Urban Transportation Planning
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Module No. # 03
Lecture No. # 09
Trip Generation Analysis

This is the lecture nine on urban transportation planning in this lecture we will discuss about trip generation analysis. It to be appropriate to recollect what we did in the previous lecture so that will get a better connectivity between the portion that we covered and what we are going to discuss in this class you may recall that we were discussing about the different steps in the system engineering process in the previous class to be more specific we discussed about solution generation phase solution analysis evaluation and choice and implementation in connection with system engineering process.

Which are directly applicable for transport system planning process then we understood that it is necessary to quantify the inputs and the outputs related to a system more accurately and more important to quantify for the origin air condition. The system inputs are nothing but, the quantum of demand for transportation in future year system outputs are nothing but, the system characteristics that you are planning for meeting the demand in the origin so we need to do detail analysis to quantify the input and then to quantify the characteristics of the system that we are purposing.

In that you got we understood that there are four important analytical steps followed to get the answer for this questions namely what would be the total demand the origin here and what would the characteristics of the system that we purposed for the origin air condition.

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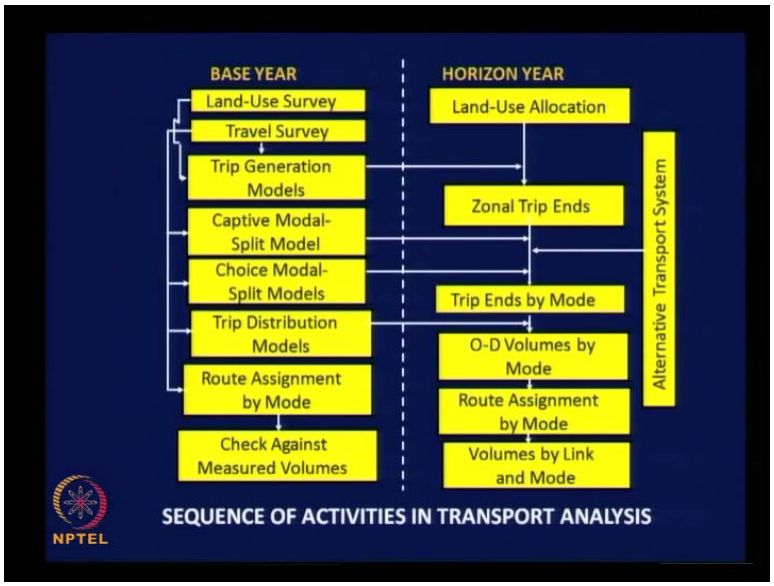

And these are the analytical steps that we have already seen in the previous class namely trip generation analysis, captive model trip analysis, choice model trip analysis, trip distribution analysis, and then route assignment by mode now in this class we will just hold the first two boxes of the fort chat on the left hand side better in to base year condition namely land-use survey and travel survey. We will discuss about these two aspects a bit later as we complete the discussion on all the four steps of the analysis.

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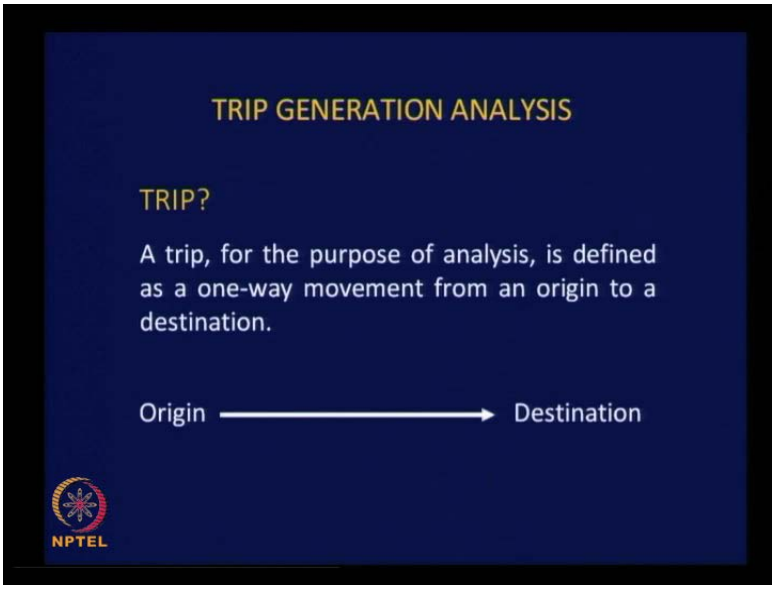

First you take trip generation analysis trip generation analysis means what understanding of the trip generated in different land use percales in an urban area to define little more prissily we need to understand what exactly mean the term trip we normally understand the trip as information related to a journey we ask a friend how was the trip Delhi this means all aspects related to the journey how about journey return journey stay and other related activities when somebody asked how was the trip London implies.

All aspects related to the hope travel from the point of start to the point of finish of journey where as, here we are going to define the term trip totally differently this is the definition of the term a trip for the purpose of analysis is defined as a one way movement from a origin to a destination one way moment from an origin to a destination to show you something pictorially this is what to mean by a trip one way moment of the person from an origin to a destination what do you mean by origin or destination in connection with trip origin could be understood as home.

Destination as worked place how exactly we understand this two terms origin and destination any suggestion for the purpose of analysis how do we define origin the connection get through and what is the definition of destination yes and the trip ends to the destination players were the vehicle start moving and the destination is where the vehicle stops yeah there is one more answer sir depending discussion based on last time we are understand would be zone to zone sir that is what exactly is a trip as far as this particular analysis is concerned.

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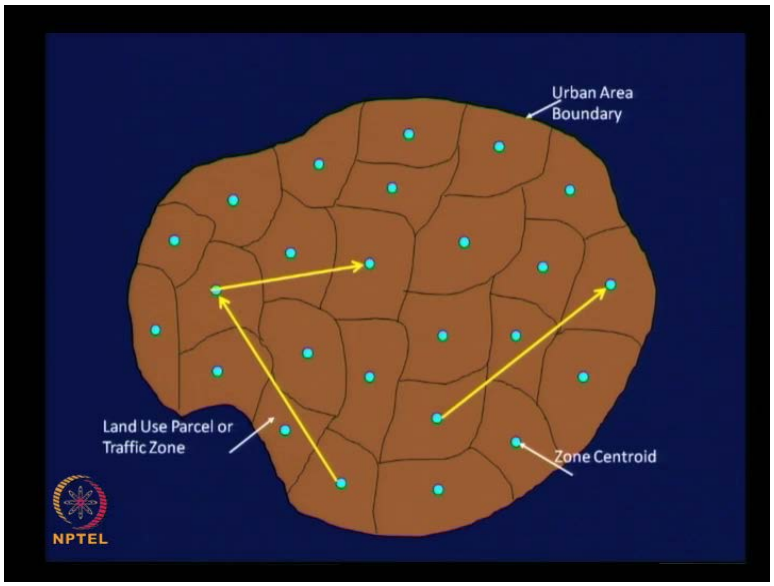

We have to remember very carefully we were talking about the entire urban area to be divided into smaller land use parcels named traffic zone and then will fix the points of origin as well as destination as zones centriod these are zones centriod so what the mean here by trip is this movement from point to another point from one zone centriod another zone centriod is a trip one way movement this is another trip this is how we understood we have to understand trip in this particular context fine.

