Urban Transportation planning
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Lecture No. # 26
Trip Distribution Analysis Contd.

This is lecture twenty six on urban transportation planning. We will continue our discussion on trip distribution analysis, and try to complete the discussion on this topic in this class. To have a continuity of discussion, let us try to recapitulate, what we did in the previous class very briefly; you may remember after completion of a discussion on doubly constrained gravity model, we discussed about growth factor methods of trip distribution. Even though these methods are very old methods and very simple with their own associated problems, still these methods have some relevance, even in today's context; that is the reason why we started our discussion on growth factor methods.

We discussed about two basic methods; number one uniform factor method and number two average factor method. Let us check our self now, whether we have captured the relevant points about these two methods; namely uniform factor method, and average factor method.

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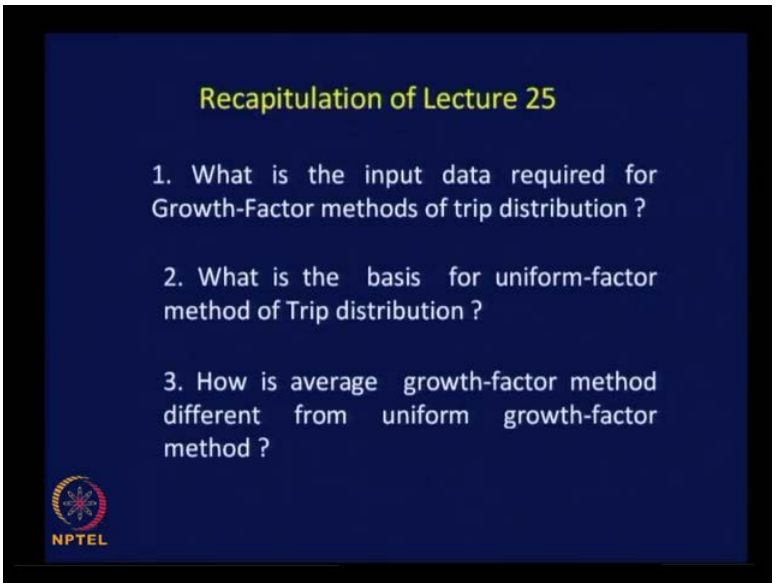

To recapitulate the previous lecture namely lecture 25; the first question to you is this; what is the input data required for growth factor methods of trip distribution, in general;

input data required for growth factor methods, it could be uniform factor method or average factor method, any response? Anybody? Just input required for this method.

Number of trip attractions, and number of trip productions should be the input for the growth factor method.

It is different; actually trip productions and trip attractions are inputs. For the earlier methods that we discussed, the synthetic models namely gravity model for this atom distribution, whereas here we need the base year trip distribution matrix itself as input data, we need to collect detailed data on origin destination information, and prepare a matrix and that is a input data for growth factor methods of trip distribution. So, input is very elaborate and we try to manipulate the matrix to get the horizon year matrix.

The next question, what is the basis for uniform factor method of trip distribution? What is the assumption that we make in this method? As the name implies, we assume uniform growth for the whole of the urban area uniform growth rate for each of the traffic zones in the urban area is a basis based on this assumption only we work on uniform factor method of trip distribution.

Third and last question how is average growth factor method different from uniform growth factor method. What is the difference, any volunteer difference between uniform factor method of trip distribution and average growth factor method of trip distribution. As their names imply in the case of uniform growth factor method, we assume or we consider a single growth factor for all traffic zones, there is no variation at all. Whereas, in the average growth factor method we recognise the fact that there could be different growth factors for different traffic zones and we consider a zonal pair and take the average of growth factors of the two zones involved in a zonal pair.

So, that is how the average factor method is different from uniformfactor method now with this understanding, let us proceed further to discussed about other growth factor methods that are available for application today.

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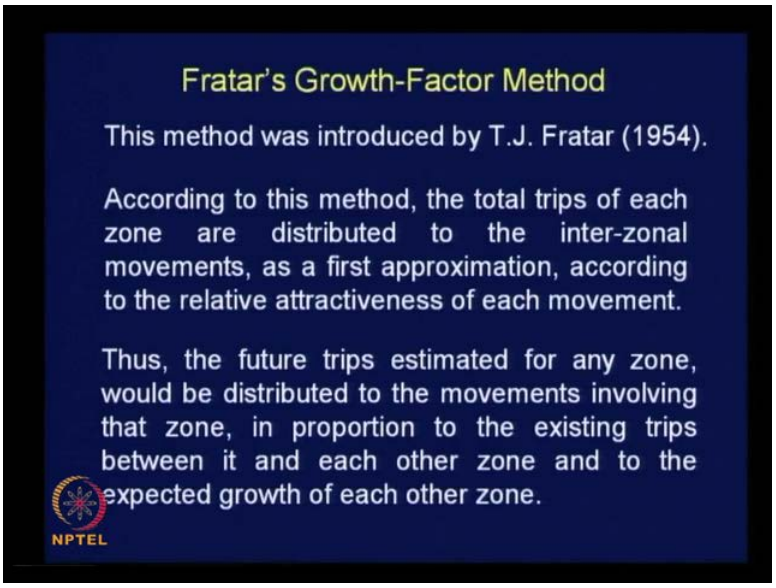

The third method is Fratar's growth factor method named after the proposer of this method this method was introduced by T.J. Fratar in the 1954, very old, but still valid even today for specific situations.

According to this method the total trips of each zone are distributed to the interzonal movements as a first approximation according to the relative attractiveness of each movement.

The trips at a zone will be attracted by a different zones based on their ability attracted trips. So, relative attractiveness is a basis for distribution of trips as per Fratar's method to add more information about this method.

We can say that the future trips estimated for any zone or the origin air trips that we estimate for any traffic zone would be distributed to the movements involving that zone under consideration in proportion to, the existing trips between it and each other zone that will be known to us, because we will know how the trips are being distributed in the base year from one zone to all other zones.

So, that is what is stated here and to the expected growth of each other zone may be we can just give the same information in a mathematical form which can be understood easily.

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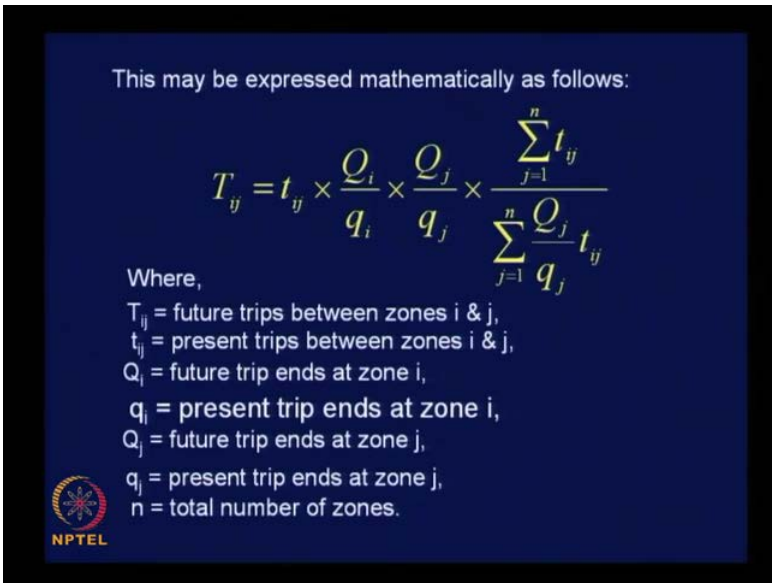

This may be expressed mathematically as follows, T i j is equal to small t i j, Q i by small q I, Q j by small q j into sigma j 1 to n small t i j whole divided by sigma j equal to one to n Q j by small q j multiplied by t i j.

Where the notation are as follows capital T i j is nothing but future trips between zones i and j, the horizon year trips that we want to know and t i j or small t i j is a present trips between zones i and j, which is known to us this information is available to us Q i future trip ends at zone i should we have information with us before distribution or not, capital Q i. We will have this information with us, because we would have completed the first two steps of the planning analysis namely trip generation and models spate.

