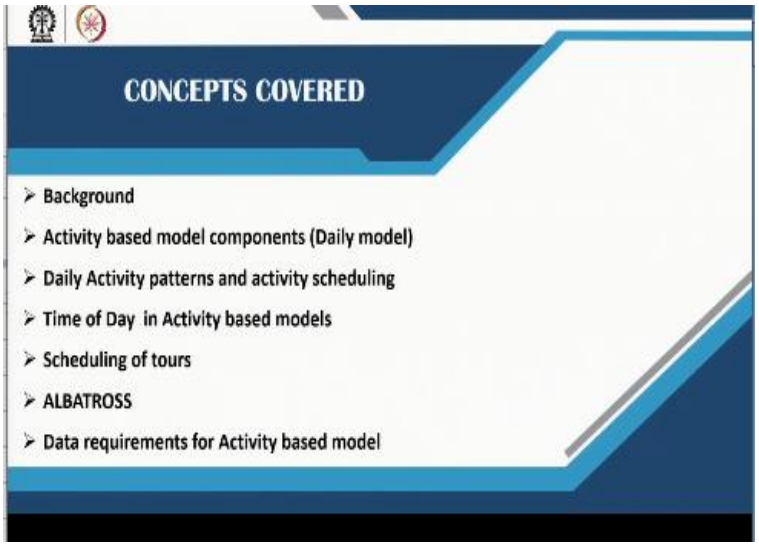
Urban Landuse and Transportation Planning
Prof. Debapratim Pandit
Department of Architecture and Regional Planning
Indian Institute of Technology – Kharagpur

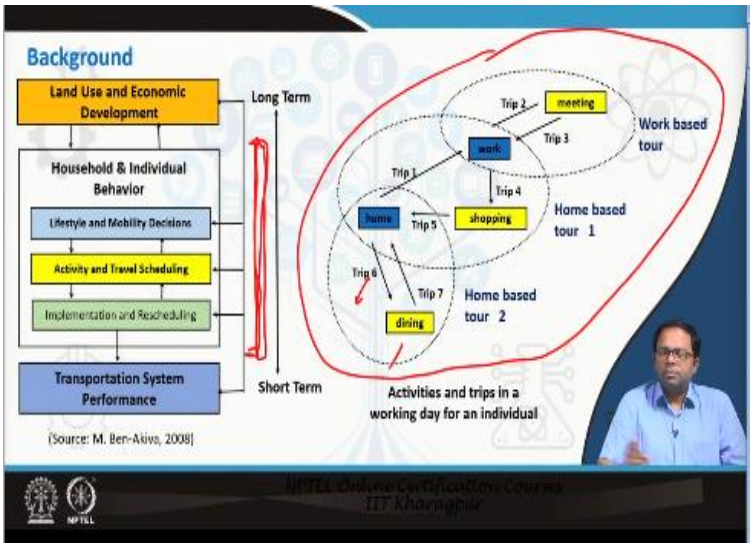
Lecture 58
Activity Based Model 2

(Refer Slide Time: 00:25)



The second part of activity based models will be covered in this lecture. The different concepts covered in this particular lecture are on the background, activity based model components, the daily model, daily activity patterns and activity scheduling, time of day in activity based models, scheduling of tours and data requirements for activity based model. In addition, ALBATROSS which is one of the most famous activity based model will be discussed in detail. The long term choice models have been discussed in the earlier lecture.

(Refer Slide Time: 01:05)



Summary of the last lecture

In the last lecture, activity based model which is part of the overall landuse transportation modelling framework has been discussed. Landuse and economic development act as input to the activity pattern of activity based model.

