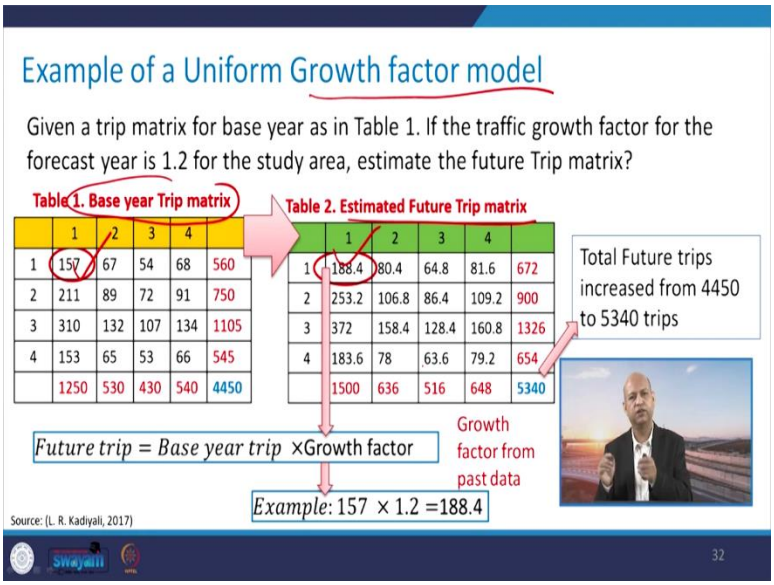

Then there are various ways of doing this basically like growth factor model, synthetic model, average factor model there are so many models and most popular and simple a synthetic model basically, growth factor model is also very much used, where you can correlate the generation related points to the attraction as we have just done in that particular matrix you have seen okay. So, in this again you can see this example of uniform growth factor model where you see like some growth factor is assume that for forecasting purpose like after certain years this much traffic will increase or this much demand will increase.

So, the base here data maybe there and the estimated for future trips can be based on that growth factor like population grows, traffic grows, so, those growth factor value can be used like here 1.2 is there.

$$Future\ trip = Base\ year\ trip\ \times Growth\ factor$$

$$Example: 157\ \times 1.2 = 188.4$$

So, the 1.2 can be multiplied by this particular base year trip data. So, this will be 188.4 so, that way the complete matrix can be revised by the using that particular growth factor.

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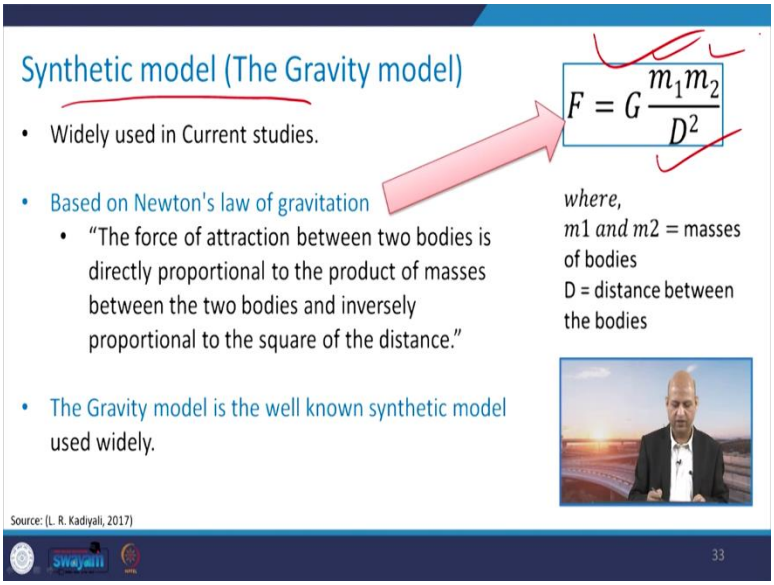