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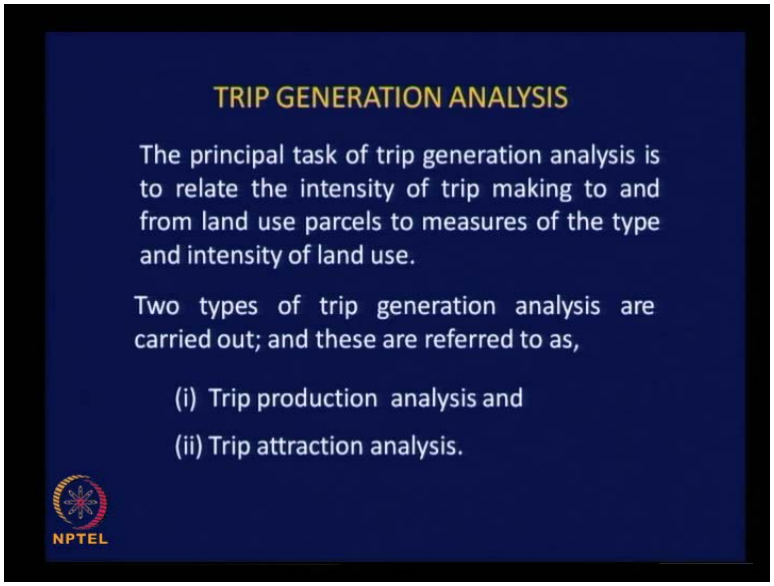

With this understanding let us proceed further to have more information about trip generation analysis the principal task of trip generation analysis is to relate the intensity of trip making what do you understand the intensity of trip making its nothing but, number of trip made from one point to several other points to and from land use parcels the measures of type and the intensity of land use types of land uses we know in urban areas their intensity in terms of effectiveness of usage of a different land use types so these are to be related the intensity of travels as to be related to the type and intensity of land use.

Let see how to go about doing this we need to understand before getting into the analytical aspect that there are two types of trip generation analysis and these are referred to us number one trip production analysis and number two trip attraction analysis trip production and trip attraction.

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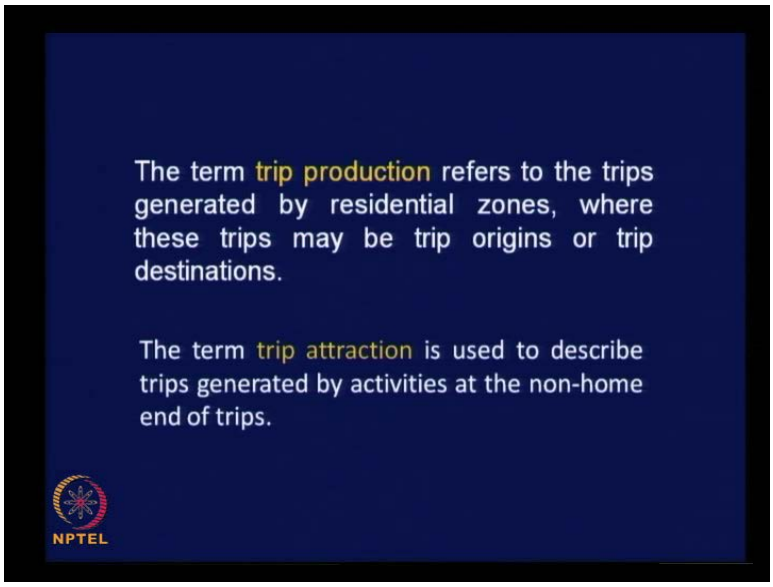

And the term trip production refers to the trips generated by residential zones where these trips may be trip origins or trip destinations very important point to be understood clearly so these are trip associated with residential zones.

This could be either trip origins or trip destinations a trip made from home to work is a home based of trip production a trip made from work place to home is also a trip production a trip made from home to school trip production school to home again trip production because one end of the trip is associated with home. So, that is how we need

to understand trip production then obviously trip attraction means trip ends the term neither the starting point or the end point are associated with home they have some other origin and different destination.

This term is used to describe trip generated the activities at the non home end of trips non home ends could be worked place to shopping area shopping area to work place or one worked place to another worked place all this moments are trip attractions.

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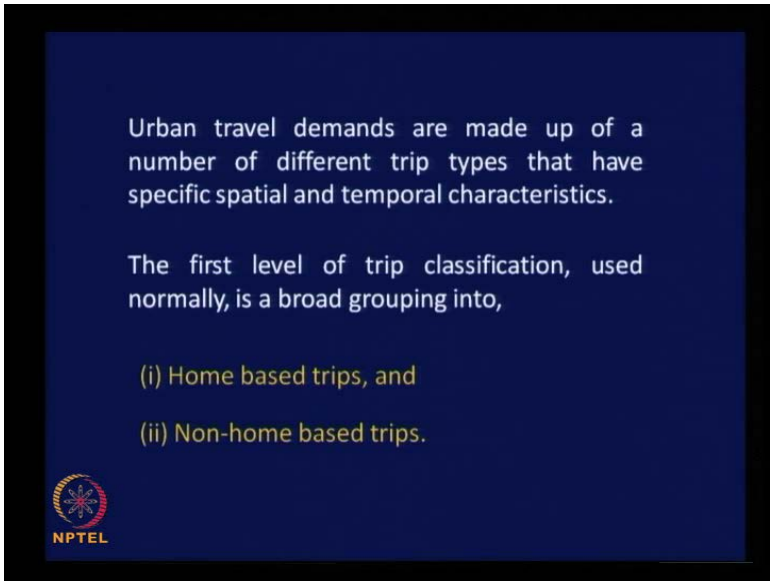

And of course, urban travel demands are made up off a number of different trip types people made trip for different purposes. So, it is better we classified the trips at least broadly to go further in the analytical process that as specific spatial and temporal characteristics with respect to the point of origin point of destination spread over the space spread over time and the first level of trip classification use normally is a broad grouping into home based trips and non home based trips and we analysis home based trip separately and non home based trips separately we cannot combine both this categories of trips and develop models we need to develop separate trip generation models for home based and non based trips because we tried of variables that might influence this trips are going to be different or even if the variables cells are same the extent of influence of this variable on this trip making might be different.