So, at the end of trip generation analysis you will know the value of q i for horizon year condition too. You will calibrate the model for base year condition and use the model to predict the trip production of each of the zones for horizon year condition. So, this value will be known to us before we do trip distribution for as an air condition q i is known to us and small q i is a present trips ends at zone i.

Obviously, it is known we collect data on q i and Q j future trip ends at zone j that is also known to us by the production process trip attractions and q j present trip ends at zone j, that is known to us through data collection process for base year condition, and n is the total number of zones in the urban area.

Are you able to understand the logic of distribution of small t i j based on q i q j and then the ratio of t a j for the base year, and t i j for the horizon year the denominator is nothing but t i j values for horizon year condition we multiple t i j for each zone by the factor capital Q i j by small q i j.

So, that is how the distribution of trips for horizon year condition is obtained as per Fratar's method we will take a simple numerical example, and see how fraters can be applied and of course, before that we need to know few aspects related to the application of this method.

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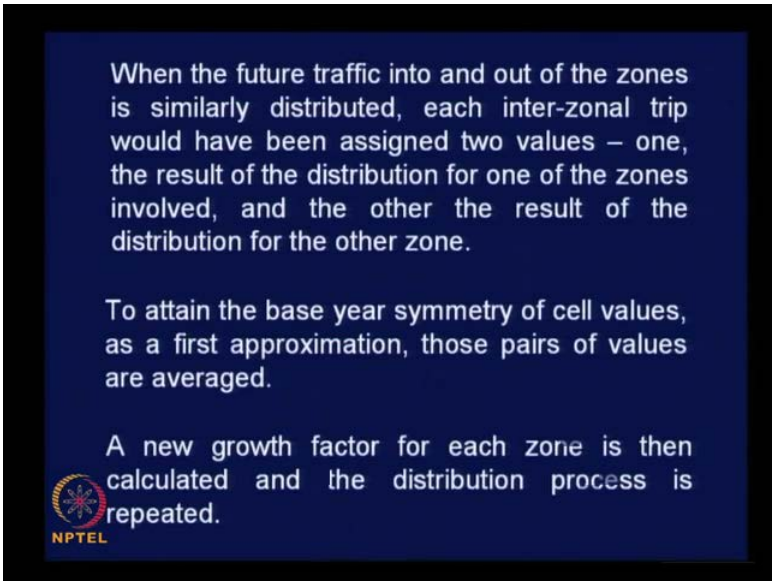

When the future traffic into and out of the zones is similarly distributed each interzonaltrip would have been assigned two values. For example, if you have zones 1 and 2 in the zonal pair will have t 1 2 and t 2 1 that is what is meant here by two values, one the result of the distribution from one of the zones involved and the other the result of the distribution for the other zone.

To attain the base year symmetry, what is base year symmetry? Fratar purposed as symmetrical trip interchanges based on practical considerations he as purposed t 1 2 to be equal to same as t 2 1 balancing trip interchanges, as a first approximation those pairs a values are averaged a new growth factor for each zone is then calculated, and the distribution process is are repeated.

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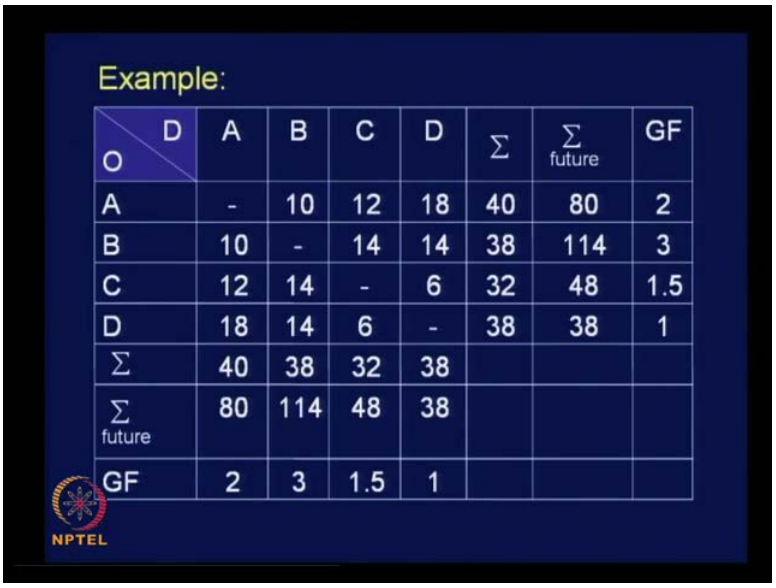

This is the example taken from the original work of Fratar himself this was published by him in 1954 in a journal; these numbers are the same numbers as used by him; it is a just investiture example that is why the zone number are just given as A B C D, normally it is 1 2 3 he has just taken it as example giving zone number as a b c d just four zones, and please note that this is OD matrix Origin Destination matrix.

So, one zone to other zone it is not total trip interchange it is specific to an origin zone and destination zone. You can see as per the data trip from a to B is same as the trip from B to A it is 10 in both the cases similarly trip from B to C or same as trips from C to B that is what is mean by symmetry purposed by Fratar, and the some of the cell values along a row are given in this column first row some 40 implies total trip production of zone A, is 40 trips.

P A is 40 and P B is the 38 P C is 32 and P D is 38 and similarly totally trip attractions are nothing but cell values sum of the cell values along columns and we find values are 40 for A 38, for B 32, for C and 38 for D.

And since we have this values with us the future trip production and attractions for each of the zones this numbers can we given straight away because it is the available data before we go for distribution of trips. So, that is what is given here 8, 114 and 48, 38 again 80, 114, 40, 80, 30, 8, because it is symmetrical as per Fratar's preposition.

Now since you know the current as well as future trip totals in the form of production and attractions you can get the growth factors or instead of production and attraction, we can say origins and destinations, because we deal with O D matrix. So, the growth factors are 2, 3, 1.5 and 1 here also 2, 1.5 at 1.

So, this calculation can be done based on the available data, base year trip interchange is known to us origin destination information is known to us, and base year trip production or trip origins and trip destinations are known to us for each of the zones that is what we have written. And we predict the trip origins and trip destinations for the horizon year also using trip production model.

So, we get this numbers also readily available before we do the trip distribution process. So, using this numbers we get the growth factor values. What is the next step? Using the growth factors we are going to change the cell values of the matrix you are going to write extrapolate or enhanced the values of the cells of the matrix.

That's what we are going to do we simply will manipulate the cell values of the given matrix and for that only we just follow the formula given by Fratar.

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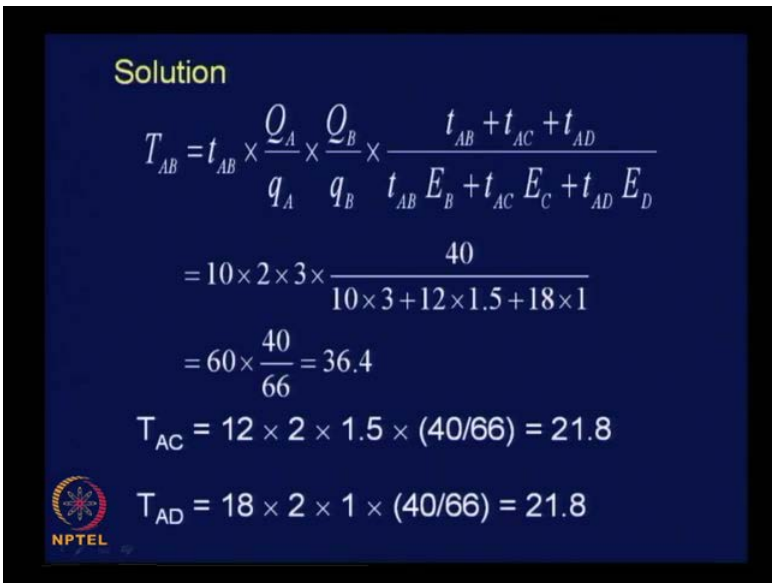

So, if you want to get the horizon year cell value for A B we just calculate T A B to be equal to small t A B into QA by q A. Fratar corresponding to the origin zone and Q B by small q B the growth factor responding to the destination zone and T A B plus T A C

plus T A D or the trips originating from zone A, to all the other zones and T A B into 8 E B.