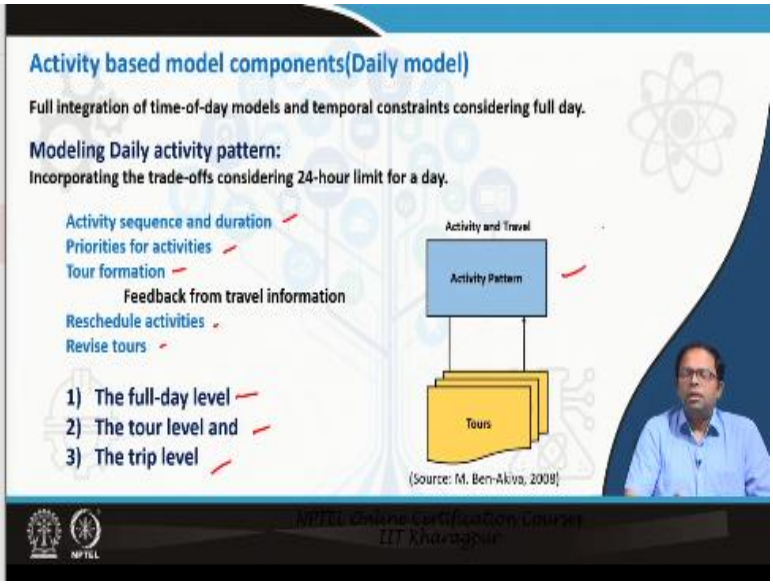
Lifestyle and mobility decisions which are part of households' and individuals' activity patterns. These long term choices influence activity, travel schedule, and individual daily travel pattern. There is a need for implementation and rescheduling of this pattern based on the certain constraint, certain activities, joint activities etc.

Once a particular schedule is fixed, it can be used as an input to the transportation system performance process by loading it into the links i.e., the tours and the trips that are designed out of this activity pattern are loaded into the transportation network which may again generate a feedback to the scheduling process.

From home, one can go for a trip to work followed by a trip to shopping and then another trip to come back to home. This together becomes one tour. Shopping is a secondary activity.. Now, from office if one goes to a meeting and then again comes back to the office, then, this is a work-based tour. Finally, if he/she goes for dining from home (i.e. trip 6) and come back to home(i.e. trip 7), this becomes the third secondary home-based tour. There are total 3 tours that one needs to schedule in a single day. Thus there are activities and trips on a working day for an individual.

After scheduling a person's activities the activities are implemented and rescheduled to arrive at a particular structure of tours and trips, which will be used to load the transportation network based on each trip's mode choice, destination choice and time of the day choice.

(Refer Slide Time: 04:14)



Activity based model components (Daily Model)

In the daily model which is component of activity based model, time of the day and different temporal constraint are integrated i.e. there is a 24-hour limit and within that limit, different sequence of activities have to be distributed. Then, time of the day for these activities are decided.

Hence, the activity sequences and duration of each activity should be known i.e. how long each activity is and its sequence i.e., what have to be done first, which has to be done second, etc. has to be determined. This is based on priorities of activities like which are the main activities, which are secondary activities and so on. Then based on this, what kind of tours could be formed out of this activity have to be decided.

When the tours are formed then feedback from travel information like network, car availability, travel time, etc. is considered. All this feedbacks may or may not lead to change in the tour. If there is a necessity, activities are rescheduled followed by revision of tours, and eventually, after a certain number of iterations, a stable pattern may be found.

Hence, at first, the activity pattern of travel is decided and then for this activity pattern, the number and type of tours required to support this activity pattern is determined.

(Refer Slide Time: 06:00)

Daily activity pattern and activity scheduling

Classification of activities

Activities could be classified as out of home activities or at-home activities. However, for out of home activities there is no fixed classification and different authors, different modelers have used different classifications as per their conveniences, but these are some of the common/standard way to classify the different activities.

Out of home activities could be classified as mandatory activities, maintenance activities, and discretionary activities. Now, mandatory activities are work or business i.e. every day a person goes to work that is mandatory and for a child, it is school, college, or university. So, these are the two mandatory activities for a person and this may also have a fixed time schedule.