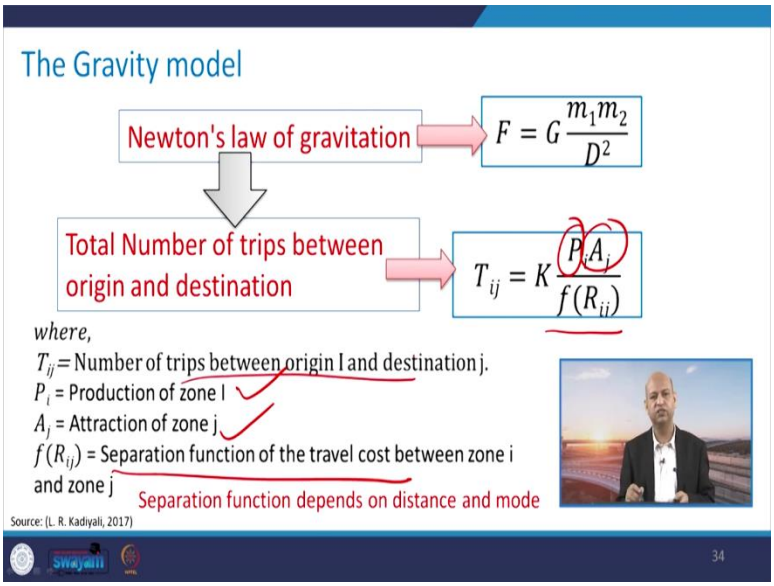

Then this synthetic model is analogical similar to gravity model, which you have seen in physics.

$$F = G\frac{m1m2}{D^2}$$

Like F equals G into m1 m2 divided by D square that is inversely proportional to the square of the distance between two bodies and these the masses of two bodies and the force of attraction this laws, Newton's law of gravitation, so, similar kind of thing is used in this particular gravity model related synthetic model, where number of trips between origin and destination is taken like production zone and attraction zone.

So, m1m2 these two bodies kind of thing and this separation function which is related to the travel cost. So, inversely because if more money is needed, then people are discouraged going for that particular mode and this is the value the constant value. So, similar kind of equation is used for estimating these values, number of trips between origin and the destination i and j. And then they are summed up properly, integration is done.

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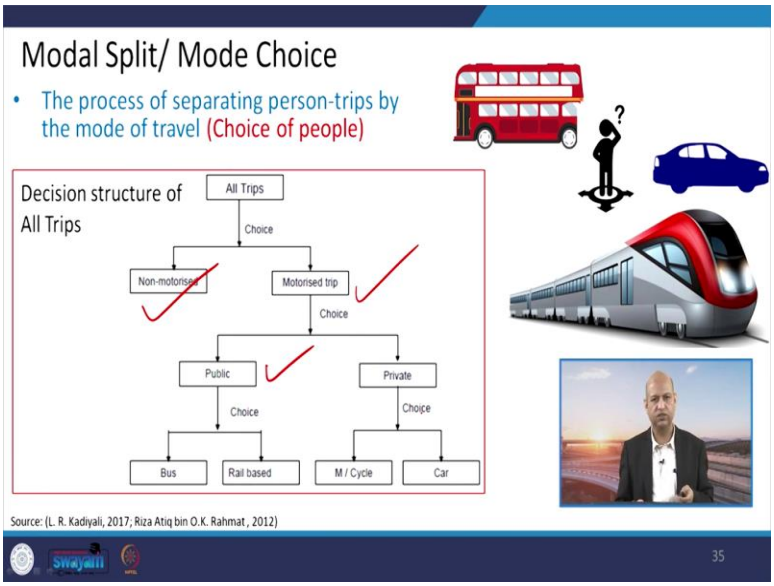