Is nothing but trips that would originating from zone a in the horizon year as per the anticipated growth factor which is E B. We multiple the trip interchange by the growth factor corresponding to the destination zone T A B multiplied by E B not E A plus t A C into E C plus T A D into E D substitute; all the values all this values are known to us t A B is nothing but the cell valuein the available matrix Q A is nothing but the row total; and Q A is also known to us is in it row totals for base year as well as horizon year known to us. And in fact, we have got the ratio also directly Q A by Q A is available to us in the form of growth factor.

So, we can take those numbers directly and these values are known and these values are to be multiplied by the corresponding growth factor that is what we have to do and... So, you can substitute the values 10 into 2 into 3 whole divided by 40 is directly available from the matrix is ration divided by the corresponding values; multiplied by the respective growth factors and...

The t A B value for horizon year condition is 36.4 on the same line you can get the values of T A C and t A D all the trips related to zone a right trips originating from A, A to B, A to C and A to D and this part is same.

Because we deal with zone a so; obviously, we can directly take this numbers as 40 by 66 that is what I have done here only these values will be change, and put the corresponding values and get the numbers as 21.8. In the second case also we get exactly 21.8 on the same lines you just calculate the other trip interchanges.

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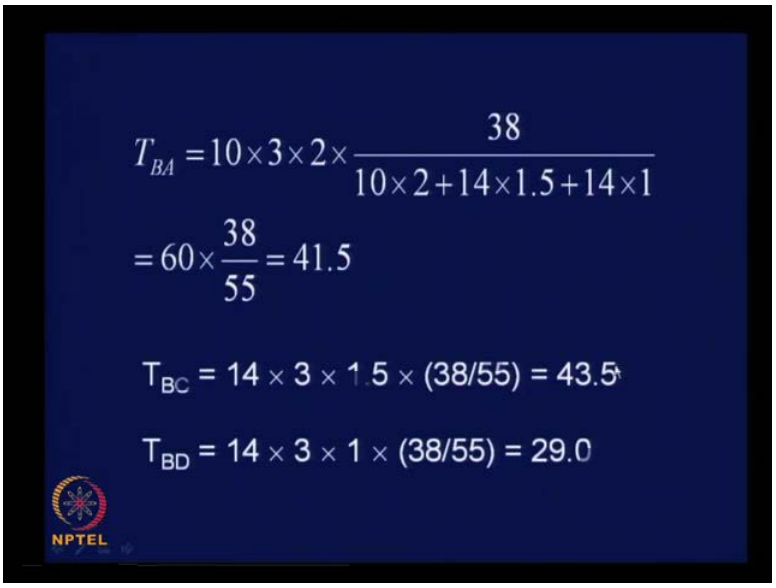

T B A substitute the corresponding values and we get 41.5 as t B A and other trips emanating from B, T B C and T B D or 43.5 and 29.0.

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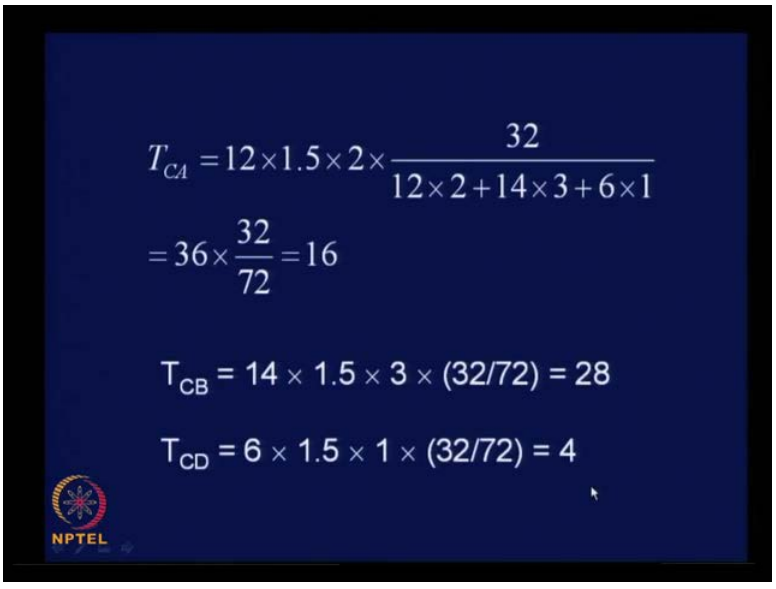

Then T C A will be 16, T C B 28, T C D 4.

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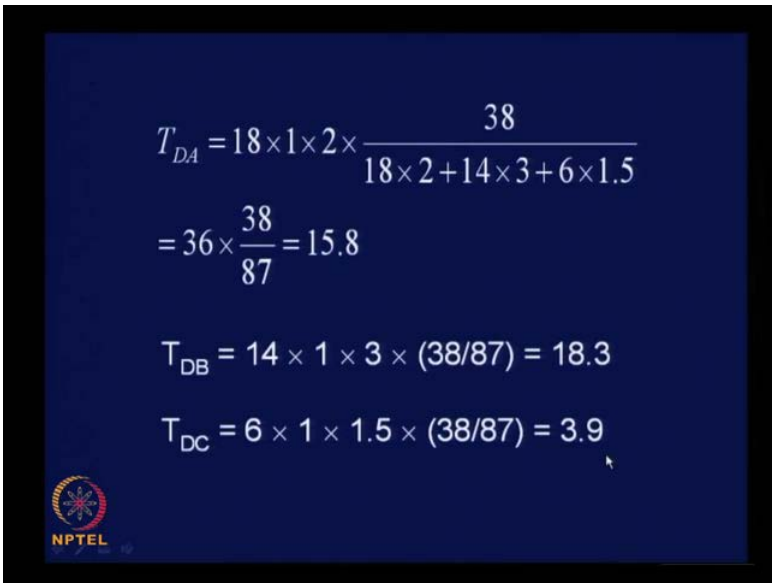

D A 15.8, D B 18.3, D C 3.9. Now, we are ready to put all the calculated values together.

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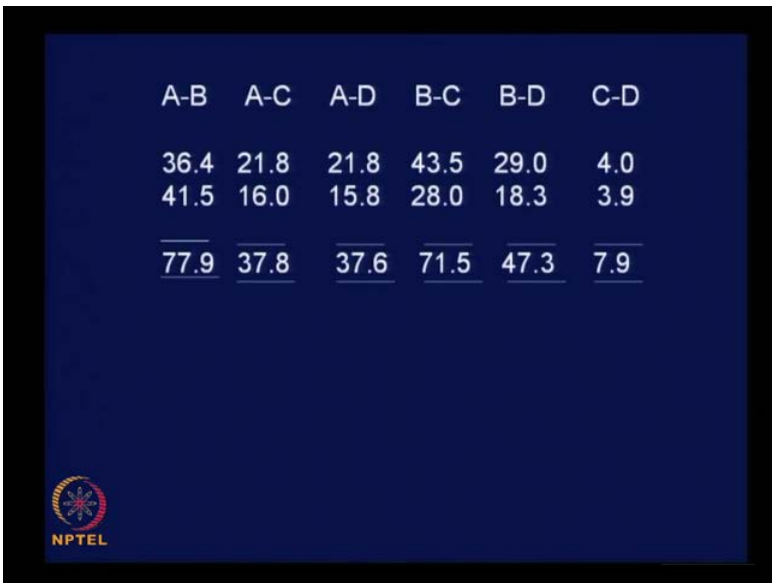

We have two values related to zone A and B, A B is 36.4, B A is 41.5, similarly for A C you have 21.8 A C is 16.0, A D 21.8, D A15.8, B C 43.5,C B 28.0, B D29.0 D B 18.3 C D 4, D C 3.9, please remember initially we have been given a data which added to symmetry condition A B is equal to B A, A C is equal to C A. So, that as to be maintained for that we need to simple have only one value for both A B and B A as well as A C and C A and so on.