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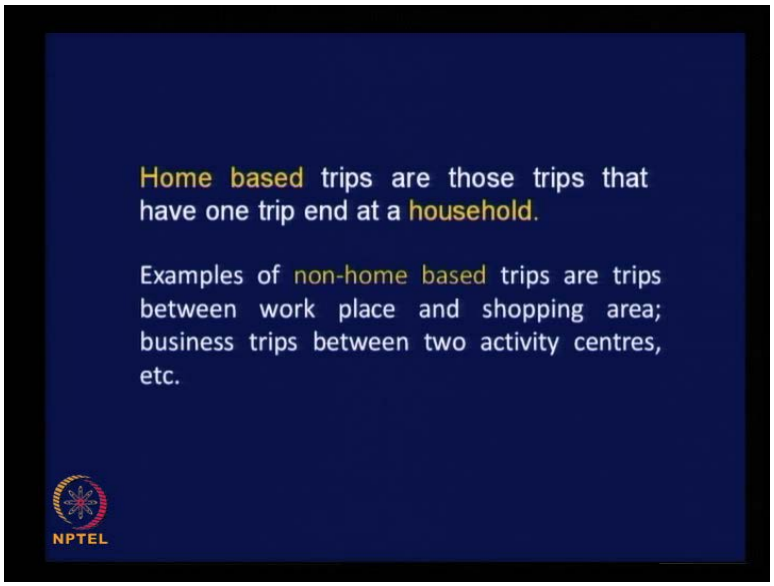

So we have to have separate models. what are home based trips home based trips are trips that have one trip end at the household either the origin or destination example of non-home based trips or trips between work place and shopping area business trips between two activity centers you may have some correlation between trip production attraction and home based non home based trips but, still we should be able to distinguish between the terms trip production trip attraction and home based non home based trips try to be very clear about the terminology and related definitions.

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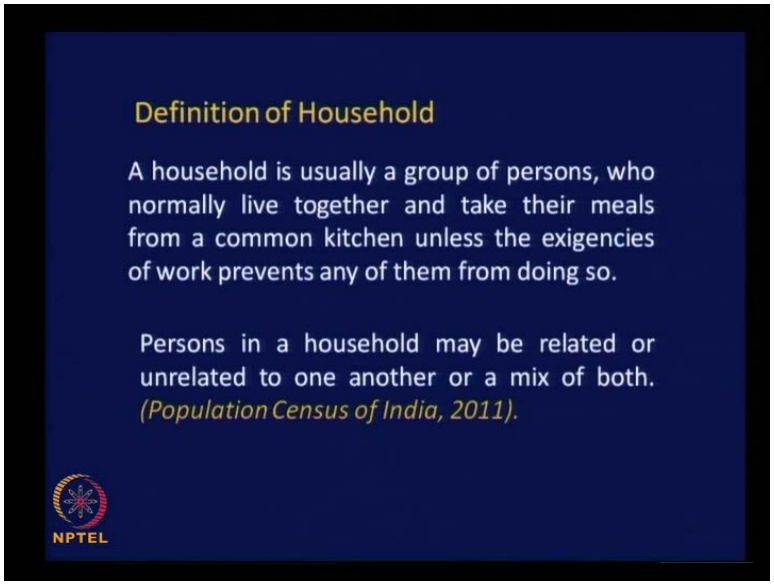

Since, we have mentioned about household in connection with home based trips it is better to understand or define the term household you may recall that at the initial stages of a discussion I asked you to assume household to be just family now you will understand that household encompasses a different sets of people including a family this is the definition of the household a household is usually a group of persons who normally live together and take the meals from a common kitchen unless the exigency of work prevents any of them from doing so one person of the family may have to leave for work very early in the morning 5 oclock and come home may be very late round 11'o clock.

That case he or she may not be able to have food from the same kitchen but, still other person can also be consider to be member of the household that is what is indicate here but, general condition is all should have food from a common kitchen and this is not the end of the definition some additional information is also is given about households persons in household may be related or unrelated to one and other or mix of both it is a very interesting point persons in a household need not be related.

And they could be just unrelated doing wells living together taking a meals from a common kitchen or a mix of related and unrelated people. So, this is the definition given by the population census the department of government of India the latest record of 2011.

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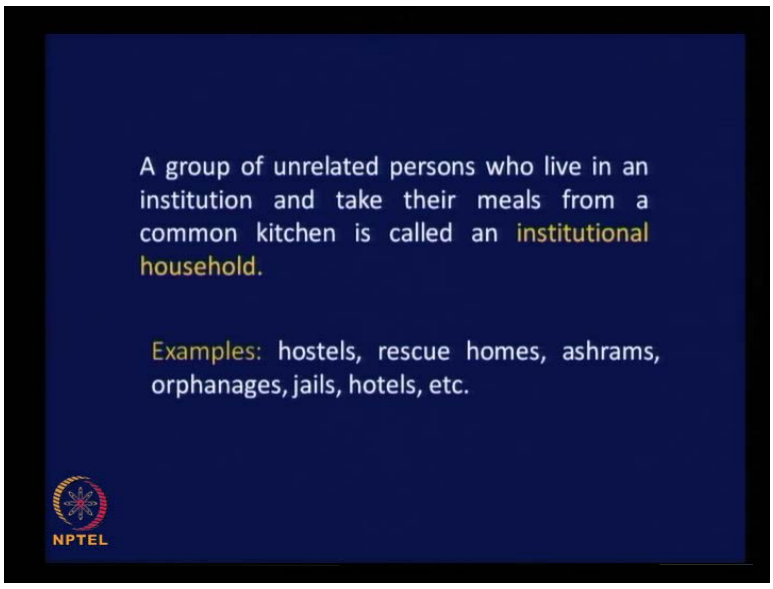

Now can we think of examples of different types households as stated here a group of unrelated persons who live in a institution and take their meals from a common kitchen is call an institutional household.