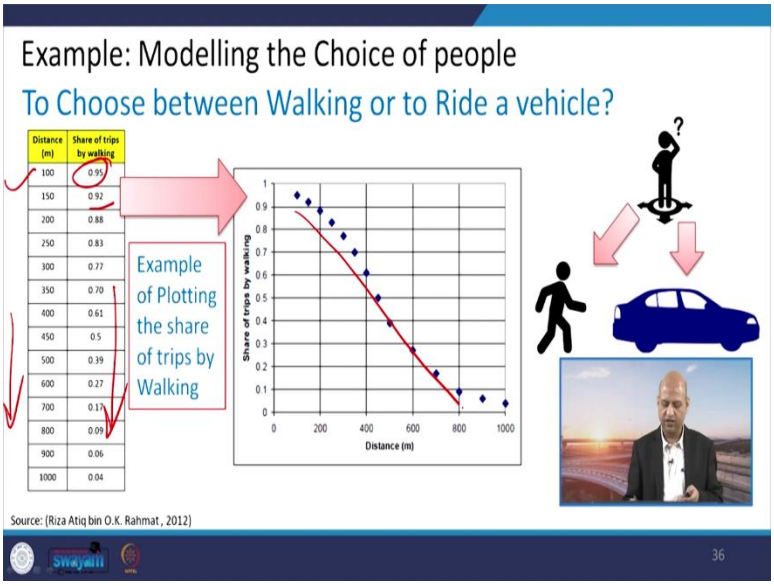

Modal split we when talk about or model choices means which kind of transport mode the person would like to have. So, the all trips may be distributed like non motorized one or the motorized trips. So, within motorized trips, the public transportation or privately owned vehicle all those

things can be distributed that value. So, we can distribute different transport modes, when we talk about the choices of the transport modes, then again this is very simple example.

For example, it depends upon the distance whether people will prefer to walk or prefer to have some automobile or other kind of transport mode. So, like 100 meter distance is there, the 95 % chances are there that people will just walk 150, 92 %. So, that way this different distances are there, when distance grows, the probability of the person to opt for walking decreases. So, you can see that as distance goes the share of trips for walking is decreasing like that.

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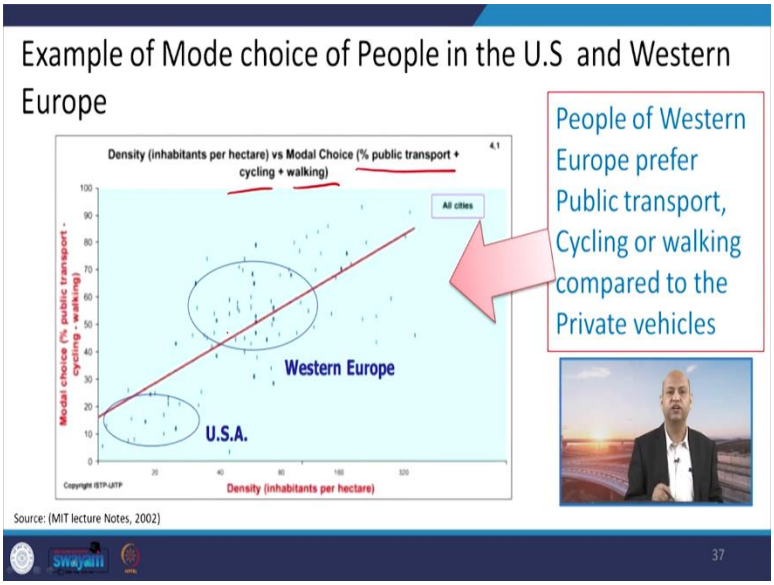