The simple method is add up and get the average numbers; average values and take this as a common value both for A B as well B A this as a single value for A C and C D to proceed with the next iteration right, the averages of the trip interchanges between the zones are given in a matrix form below to determine the new growth factors put this numbers and develop the trip distribution matrix.

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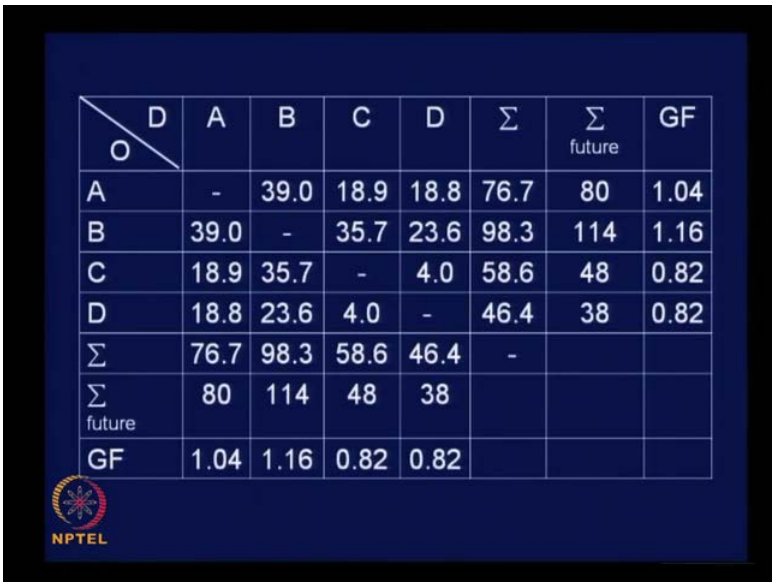

And this is the matrix you will be getting you can see the average numbers that we obtained earlier are given as cell values. 39, 39, 18.9, 18.9, 35.7, 35.7 and so on; symmetry is maintained then add up, these are the calculated trip destinations. And calculated trip origins as per the first iteration and then future values are fixed already known to us those values are there, then based on the calculated trip origin values and destination values arrive at the corresponding growth factors.

You get 80 by 76.7 as 1.04 and so on 1.16, 0.82, 0.82; similarly we get the same numbers on the other side because we maintain the symmetry that is how the growth factors are same on both sides. Now, take these growth factors and proceed with the subsequent iterations.

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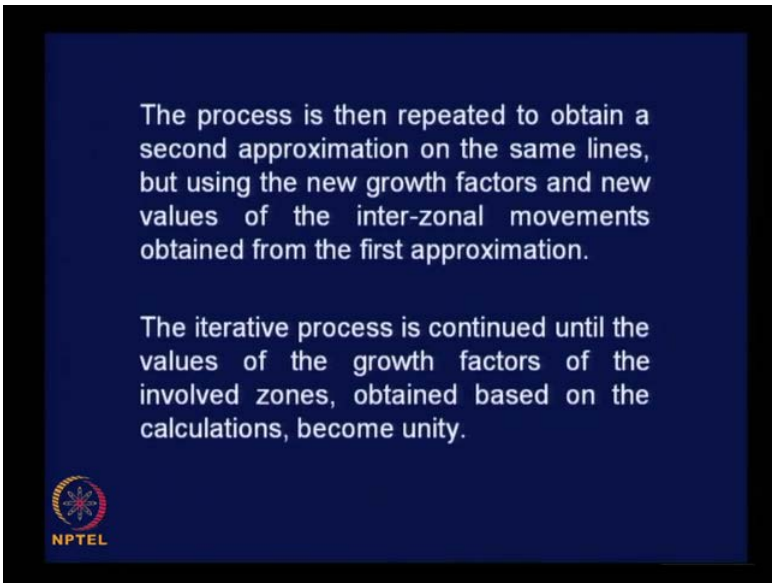

The process is then repeated to obtain a second approximation on the same lines as you seen earlier, but using the new growth factors, and new values are inter-zonal movements new values of the cells obtain from the first approximation.

The iterative process is continued until the values of the growth factors of the involve zones obtain based on calculation, become unity once it becomes unity your calculated and projected or predicted values are same that is what you want after distribution the row totals and column totals of the cell values should match your predicted trip origin totals and trip destination totals.

That will be satisfied once you get a growth factor evaluate to be unity.I strongly advice all of you to continue this exercises and reach the point of convergence, where the growth factors reach unity, and check whether you are able to get the excepted matrix for the horizon year condition this is about Fratar's method of trip distribution.

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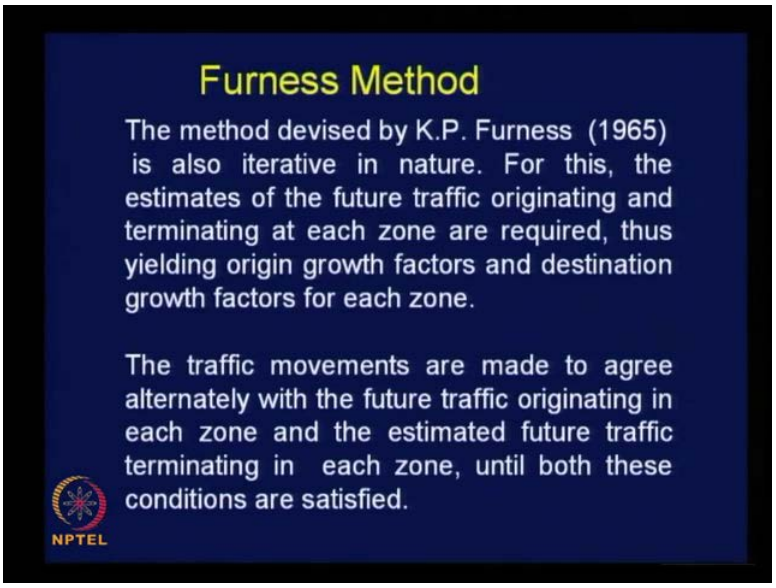

And after Fratar a person named Furness suggested a similar method that relatively simpler in the analytical procedure, and method device by K. P.Furness in 1965 is also iterative in nature. For this, the estimates of the future traffic originating and terminating at each zone are required, thus yielding origin growth factors and destination growth factors for each zone.

I am just reading out the background information as given the literature it is nothing different from the input required for Fratar's method the same information about the originrelated to trip origin, and trip destinations it is nothing different from the previous method as for us the input data is concerned.

The traffic movements are may to agree of natively with the future traffic originating in each zone and estimated future traffic terminating in each zone, until both this conditions are satisfied. Please remember the term traffic is used in the original literature and Iam just repeating the same thing.

If you can understand this as future trips or involved traffic both are same, the word traffic can be replaced by trips as for as are these explanation is concerned nothing different, because we are dealing with only person trips not vehicular trafficthe term traffic here means only person traffic.

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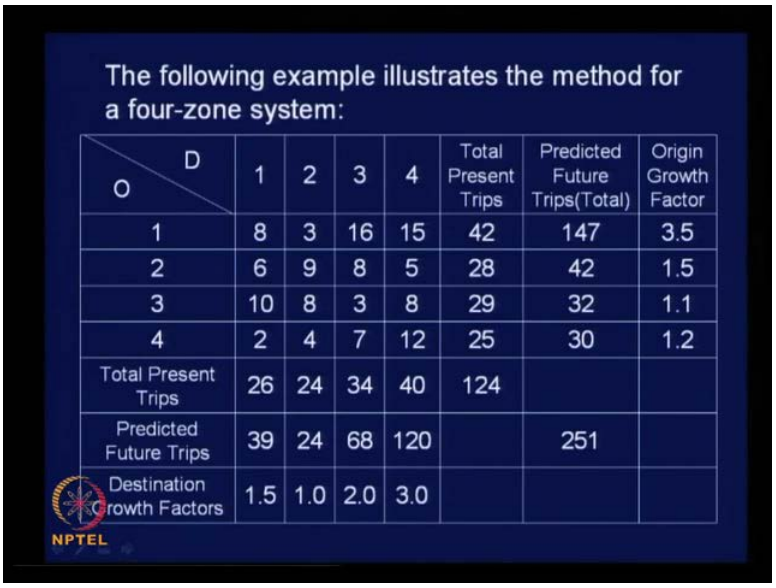

We will straight away taken example and see how Furness method is applied for distributing horizon year tripsthis is the example origin and destination information pertaining to four traffic zones are given here.