It is very important to understand the term institutional household because all later we may have to collect data for transportation planning process from households if we understand that households are only people who are living in houses who are mostly related to one and other then we will be missing out other categories of households so it is very important we consider the normal households as well as institutional households can we think of a examples for institutional households hostels all the hostels are institutional households rescue homes ashrams orphanages jails hotels all households of institutional category we should not leave out these kinds of households while collecting data.

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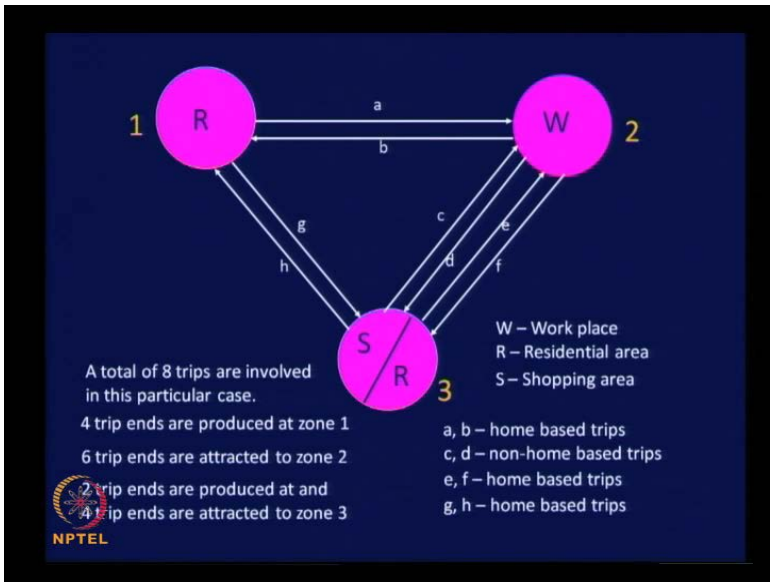

Now let us try to rain force our understanding with regard to home based and non home based trips as well as it terms trip production and trip attraction what I have shown here or three land use parcels on traffic zones numbered as 1 2 and 3 and let it W stands for work place you can see now zone 2 is completely work zone no other land use activity just a work place may be a factory location or location with full of institutional and offices and R stands for residential area.

Zone 1 is completely residential zone there is no other land use activity where as zone 3 you can see it is partly residential and S stands for shopping so it is partly residential and partly commercial this is the reality you may have mix land uses in traffic zones its undividable and the Indian conditions particularly we have developed or we are permitted mix land use development in most of cities and towns. Now let us try to gives some normal nature for the following trips.

Starting from a and b shall we say a and b for home based trips why a and b are home based trips you can see a is eliminating from R leading toward W where as b is originating a W and rest into R but, we call both the trips as home based trips right how do we call the trips c and d c d any suggestion trips are from a worked place to a shopping place so they should be non home based both the trips are non home based yes sir both are non home based why because none of them residential area is one of the end that is the point.

So in this case we see that c and d are non home based trips c eliminate from S and it is destine from W and d eliminates from W and ends at S so both are non home based trips how about e and f e and f are home based trips and g h g and h are again home based trips I think now we have very clear understanding about the distinctions between home based and non home based trips let us go further to understand the difference between trip production and trip attraction.

In this case a total of eight trips are shown is in it four plus two plus two eight trips are shown here a total of eight trips are involved in this particular case and if you consider zone 1 four trip ends or produced at zone 1 I do not say four trips are produced I say four trip ends or produced at zone 1 as per as this analysis is concerned b concerned with trip ends not the whole of the trip trip ends associated with a particular zone is our concept so 4 trip ends a produced at zone one irrespective of the direction of moment you just count the number of trip ends connected to the particular zone if the zone is a residential zone all are production so that is how we say that four trip ends up produced at zone 1 and how about zone 2 six trip ends are attracted to zone 2 because zone 2 is a work place zone so all the trip ends associated with non-home kind of activity is obviously a trip attraction so that is how we can say that six trip ends are attracted to zone 2 how about zone 3 yes please a four trip zones are produced from zone 3 and two trips are attracted to zone 3 yeah it is a the other way round infect you must look at the trip ends associated

with R these are productions how many trip ends are associated with our only two trip ends are associated with R.

That means there are only two trip end productions in zone 3 and other four trip ends are at attached to the part S so there are four trip end attractions in zone 3 two trip ends are produced and four trip ends are attracted to zone 3 so this is how we need to understand the terms home based trips non home based trips trip production and trip attraction later on when we proceed further with analytical aspects we should not have any doubt about this basic concept.

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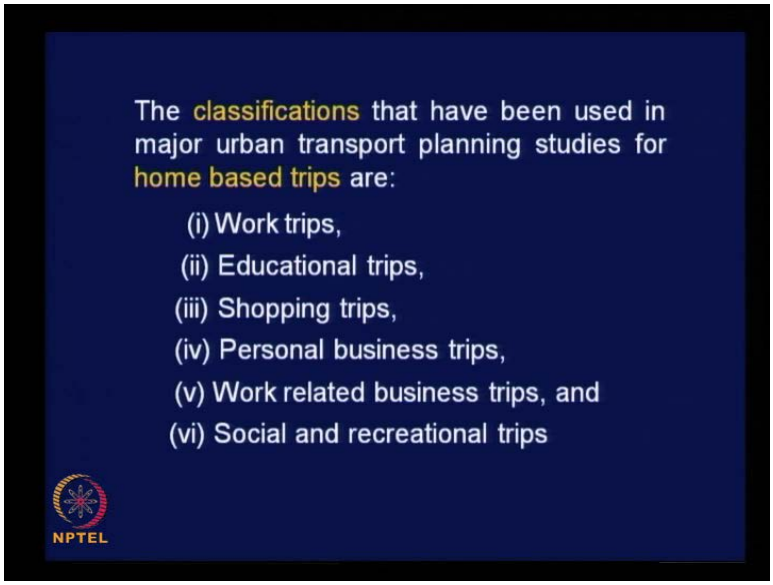

Let us proceed further the classification that are been used in major urban transport planning studies for home based trips or as for both anybody who can think of the different types of home based trips what is the basis on which we will be able to classified home based trips people made trips for different purposes obviously we can classified home based trips based on the purpose for which trips are made example is work trips if they go from home for work we can call those trips are work trips like that educational trips trip made to schools and colleges infect in international literature you find school trips.