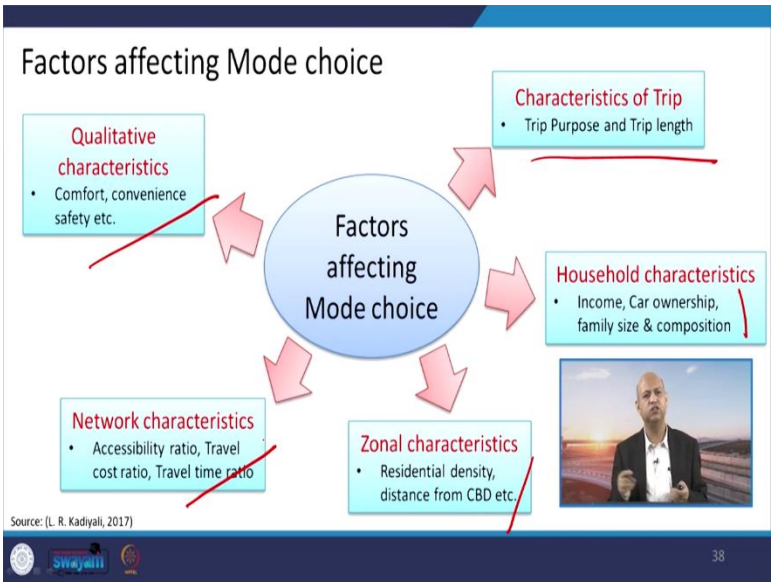

Similarly, if we want to relate the mode choice or the transport mode choice by the people that will also depend upon their, the overall lifestyle like in USA people live at farther distances, the density of the population is very less per square kilometres. So, where in Western Europe, people use much public transportation system. So, the density is more and it is quite incentive to use the public transport system it is easier comfortable. So, you can see this relationship in USA, very few people are using the public transportation system, whereas in this public transport, cycling, walking all those kind of in totality in Western Europe most of the people are choosing these kinds of transport modes.

In USA many people use their cars and their own vehicles, well there are certain factors which affect the mode choices and they are depending upon trip of the purpose like we are going and the for whole day some tourism purpose or for the working or something, household characteristic like income car ownership and family size and composition as we have discussed, because that will determine whether you are going to use your own car or not, if you are a big family then in any you are having only one car then maybe you choose another mode of transport.

Zonal characteristics like residential density, distance from the central city places then comfort and convenience of the safety issues which a passenger or person want to have then accessibility ratios towards our travel cost, all these factors will determine which kind of mode, transportation mode a person will choose.

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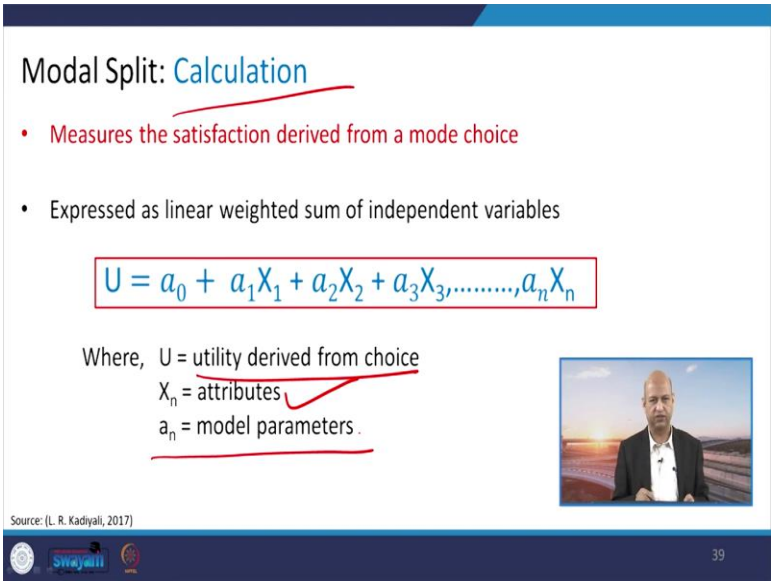


Modal Split: Calculation by Binary Logit Model

- Calculates the probability of selecting a particular mode of transport

$$p(K) = \frac{e^{Uk}}{\sum e^{Uk}}$$

Where, p = probability of selecting mode k

The probability of choosing public transport (pt) over automobile (auto) between zones i and j ,

$$p_{ij} = \frac{e^{Upt}}{e^{Upt} + e^{Uauto}}$$

The probability of choosing automobile (auto) over public transport (pt) between zones i and j ,

$$p_{ij} = \frac{e^{Uauto}}{e^{Upt} + e^{Uauto}}$$

Source: (L. R. Kadiyali, 2017)