And please note that the symmetry constrained is not introduced here.For example, number of trips originating at zone 1 and destining to zone 2 or 3 and number of trips originating at 2 and destiny to 1 or 6. So, 1 2 is different from 2 1. So, that constrained is not introduced in this particular case it is just open situation you can deal with any kind of origin destination information as per Furness method.

And total present trips are given here as well as the, total for the rows are given here the totals are totally different from one, and other because there is no symmetry condition introduced in this particular case.

And this information will also be known to us the horizon year, trip origins and trip destinations zone wise would have been already calculated by us using trip generation model. Then using these totals you calculate a destination growth factor and origin growth factors one divided by the other the values are as give here 1.5, 1, 2, 3, 3.5, 1.5, 1.1 and 1.2. We are also not maintaining any symmetry.

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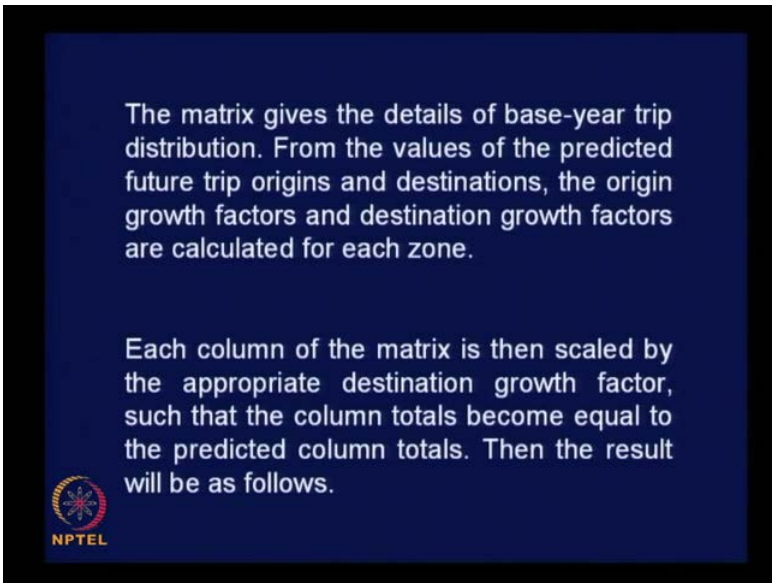

The same step is explained in the form of statements here the matrix gives the details of base year trip distribution from the values of the predicted future trip origin and destinations. The origin growth factors and destination growth factors are calculated for each zone.

That is what we have seen andeach column of the matrix is then scaled by the appropriate destination growth factor, such that the column totals become equal to the predicted column totals. Then the result will be as follows. What is mean by the statement?

Each column of the matrix, when they say each column of the matrix they mean each of the cell values in column each of the cell value sin column, when they say each column each of the four cell values in columnis then scaled by the appropriate destination growth factor we saw the destination growth factors are given at the end of each column.

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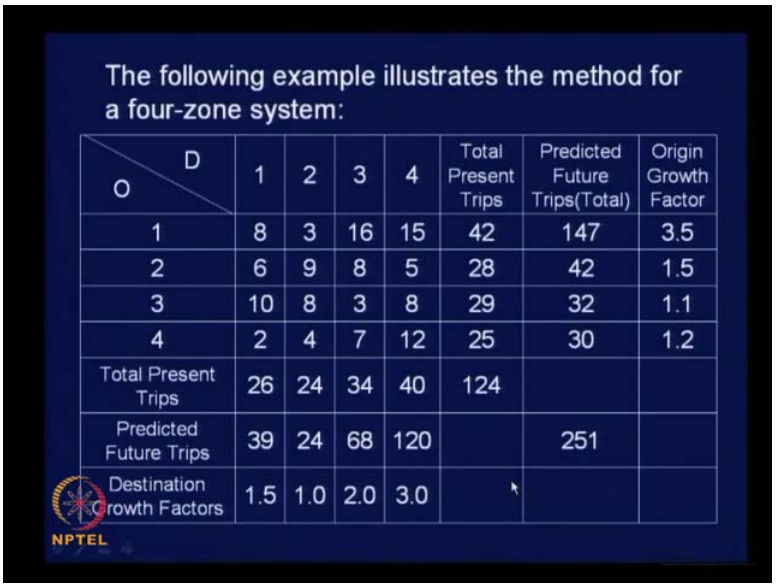

So, this is the given data. So, these growth factors are destination growth factors these are origin growth factors, by the statement that we have just now seen what is meant is this? we multiply each column. By the corresponding destination growth factor first or in other words each of cell values in column is multiply by the corresponding destination growth factor

We are going to multiply 8 by 1.5, 6 by 1.5, 10 by 1.5, 2 also by 1.5, then 3 will be multiplied by 1, 9 again by 1, 8 by 1, 4 by 1 . So, this is process that we actual we by this statementeach column of the matrix is then scaled, scaling up based on the growth factor by the appropriate destination growth factor such that the column totals become equal to predicted column total; obviously, when you multiplyby the corresponding growth factors will find that the totals are matching which you are predicted totals. Then the result will be as follows, let us see how we get the result after this particular step.

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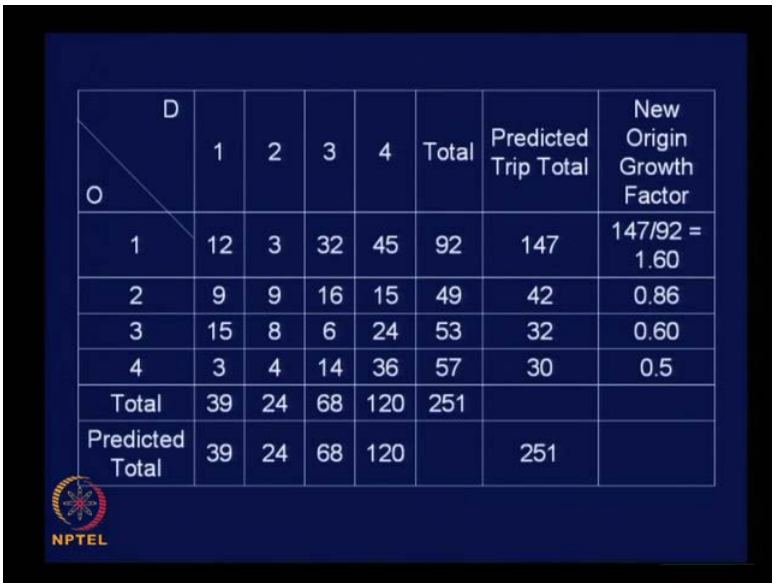

Since we have just scaled the columns using the growth factors we find interestingly the calculated totals as per; after scaling up or this values 39, 24, 68 and 120 and the predicted destination values are the same. And because of this scaling up there is change in the cell value, and if you total up this cell values along rows we are getting totals like this 92, 49, 53, 57 and so on and the predicted values for each of this zones along the rows are 147,42,32 and 30 they are; obviously, different from the predicted values .

So, calculate new growth factor based on the required desired values or your own predicted values can be calculated values 147 by 92 for example, gives you 1.6 do the same calculation for other rows your getting 0.86, 0.6 and 0.5 as growth factors for origin zones. What is the growth factor fora destination values? It is already one and continues the exercises now by scaling the rowswith the corresponding growth factors.