As equal normal nature school in there context means both colleges and schools right from kindergarten to university right but, we give this normal nature educational trips inclusive of school trips as well as trips made to colleges and universities and these two

trips are more or less mandatory trips people made this trips on a regular bases there is no choice right people have to go to work and all the working days children have to go to school and all working days were as the case of other categories for example, shopping trips this trips occur at random.

It did not follow a regular pattern and personal business trips what is the different between shopping trip and personal business trip yes please could like visit to a bank or any kind of thing related to the running of the household yeah it is related to running a household but, personal business trips can be related to individuals as you rightly point it out going to bank for some transaction going to post office visiting a doctor for consultation or visiting a beauty parlour for dressing up all this things are personal business trips and there could be work related business trips considered.

The sales representatives copying from one institution to another institution their work is just shopping from one place to another it is the work related business trip or some person going from one office to another office for consultation coming back all this things are work related business trips and social recreational trips yes please how come work related business trips are in home based trips yeah your question is how do we bring in work related business trips as home based trips let us consider a sales representative fine he or she may go from home to a place of work one day to attained the work.

The next day the same person may not go to the same place but, may go to another office and another business place for attain the some other work so when the destination is not same for individual for a particular type of work then it becomes work related business trip so that is how we can include this trip also as one type of home based trip but, the percentage of this category of trip might be much less compare to the regular work trips and other categories of trips right how do we distinguish between social and recreational trips can you give a examples of social trips yes visiting friends and relatives a typical example of social trips attaining marriage ceremony things like that.

Or social trips recreational trips you can imagine all kind of recreations and trip made for recreation purpose or recreational trips now my question is why should be classify home based trips into several categories like this into six different categories why not we just treat home based trips together as one category of trip and continue with to modeling

process or develop trip production equation any responds you must think about the causal factors what are the factors that might influence work trips made by a household and what are the factors are might influence the number of work trips made by a household.

And member of educational trips made by household can we say that in both the cases the set of factors as same to causal factors could be different if the number of workers in a household its more than will be more work trips if number of students in a household are more there will be more educational trips is in it if there are more youngsters in a family there will be more educational trips if there are only yarely people in a family there could be less a work trips so the causal factors are different for different categories of trips or the influence of the causal factors will not be have same extent for all this categories of trips.

You take for example, household income household income may not influence educational trips significantly compare to its influence on shopping trips is in it we may have variables but, influence of the same variable on this different categories of trip should be different so that is why we need to classify the trips as per the classification shown here so that our modeling process is more refined and we are able to accurately replicate the reality that is a purpose of this kind of classification.

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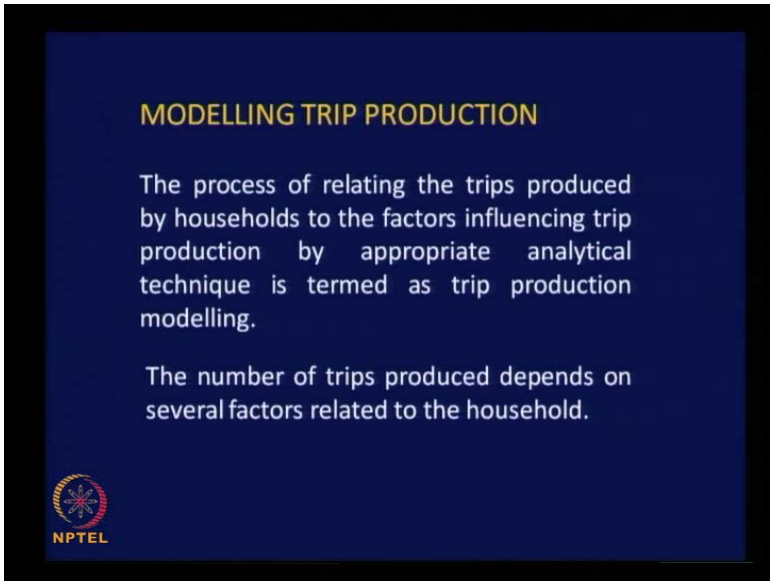

Now let us come to modeling trip production proper the process if relating the trip produced by households to the factors influencing trip production by a appropriate analytical technique is termed as trip production modeling very simple to understand we are trying to relate the number of trips produced to a set of influencing factors and this process is what we call as trip production modeling.

The number of trip produced depends on several factors related to the household because household is the major unit of trip production so that is how we understand household factors to be influencing trip production to a significant extent then its logical to think of the various household factors that might influence trip production rate.

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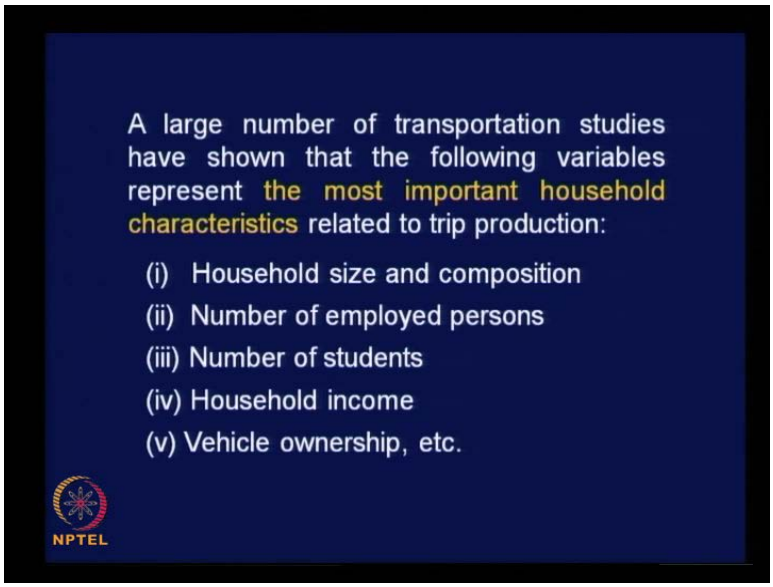

A large number of transportation studies have shown that the following variables represent the most important household characteristics related to trip production the variables are household size and composition by household size we mean the number of persons in a household if it is normal household the number of persons are lightly trip between say one and six or seven if it is institutional household the number could very.

ten twenty or in hundreds so we need to understand the household size in that particular context and composition of household what do you understand by composition of household household composition you may have six persons in a household the composition could be different when you consider two household of same size six individuals in one household if you look at average age of the household the average age

could be fifty in another household the average age could be twenty the distribution of the age of the individuals in a household is very important while understanding the trip production by households.