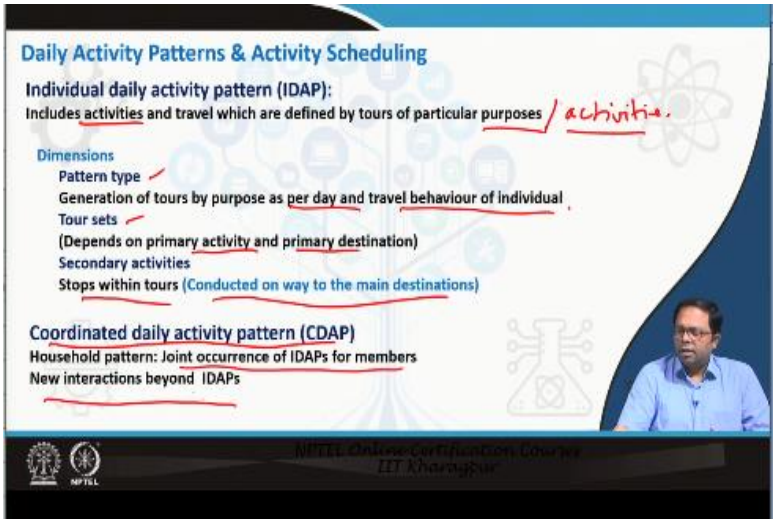
Then, there are maintenance activities like escorting passengers, escorting kids to school, daily shopping, etc. This results in a maintenance tour. As the kid has to go to school somebody has to escort. Thus, a maintenance tour is mainly performed to support somebody else in the family. Similarly, shopping is an activity that is required for the household. So, either the wife has to do it or the husband has to do it or both have to do it i.e. it is a maintenance activity. Then personal business e.g. related to medical or some other checks is also mandatory. Next, there are discretionary activities like eating out, visiting relatives and friends, social and recreational activities. These are second priority activities i.e. these activities will be performed after taking care of the mandatory activities. However, one can think differently, i.e., all these activities have to be done in a joint fashion where some

maintenance activity can be traded off with some discretionary activities. One may postpone shopping to the next day to perform some recreational activity today. These kinds of trade-offs can happen, However, considering norms followed by most, these activites can be prioritized and these prioritizing and scheduling rules are created at the beginning.

There are also intra-household interactions that also needs to be considered. The intra-household interaction can be related to individual level activity or to a joint activity. These activities can be allocated to any particular household member i.e. somebody is allocated a certain task. For joint activity who will perform the activities together have to be decided like for joint shopping, mother and son can go together, husband and wife can go together and then three of them may go together.

Priority within a tour has to be decided. E.g. one goes to the office and while returning from the office he may have to go for maintenance activities like shopping which is a secondary activity. The secondary activity can be only performed if time and location permits, after completion of the primary activity. The activities are not decided together to maximize their total utility. It has been done one at a time i.e. in sequence.

(Refer Slide Time: 10:25)



After understanding the different types of activities that are possible, the individual's daily activity pattern or IDAP has to be developed i.e. it includes activities and travel which are defined by tours of particular purposes or activities. There could be sub-activities within activities.

Both activities and travel are determined for a particular person. The different dimensions of the activity pattern like generation of tour by purpose and as per day and travel behaviour of individual based on the long term choices i.e., when and where does one want to go (i.e. will he go to work in the office or will he stay at home?) etc. have to be found out.

In the tour sets, primary activity, primary destination, and secondary activities are combined to decide which are conducted on the way to main destinations. This gives the overall individual daily activity pattern and then there are some coordinated daily activity patterns.

Next based on household charecteriscts, mandatory activities and what a particular individual has to do, what tour he has to make etc. has to be decided. Coordinated daily activity pattern also needs to be determined. The joint occurrence of IDAPs for members i.e. both the IDAPs of the two individual members has to be compared.

One segment of that IDAP would be assigned to a joint activity if both of them are free in that particular segment. That is where the household pattern comes in. The interactions between two persons' individual activity patterns have to be checked to see where the dependencies are, where are the constraints, and so on. Though this sounds a little complicated but can be done in a simple way.

(Refer Slide Time: 12:55)

For example, while deciding the daily activity pattern of a person, what he chooses to do is important to decide. In the second column of the above figure there are some mandatory activities and some non-mandatory activities.