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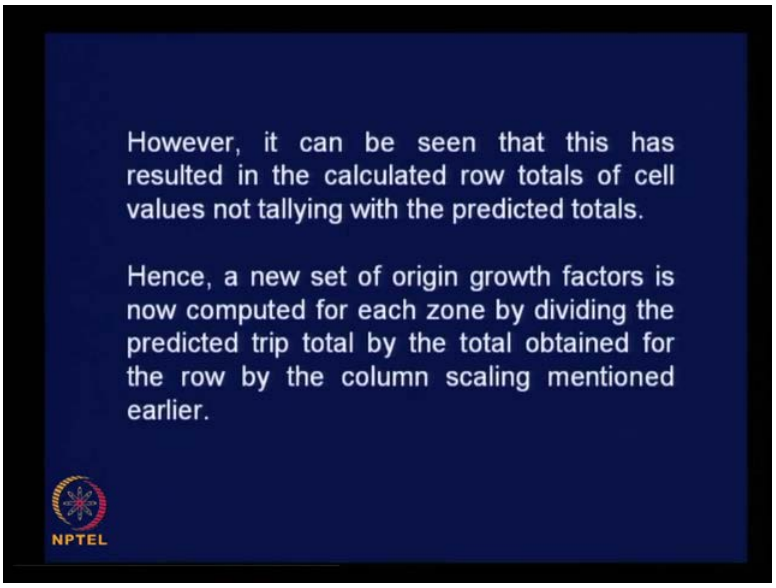

However, it can be seen that this has resulted in the calculated row totals of cell values not tallying with the predicted totals. That is what we have seen and.Hence a new set of origin growth factors is now computed for each zone by dividing the predicted trip total by the total obtained for the row by the column scaling mentioned earlier.

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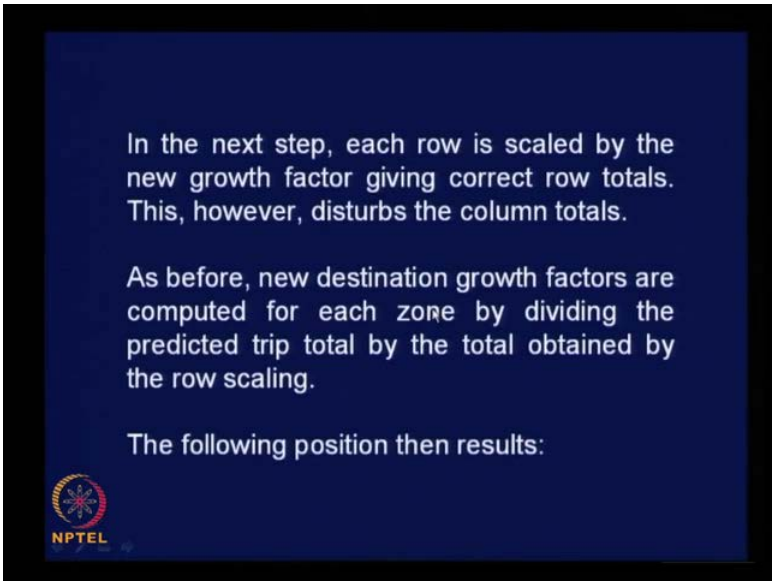

In the next step each row is scaled up by a new growth factor giving correct row totals this; however, this disturbs the column totals; obviously, when you try to tally the row totals the column totals will get disturb. As before, new destination growth factors are

computed for each zone by dividing the predicted trip total by the total obtained by the row scaling.

Are you able to understandthe iterated procedure first you scaled up based on destination growth factor and the origin growth factorsor origin cell values get disturbed, origin totals. So, calculate growth factor use those factors to scale up the cell values along each row now will find along each column there is disturbance then work out new growth factors along for each column and use those factors to scale up the cellvalues, and there will be disturbance along row, and continue the process until there is a match; until there is no disturbance along columns as well as rows. So, analytically you find that the procedure is quite simple compare to are the procedure purposed by Fratar.

He is involvingbig analytical procedure involving the current trip interchanges then growth factors for origin, destination zones and ratio of the trip interchanges for the base year and horizon year and.

So, on all these things are not here simply only, one simple calculation involved here namely scaling up the cell values using the growth factors for column first, and then for rows and repeating procedure until you get the growth factors to be almost unity. So, there is no disturbance of the cell values; of the matrix and I just to show you the result of this exercise you can see the result here.

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O \ D	1	2	3	4	Total	Predicted Total Trip
1	19.20	4.80	51.20	72.00	147.20	147
2	7.74	7.74	13.76	12.90	42.14	42
3	9.00	4.80	3.60	14.40	31.80	32
4	1.59	2.12	7.42	19.08	30.21	30
Total	37.53	19.46	75.98	118.38	251.35	
Predicted Trip Total	39	24	68	120		251
New Destination Growth Factors	1.04	1.23	0.89	1.01		

After, scaling up using origin growth factor you find that the calculated values of origins for each of the zone are shown here they are nearly equal to the predicted values or desired values 147.2 instead of 147 you can take it as a rounded of to 147 itself and this can be rounded of to 42, the desired values 42 and this can be rounded of 32 and desired values also 32 you can rounded of this to 30 desired values 30 its exactly matching whereas, here there is difference between the calculated totals and the desired values we have 37.53 instead of 39,19.46 instead of 24,75.98 instead of 68 and 118.38 instead of 120.

So, work out new growth factors for the columns we get 1.041.23,0.89,1.01, are much better they are relatively closer unity compare to the previous iteration, use these growth factors scale up the cell values along each column using this factors and get the result in matrix and you will see that there is some disturbance in the column totals. And repeat the procedures until there is no disturbances at all involve cell values and you get growth factors to nearly unity.

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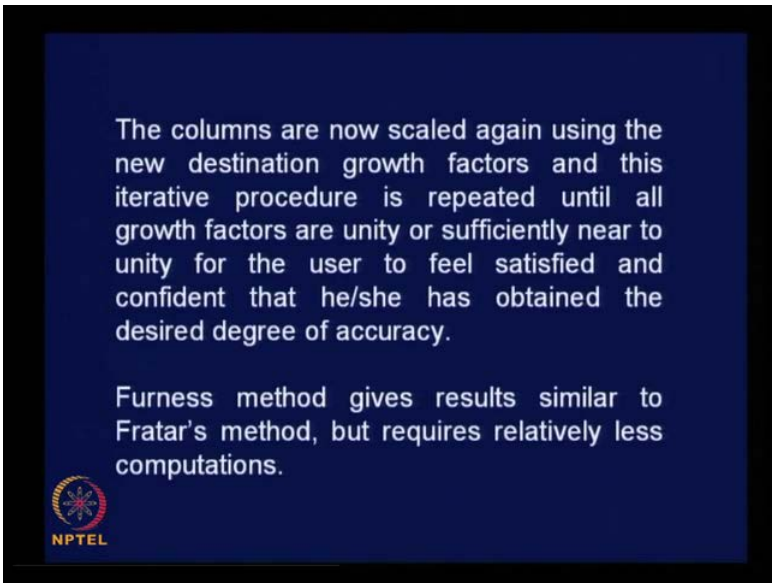

The columns are scaled again using the new destination growth factors and this iterated procedure is repeated until all growth factors are unity are sufficiently near to unity this indicates to give that it may be very rare that you get exactly one as growth factor for all a trip origins and trip destinations. That is why you must go on iteratively doing the exercise and identifying the point of convergence.

Until all growth factors are unity or sufficiently near to unity for the user to feel satisfied that is more important for your satisfaction is more important, and confident that he or she has obtained the desired degree of accuracy is left your desire you fix an level of accuracy and try to attain that level by the iterated process.

And this is the final statement regarding Furness method. Furness method gives result similar to Fratar's method same result that requires relatively less computation that is a advantage of Furness method. So, Fratar purposed method in 1954 after 11 years he is come out with a method which is relatively simpler in terms of analysis, but still gives you the same result.