And the distribution of sex of individuals particularly in developing countries male female proposition is also another important factor this is how you need to understand the composition of household as well as the level of education of individuals in a household if the educational level is relatively low then you can anticipate a relatively lesser trip rate compare to another household with higher educational level because there activities will be more or less proposition to the level of education we can extend this discussion on various issues related to household composition these are examples of household composition.

And number of employees in a household for number of employed persons in a households very important factor influencing trip production then number of students in household household income vehicle ownership and so on please remember transport planner as to collect this data from the households while choosing variables for trip production modeling you should be aware of the amount of work involved in collecting data as well as the level of accuracy of the rate of base for example, if you try to collect data about household income.

Do you think that you will be able to get accurate estimate household income even though it is very important factor influencing the trip production rate most cases it may not be possible then what we do look for information which are proxies for household income right the vehicle ownership obviously under have a condition it is a very important indicator of household income car owning households in India could be consider to be of higher income group where as if you look for car ownership as an indicator of income in developed countries will be disappointed you will find that very household is owning a car as I told you earlier the car ownership is five hundred cars per one thousand population so you cannot use car ownership as indicator of income in developed country where as in our country for some more time it is possible to use car ownership as indicator of household income and when the country develops you must look for other indicative like the type of dwelling own it in which the household is living in terms of the type of construction and floor space and so on. The other accessories they

have in the household So we cannot collect the household income directly but, we can look for indirect indicators.

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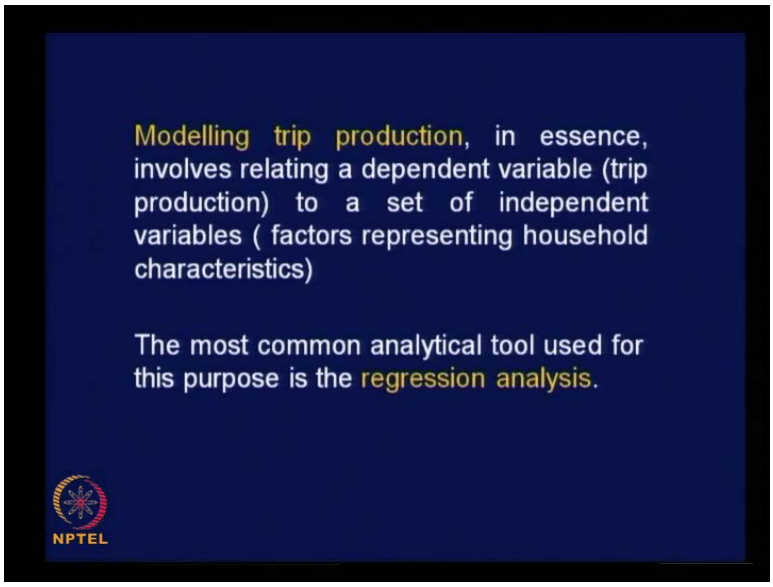

Now modeling trip production in essence involves relating a dependent variable namely trip production to set of independent variables namely the factors representing household characteristics as we listed starting from the household size number of employees and so on see essentially we are trying to relate a single depended variable to a set of independent variables.

What kind of analytical techniques we used for this kind of relationship any suggestion the most commonly used analytical technique is regression analysis the most analytical tools used for this purpose is regression analysis regression analysis will be thought normally in probably a statics course its beyond the scope of this course to go into the detailed statically aspects of recreational analysis I except each one of you to develop some background knowledge on regression analysis.

It is possible and still for continuity sake I will just give a feel of regression analysis by providing basic information about regression process and the results related to the important step in the regression analysis that is what I will do now.

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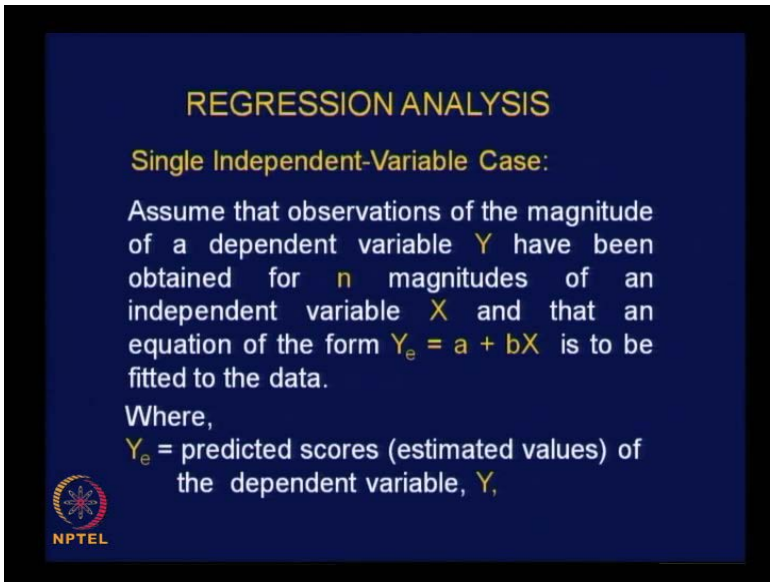

Let us take very simple case of relating one dependant variable with a dependent variable one to one cage trying to relate one independent variable with dependent variable assume that observation of the magnitude of a dependent variable Y have been obtain for n magnitudes of a independent variable X.

And that an equation of the form Y e is equal to a plus b X is to fitted to the data Y is dependent variable and X is the independent variable we assume in this particular case we have information on data about n values of Y 1 Y 2 Y 3 and so on Y n values are known to us similarly, the corresponding S X values are also known X 1 X 2 X 3 X n values are known to us and we are trying to relate Y with X using the equation Y e to be equal to a plus b X from the relationship you can understand that we are basically assuming a linear relationship between X and Y.

It is an equation of a simple straight line it mean not necessarily to be linear but, I have taken a very simple example to explain to the basic concept of regression analysis the relationship between an independent variable and dependent variable in reality may or may not be linear later will see what to do if you come across non-linear relationship between a dependent variable and independent variable and Y e here is nothing but, the estimated value of Y estimated value of Y.