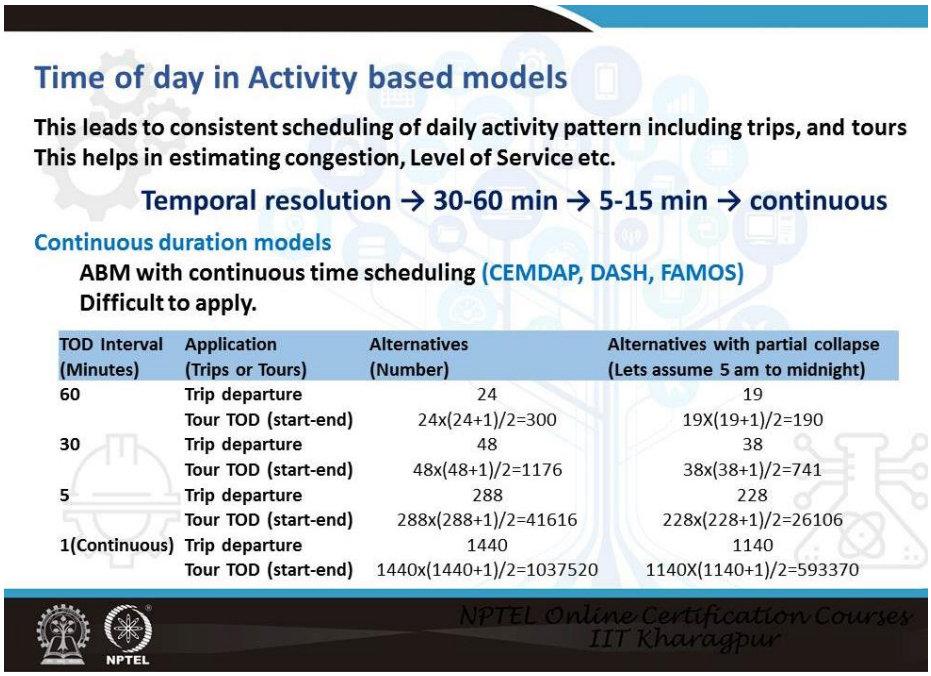
The mandatory activities are work, ‘2work’(‘2 work’ means either one goes to two places to work or has two shifts to work in one workplace), one work and one school i.e. one goes to school as well as one does part-time work or it could be just going to school or university. One can stay at home as well.

One can do just non-mandatory work i.e. he/she does not do any mandatory work and does only non-mandatory work. There could be also zero non-mandatory tours. One can have one escort shop or maintenance activity tour. One can have one eating visit or discretionary tour or one maintenance and one discretionary tour. Thus, one can have different combinations of non-mandatory activity.

There are 4 non-mandatory activities and 5 mandatory activities. Hence, there are 20 (i.e. 5*4) options of combinations of activities for a particular tour. E.g. one can go to work followed by eating out or one can go to work followed by doing maintenance activity or one can go to two works followed by eating out and so on.

A particular alternative for a particular day (i.e. weekday or non-weekday) will be assigned to a particular person or a household based on other lifestyle choices like car ownership, location of stay, economic background, and based on survey data. Some other tours can also be assigned to this main primary activity pattern. Thus, the likely activity among the alternatives is assigned based on the probability considering context, background, socio-economic characteristics etc. This is done for all individuals in the city using a simulated population.