Modal Split: Numerical example 1

Qn: Suppose, the utility function of public transport (pt) and automobile (auto) are represented by the utility equation:

$$U = a_k - 0.35t_1 - 0.08t_2 - 0.005c$$ Where,

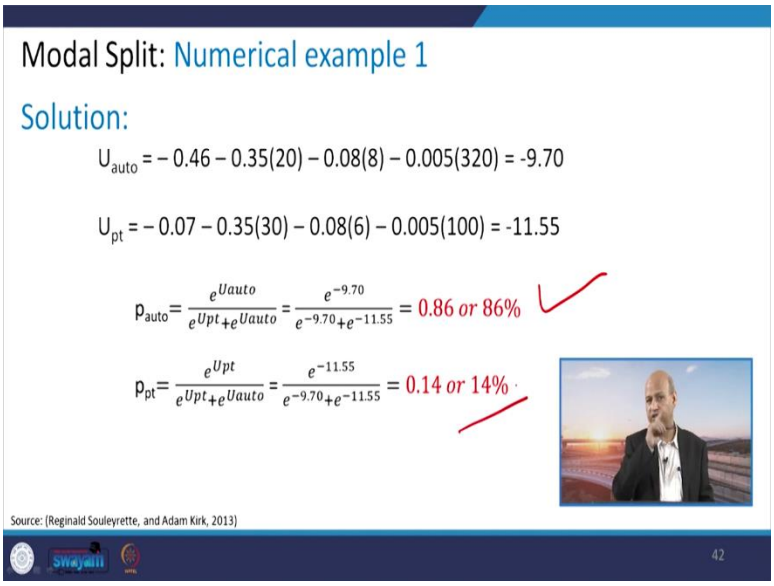
a_k = mode specific variable
t_1 = travel time in minutes
t_2= waiting time in minutes
c = cost (cents)

and the travel characteristics between two zones are given in table below:

Variable	Auto	Public transport
a_k	-0.46	0.47
t_1	20	30
t_2	8	6
c	320	100

Calculate the probability of choosing automobile and public transport w.r.t other mode.

Source: (Reginald Souleyrette, and Adam Kirk, 2013)



So, the modal split, we do calculation. So, this is one way utility derived from choice which particular transport mode one will choose and this is the attribute x, x1, x2, x3 those kinds of attributes which are dependent on factors and those attributes related some model parameters are assigned to those and then we calculate.

$$U = a0 + a1X_1 + a2X_2 + a3X_3,\ldots\ldots,anX_n$$

$$p(K) = \frac{e^{Uk}}{\sum e^{Uk}}$$

So, the model is split calculation can be done by binary logic model also and these are the equations, empirical equations which are used for this purpose, you can have these calculations very simple calculations for example, certain variables are given, auto related data, public transport related data attributes and those mode specific variable aka these value, t1 t2 travel time minutes, travel time minutes, these are the values then the cost.

$$U = ak - 0.35t_1 - 0.08t_2 - 0.005c$$

So, all these attributes are given and for auto and public transportation system. So, you can use like these are the constant values 0.35 0.08 0.005, then you put those values t1 t2 like 28 on those kinds of values and you come here and you can calculate ultimately, we got to know that the auto probability is 86 % people will use with these values which are just an example and the public transportation system will be used by 14 % within those attributes, within those factors.

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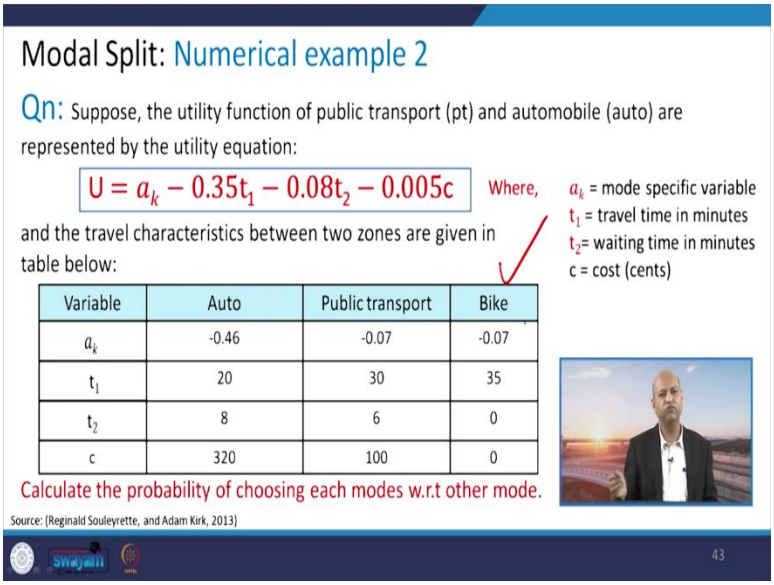