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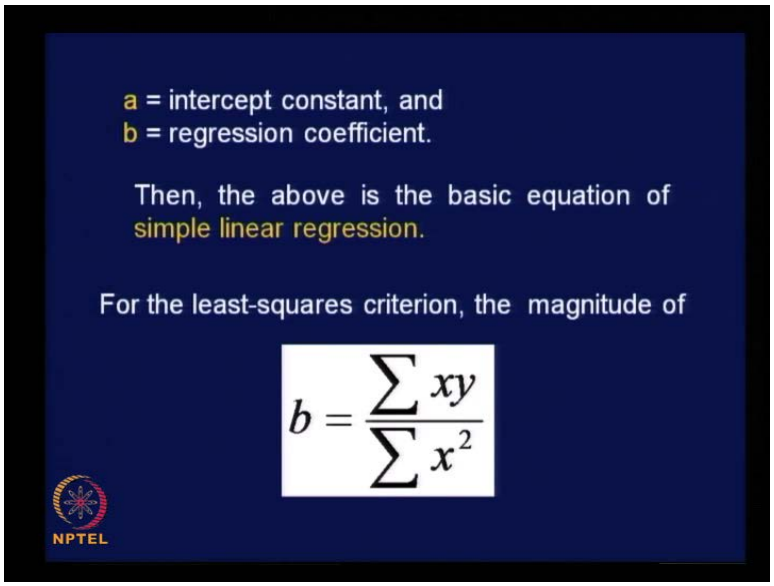

This is because of the reason or fact that you not to be able to exactly estimate the value of dependent variable using the regression analysis there will be some deviation that is why we just given rotation suffix e for y in the equation so always estimated value of y and a as you know is a intercept content and b is regression coefficient then the above is a basic equation of simple linear regression basic equation of simple linear regression for the least square criterion.

The magnitude of b can be collected as sigma x y divided by sigma x square now you need to know what is least square criterion that is the bases for this equation for b.

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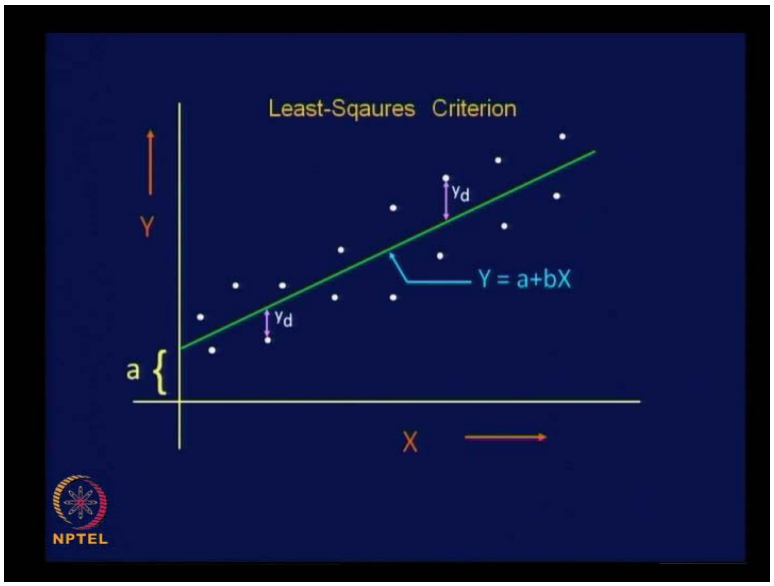

As the name implies we are looking for this square deviation of Y observation and then we are trying to fit a straight line in such a way that this sum of this square deviation are minimum and let us say we have the X and Y values for a particular case and this is the observe data we are ploted the observation the form of a scatted diagram.

This is how initially we plot the observe data relating X and Y our interest is to fit a straight line to represent all this points or to represent the variation of Y based on the value of X let say we try out several possibilities and finally, feel that this straight line may give a good fit this line can be named as regression line and this is the equation of the straight line because Y e is missing here we must always write the equation as Y e to be equal to a plus b X and this is the intercept on Y access.

Let say the deviation of the actual observed point from the regression line is Y d and deviation of another point which is below the regression line is again Y d we generally named the deviations as Y d that the deviation are in opposite direction they have positive and negative signs but, we want to ensured while fitting this straight line that the sum of squared deviations is minimum that is our objective.

If that is minimum we can say that this straight line represents more effectively all the points that is plotted only graphs right that is what is mean by least square criteria square all the deviations sum up get a number do this for various alternative positions in the straight line and choice the straight line which gives you a least value of the sum of the

square deviations that is what is mean by least square criterion for fitting a straight line for a plotted data because this is what we call as least square criterion.

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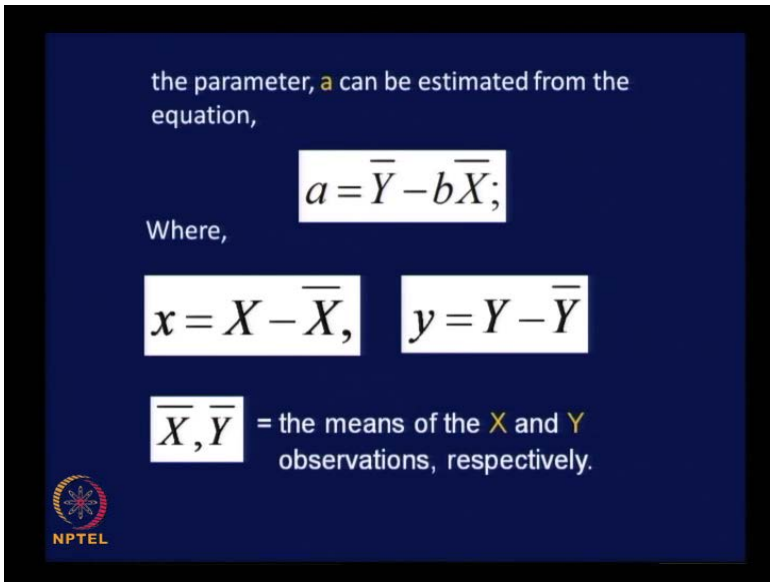

Then the parameter a can be estimated from the equation a is equal to Y bar minus b X bar please note here Y and X of capital letters capital Y and capital x. Were as previously the equation for b contains lower case X and Y there are not same b is equal to sigma X Y divided by sigma X square and let us get back to this particular aspect here small x is equal to X minus X bar and small Y is Y minus Y bar X bar and Y bar or the means of X and Y observation respectively or you may wonder how do we get the equations for b a and so on why should be call X to be X minus X bar Y to be Y minus Y bar and so on please go through any standard provident statics book we will get complete derivation for this kind of regression analysis that is very important you have to go through that you will thought about regression analysis in your provident statics course most probably.