And in practice people make use of both the methods, I would says some planners make use of Fratar's method even today, because of the fact that Fratar's method goes in detail about the present trip interchanges and predicted trip interchanges also the formula takes care of those variations.

Whereas, Furness method realise on mainly scaling up the cell values based on the growth factors. It is not relying much on the trip interchange values for every iteration. This completes our discussion on the different growth factor methods available for trip distribution, now let us try to look at the disadvantages, as well as advantages of growth factor methods.

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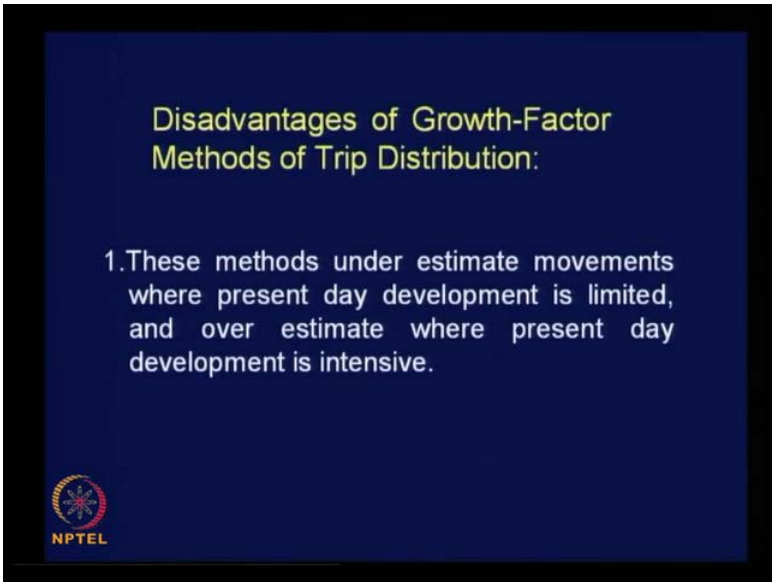

Disadvantage of growth factor methods of trip distribution or you can call it as limitation a first disadvantage is this. These methods under estimate movements where presently development is limited, and over estimate where presently development is intensive. What you understand by this statement?

Let say there is a large number of trip interchange between a particular zonal pair for base year condition, because both the zones have fully developed and by growth factor methods. We just extrapolate or manipulate the cell values which are reflection of trip interchanges for base year condition to gethorizon year values this implies that when you have a higher value of trip interchange between a zonal pair your horizon year trip interchanges is also going to be proportionate your base year trip interchange.

In another case, zones would not have develop that much under base year condition, but might have potential for fast development later after five year, ten years the current trip interchanges may be relatively less that you are going to assume that even horizon year condition for such zonal pairs a trip interchanges are going to be relatively less, it may not be true the zones might grow faster and interchanges may be quite different from the base year trip interchanges. So, this possibility or this kind of possible changes or not taken in account in the growth factor method because we are simple manipulating with base year matrix.

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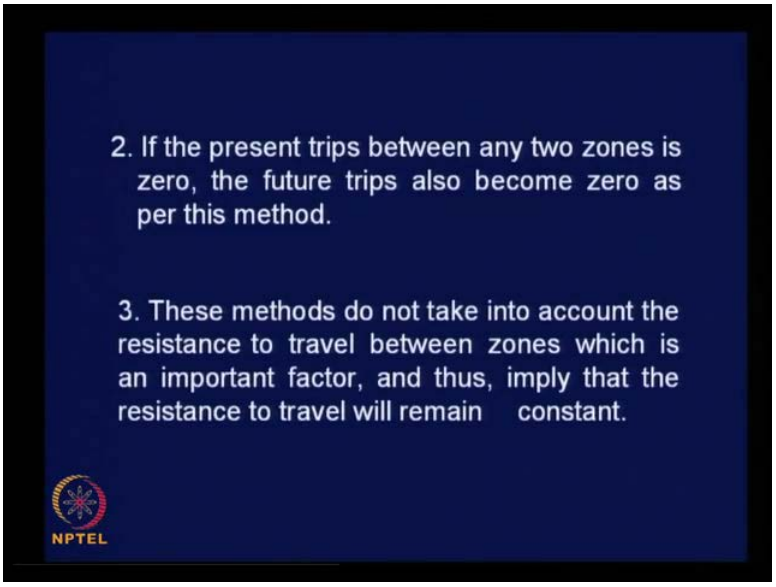

The extreme case is this. If the present trips between any two zones is zero it is possible trip interchanges between set of zonal pairs become zero between zone one and zone two hundred which are quite far away might be zero for base year condition as per the growth factor methods the future trips also will become zero, because of the base year value being zero, because the base year value is zero.

So, this is the extreme situation we are simple trying to reflect the base year condition by growth factor methods, and then these methods do not take into account the resistance travel between zones which is an important factor, and thus imply that the resistance travel will remain constant.

There is no f i j involve in the trip distribution using growth factors f i j is very important factor reflecting the resistance travel in the form of travel time, travel cost and other associated benefits and dis benefits. So, that factor is not at all brought into the picture in growth factor methods, we simply ignore the travel resistance once we ignore the travel resistance it implies where we have assume thatthe travel resistance is going to remain unchanged between base year condition and horizon year condition.

For base year condition whatever cell values you have in the matrix base year matrix is; obviously, reflective of the travel resistance, because people have actually a change trips the cell values for base year condition reflect f i j values accepted, but f i j between zonal pairs need not remain the same for horizon year condition traffic conditions might change that there will be change in f i j values for zonal pairs. So, there is no way such changes can be brought into the picture as per the growth factor methods.

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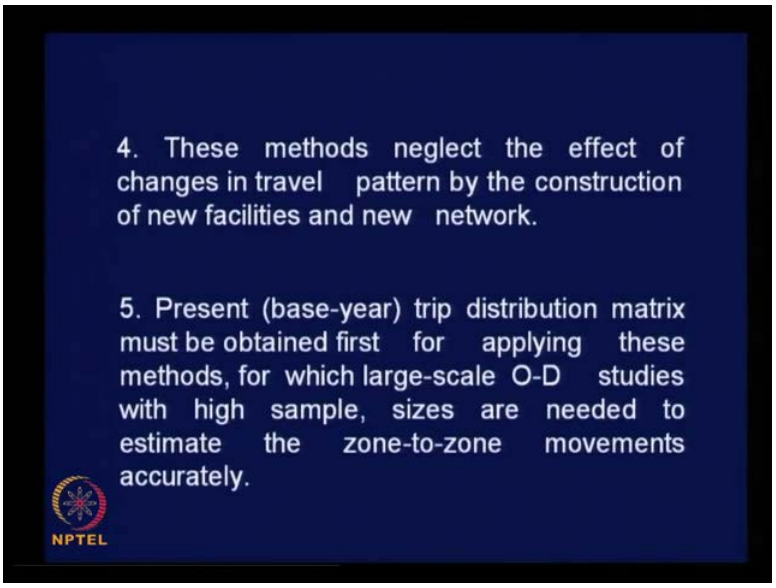

These methods neglect the effect ofchanges in travel pattern by the construction of new facilities and new network. Travel pattern itself might change. So, this kind of changes cannot be accounted for in the growth factors method. Please note that all this disadvantages are taken care of in the synthetic model namely gravity model we consider all this possibilities.

Then present or base year trip distribution matrix must be obtained first for applying these methods, for which large-scale origin destination studies with high sample sizes or needed to estimatethe zone to zone movements accurately. Another important requirement your planning expenditure is going to be high the form of increased requirement for data collection, your sample size as to be increased and you must collect very accurate data with regard to trip interchanges between zonal pairs. So, this is another important disadvantage of growth factor.

This a first question I posed to you at the beginning of this class what is the data requirement for growth factor method of trip distribution? We need to have O D matrix for base year condition which is going to be expensive, because of the requirement of large data base to develop such matrixes if you want to be accurate, and as I told you Fratar's method in Furness method or still applied for certain specific situations.