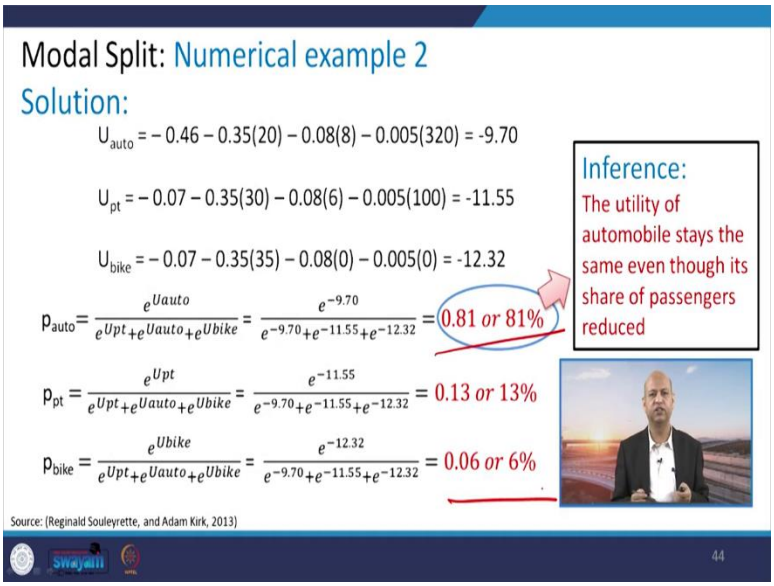

If we add like one more attribute or the mode, mode related attribute or choices like bike then thing will the total value will be changed and you will see that 81 % becomes this auto related because then some got shifted towards the bike also. So, every transport mode has its own probability of choice by the people.

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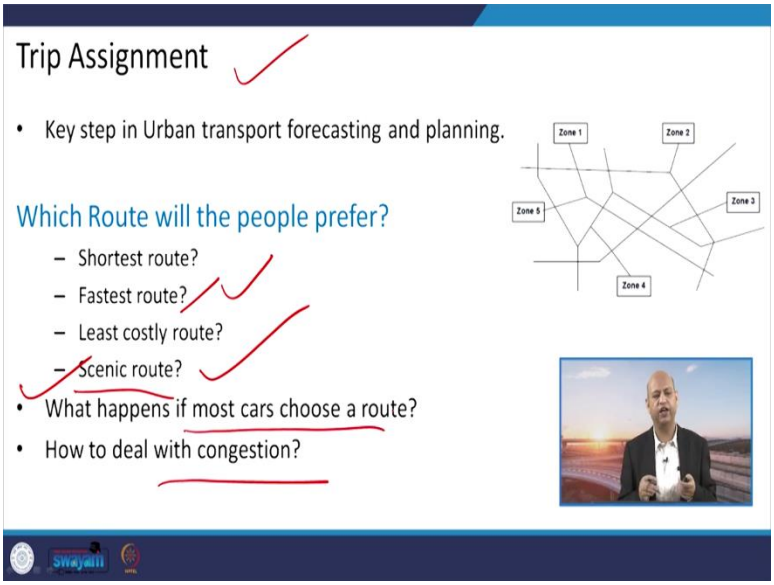