(Refer Slide Time: 17:00)



Time of day in activity based models

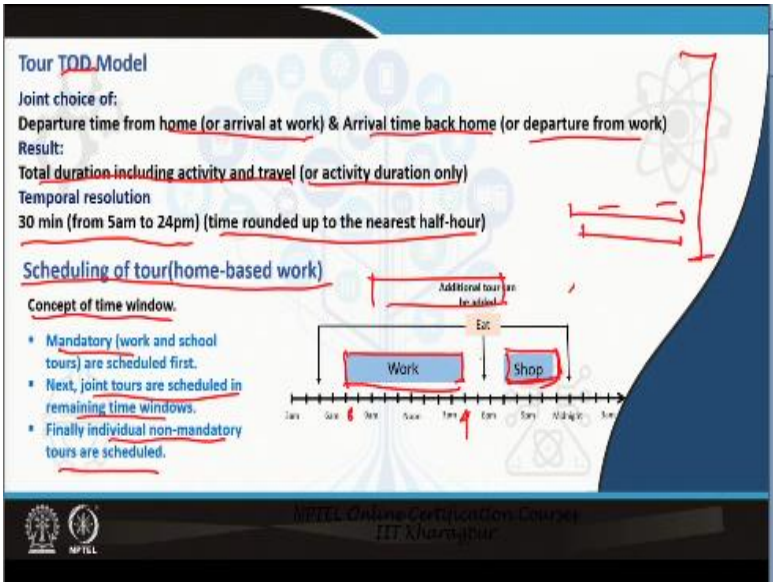
While the main activities are fixed, there is a need to understand at what time of the day these activities will be performed which leads to consistent scheduling of daily activity patterns including trips and tours and this helps in estimating traffic congestion, level of service, etc. Thus, if it is known at what time the trip has been undertaken (i.e. whether it is during peak hours or non-peak hours) one can estimate the associated impacts.

Time of the day is important and it also helps in scheduling the activity pattern. When one activity has got a fixed time period like work, the individual will only get free time to travel after completion of that activity. If work ends at 5 o'clock and one has to return home by 7 o'clock, then in between these 2 hours (i.e. equivalent to 120 minutes) he/she can do something else along with traveling. He/she can also start the trip at any point of time within those 120 minutes taking into account the actual time required for traveling. In this case. minute is the temporal unit in the model.

But, if 30-minute intervals are considered in the model, then only 4 options are present and he/she can choose any one of those 4 options to start a trip. Temporal resolution can be either 30 to 60 minutes, or 5 to 15 minutes, or it could be continuous i.e. every one minute. Even though it is discrete it can be considered to be continuous.

It is challenging to decide the temporal resolution. CMDEP, DASH, TASHA have incorporated continuous i.e. one minute time schedules. These are very difficult to apply. If 60 minutes interval is taken for a day (i.e. 24 hours) then, there will be 24 chances to have a trip departure. Now, let us assume that, it cannot start before 5 am and it cannot start after 12 at night as people will sleep which is a constraint. So, it can only start within any one of the 19 options, which is beyond 12 am to 5 am. Now, this is for trip departure. But, if the tour is considered, there is a start and end of a tour. Hence, the total option available will be 190 (i.e. 19*(19+1)/2) as an end is conditional on the first start time. The average is taken because if one starts after 6 hours then automatically the time slots for end-time reduces and the options become half. Hence, a tour with hourly interval without constraint will have 300 (i.e. 24*(24+1)/2) alternatives. Similarly, there will be 1036800 alternatives if 1 minutes interval is taken without constraints. This becomes impractical. Constraints can also limit the number of choices. The probability distribution from the sample survey is also used to determine decision rules. Certain start times can be also selected randomly by using random numbers.

(Refer Slide Time: 22:56)



Tour TOD Model

In the tour time of day model, joint choice of departure time from home (or arrival at work) and arrival time back home (or departure from work) can be done. At first, the activity duration is decided. Then, the total duration including activity and travel can be determined from start time, time of tour etc.