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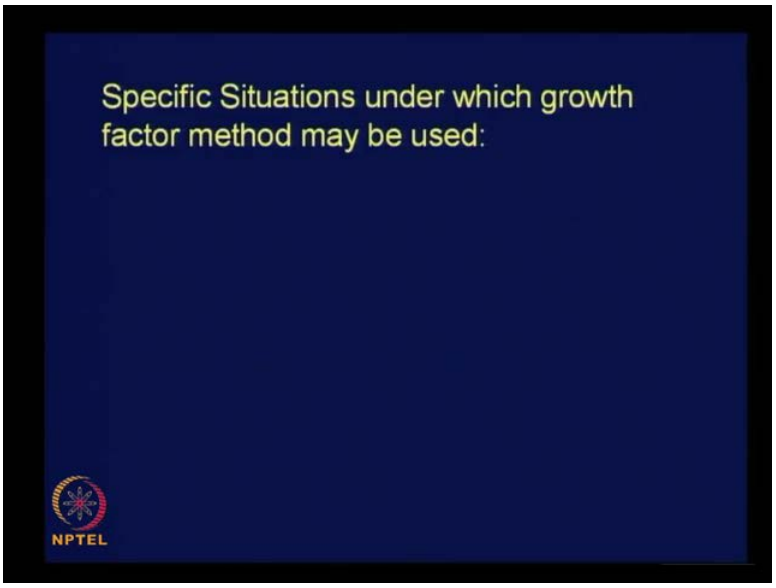

Specific situations under which growth factor method may be used, and you may recall our discussion with regard to their possible types of trips that might take place in urban area.

The most common trip interchanges are between traffic zones within the boundary that will eliminate as your study area boundary, let say on a typically day that you consider for your study certain percentage of trips have you emanated from outside your study area, and ended up in different traffic zones inside your study area.

People are travel from Tiruchirapalli and arrived at Chennai is your study area right its one way movement for trip origin is not within your study zones it is elsewhere that this trip is also going to add to the traffic in your city road network. So, this kind of trip is called a external to internal trip.

Internal is your study area similarly certain percentage of people might have travel on your particular day under consideration from Chennai to different places, different other places Chennai to Delhi, Chennai to Vijayawada, Chennai to Tiruchirapalli, Chennai to some other destination Bombay and so on all are trip contributing to a traffic on that particular day where it is one way movement trip origin is in your study area destination is elsewhere.

And this kind of trips are going to be there in the horizon year also, how to account for the prediction of this kind of trip distribution in the horizon year. Since you have traffic zone within this study area we are able to predict the trip production, trip attraction in turn trip origins, and trip destinations, for all the zones in your study area whereas, when the other end of your trip is outside the study area you cannot treat that as a zone, and go in to the details of the socialeconomic characteristics that influence the number of trip origins destinationextra which is too much.

So, in such a case we try to manipulate the present day trip interchanges to get the future trip interchanges, that is how the growth factor methods are relevant to deal with internal to external trips and external to internal trips.

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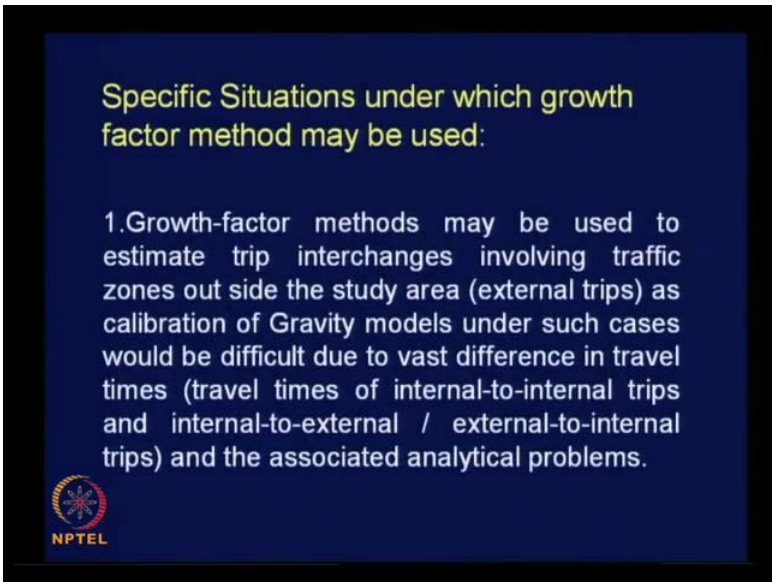

Growth factor methods may be used to estimate trip interchanges involving traffic zones outside the study area, external trips as calibration gravity models under such case would be difficult due to vastly difference in travel times within urban area your - travel time range could nearly a minute to let say about seventy minutes; whereas, if you take the travel time between Chennai and Vijayawadachennai and New Delhi is not going to be comparable.

When such vast variation is there you cannot apply your gravity model, it will not workunder such cases will be extremely difficult application of gravity model under such cases would be extremely difficult due to vast differences in travel times of internal to

internal trips which are within the range and internal to external or external to internal trips.

And the associated analytical problems that is how you cannot apply your gravity model to deal with internal to external and external to internal trips that is where the growth factor methods will be very useful.

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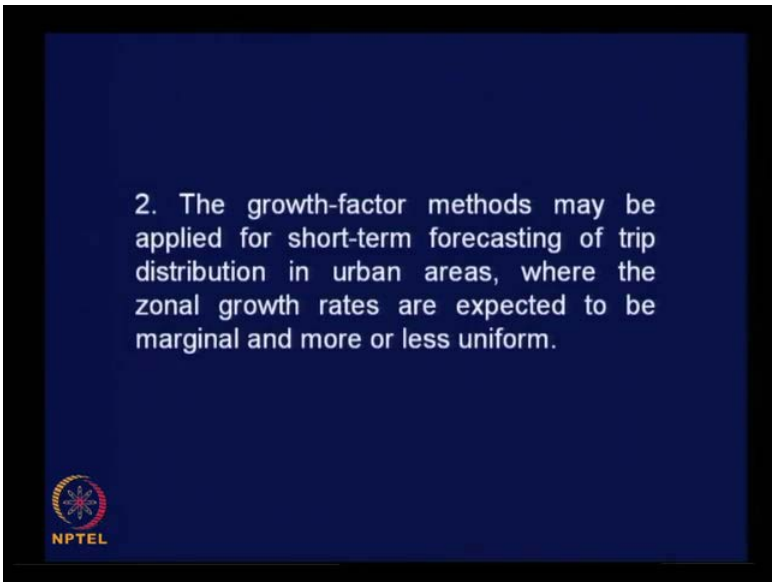

The growth factor methods may be applied for short term forecasting is the another situation where growth factor methods can be advantage made use of for short term forecasting of trip distribution in urban areas, where the zonal growth rates are excepted to be marginal and more or less uniform.

In that case there is no problem, and you can going for application of growth factor method let say for some reason you like to have some idea about the trip distribution pattern for a time which is about five years ahead, and base year value is known to you. There is no need to worry about gravity model application for such requirements you can as well do the exercises using growth factor method. So, these are the two specific situations where still growth factor methods are valid.

So, this completes our discussion on trip distribution analysis to summarise what we did in this class, we started our discussion with growth factor methods of distribution. And we discussed detail about two specific methods first method that we discussed was

Fratar’s method of trip distribution and Fratar’s method is iterative procedure which just manipulate the cell values of the matrix based on the predicted trip origin and trip destination for the horizon year, and it is iterative procedure and iteration endswhen a growth factors become unity or nearly unitrip in all the cases Furness method, the second one that we discussed about, this is similar to Fratar’s method that very simple in the analytical procedure because we just scale up the cell values using the growth factors of origins and destinations. In this method also we stop iteration when the growth factors approach unity with this we will close for today, and will continue our discussion in the next class on the new topic namely Route Assignment or Traffic Assignment.