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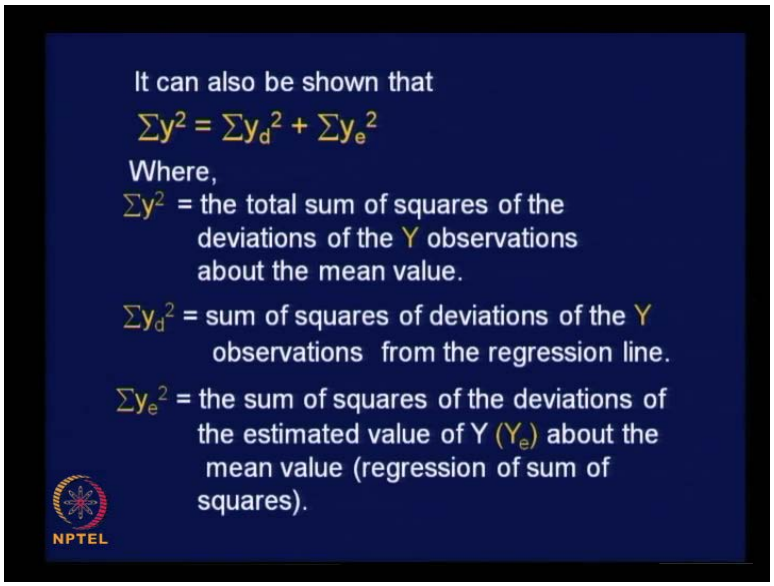

It can also be showed that sigma Y square is equal to sigma y d square plus sigma y e square where sigma y squared is nothing but, the total sum of squares of the deviation of y observations about the mean value and sigma y d square as you have seen graphically this is a sum square of deviation of the Y observations from the regression line.

And sigma y e is square is equal to the sum of square of the deviation of the estimated value of Y namely Y e about the mean value namely regression sum of squares.

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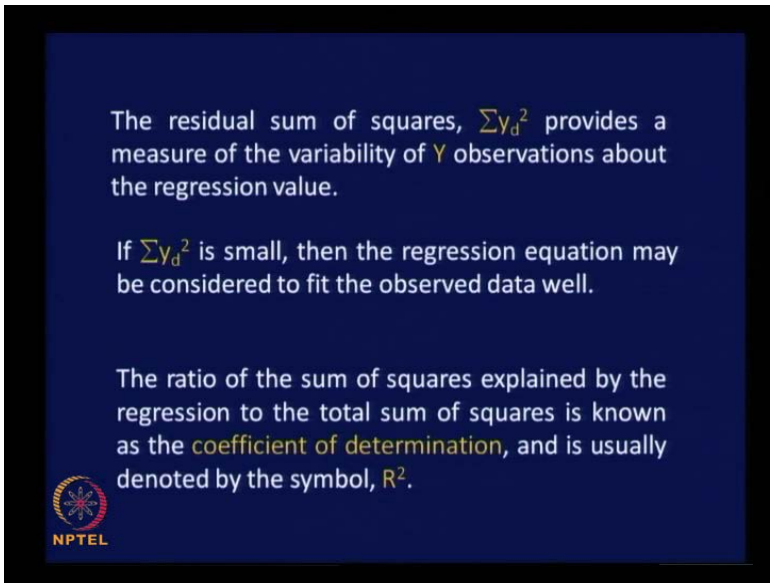

The residual sum of squares, sigma y d square provides the measure of the variability of Y observations about the regression values that is what we have seen graphically also and if y d square is small, then the regression equation may be considered to fit the observed data well.

Obviously if the ratio of the sum of square explained by the regression to the total sum squares is known as the coefficient of determination the ratio of the total sum of squares and the ratio of the sum of square as explain earlier is what we call as coefficient of determination and its usually denoted by the symbol R square some of you herald about coefficient of determination.

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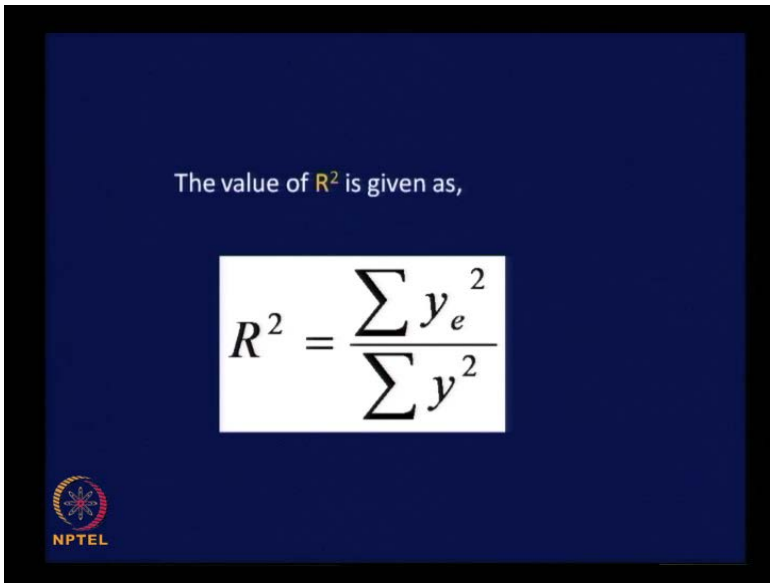

Let us try to understand little more clearly the value of coefficient of determination using this equation R square is given as sigma y e square divided by sigma y square.

This is very important indicator of effectiveness of regression analysis coefficient of determination will indicate the extent of accuracy involved in regression analysis to sum up today's discussion you may recall we first try to define the term trip trip is one way moment from a origin to a destination then we understood the terms trip production and trip attraction then the terms home based trips and non home based trips then we were trying to list the factors that might influence the production rate of home based trips.

And all the factors are related to household characteristics because households only mainly produce all the trips then while modeling trip production we understood clearly that it is necessary to classify the home based trips as work trips educational trips and so on because the set of variables that might influenced these categories or this types of home based trips could be different and there extended influence trips also could be different.

Then how we found that trip production analysis is nothing that relating a dependent variable to a set of independent variables the dependent variable is nothing that the trip production rate for number of trip produced by household and independent variables are related to household characteristics the analytical tool used for this analysis is regression analysis we took up a very simple case of regression of relating one independent variable with the dependent variable and just try to understand the basic steps involved in the regression analysis and finally, a static namely coefficient of determination which will give some idea about the effectiveness of the regression process with this will complete our discussion for today will continue with rest of it the next lecture.