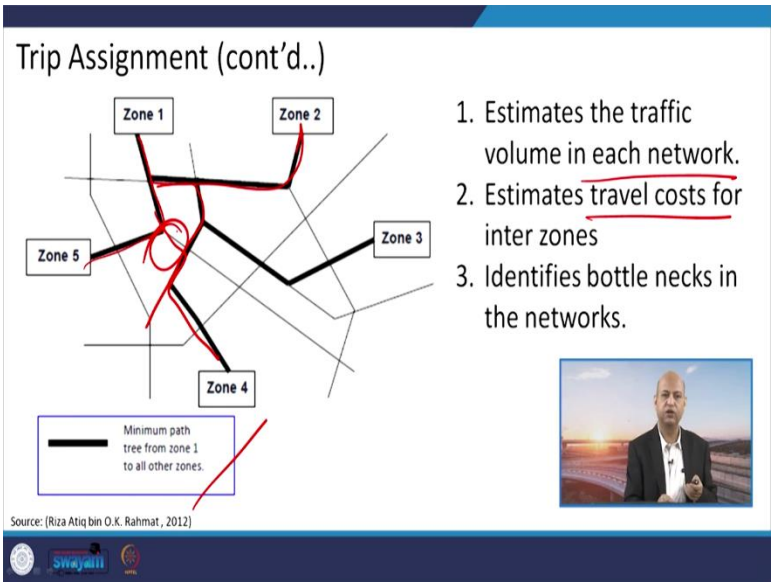

So, at last we do this four step particular view of trip generation and all those things. So, at last we do the trip assignment related activity. So, different zones are there and different routes are there which route person will choose to follow will depend on several factors for example, if somebody is at leisure and he wants to enjoy the time so they can take the scenic route etcetera somebody is having very less time they can go for fastest route and then if there are congestion related possibilities or not, or some cars are having a particular route.

So, those information will help us to assign the trips and that way the same picture is here. So, this for zone 1 to zone 5 this particular route has been assigned or trip has been assigned. Similarly, for

zone 2, it will come and we will go to that way. And zone 4 zone 3, so, different routes, it is not like it is coming here and going there, it has come here and because that there may be some issue. So, that is why this assignment has been done in that way, that may be little bit longer route, but maybe time saving is there, because a lot of congestion maybe there, those kinds of things are to be taken care of.

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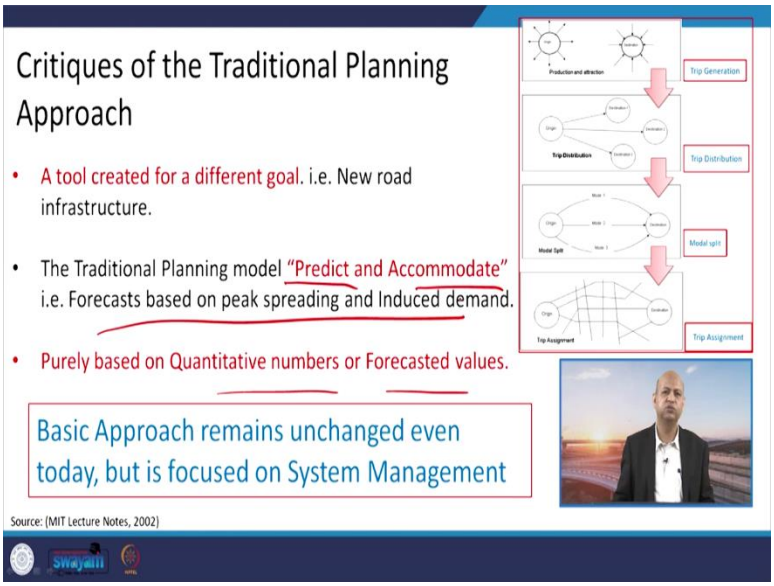

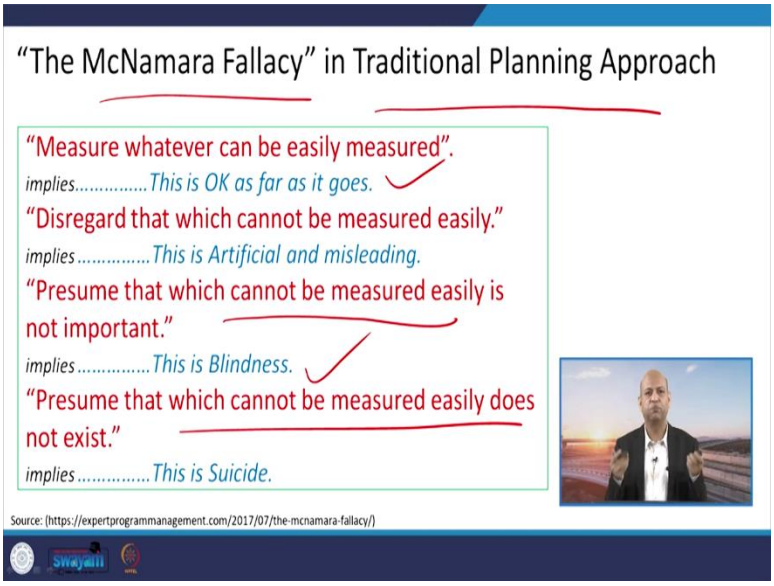

Well, there are critics of this traditional planning approach, which we have just seen, because this is based on purely quantitative numbers and forecasted values. So, that is not necessarily that it will always meet the, address the ground reality. So, this traditional planning which is predicting

and accommodating or the forecast based on peak spreading and this induced demand. So, those values are being criticized by the new approaches, and they say that there must be some other additional factors which should be taken into account for planning purposes.

And it is not necessary that every factor, every shoe can be major there may be many other things which are not measured, but that should be taken into account for example, BRTS system could not succeed properly in Delhi, that means, there were some issues which could not be figured out in these kinds of calculations. So, that way this McNamara fallacy is there in terms of traditional planning approach, which says that, this measure whatever can be easily measured.

So, this is, as far as it is possible, but then disregard that which cannot be measured easily. So, this is artificial and misleading, because, if we are not able to measure something that does not mean it does not exist, it will be there and it will affect our total transportation behavior or system then presume that which cannot be measured easily is not important. So, this is again, the kind of blindness, we are not giving the importance to the things which cannot be measured.

So, that is very wrong and it will really affect our planning in long run, then presumed that which cannot be measured easily does not exist. So, that will be completely kind of fatal thing, because, the issue which has been ignored totally, which will surface at certain point of time in future and that will completely disturb your, the planning, which we have done on these quantitative based analysis.

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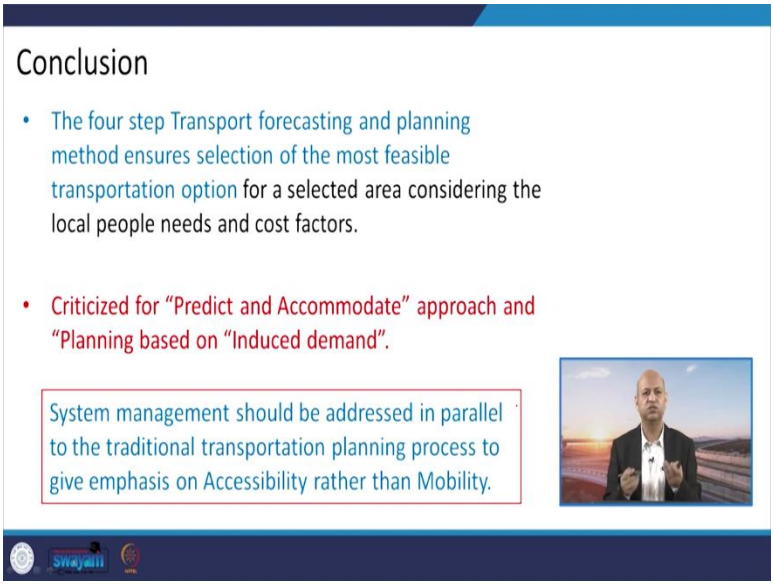

In conclusion, we can say that, that this traditional approach of four step transport forecasting and planning, which is mostly used and it can meet several our needs of the hour, but, there are new upcoming philosophies and policies and like predict and accommodate, and then plan and then induced demand, all those things, which have been totally criticized or to be addressed by new approaches.

And one of the approach which is, now, people are encouraging and embracing is the system management approach, because in system management approach, even if something is not quantified, it is taken by based on some like perception based surveys or those kinds of things, and it is given some importance and some options or some approaches or opinion of the people that also be taken into account properly even if it is not quantified. So, that is very important.

So, the systemic approach in future can really help us to do better planning and maybe that planning which is done based on the system's approach goes for meeting the demands and the needs of the people for several decades. So, that is kind of issues are there for us to learn and implement.

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These are the references for additional information you can go through and thank you for your kind attention. So, we will keep on discussing this planning related issues in further lectures also. Thank you.