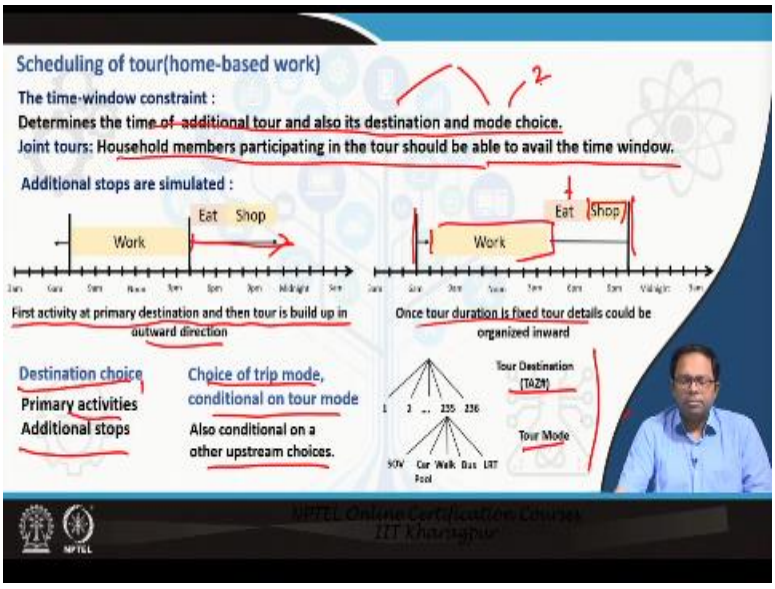
Now, there are a start and end time and the duration of that particular activity. This concept is called the concept of the time window. Now tours for home-based work can be scheduled by

using this concept of the time window. Hence, the overall schedule (i.e. going to work and coming back from work) is fixed for activity.

For scheduling a tour, first, it needs to be decided, what is the mandatory tour?. Work and school tours are usually mandatory tours. E.g. An individual's work time starts somewhere around 8am. and ends around 4pm.. This is the fixed time for work. Next, the joint tour schedule is proposed in the remaining time window. One has to go shopping with somebody else. Suppose, his wife becomes free after 5 pm. after her office and they can go together for shopping. This is the next joint tour schedule. Finally, individual or non-mandatory tours that have to be scheduled can be scheduled in between. This is the process of how activities within a particular time, within a day, can be scheduled.

Suppose there is a 2-hour gap and only 1 hour is required to travel then they will have multiple options to start and end which depends on probability and the mode choice. This is how tours are scheduled and from tours, trips will be formed.

(Refer Slide Time: 26:20)



The time-window constraint determines the time of the additional tour and also its destination and mode choice. Joint tours with household members participating in a tour can be scheduled only if all the participants are able to avail the time.

Certain activities are not possible because of the choice of their destination and mode choice. If traveling by a particular mode takes 2 hours or the destination is at a certain distance so that it takes 2 hours to reach there, probably those alternatives will not be available to choose

from. This choice of a location to go for eating will probably depend on that available time that is in hand.

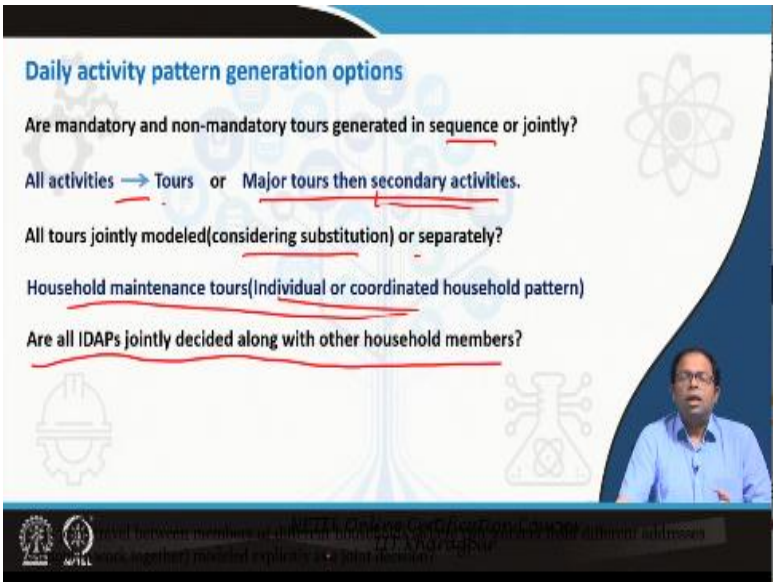
This depends on the modeler how he thinks of those processes and the way he has assumed those processes to happen. He may assume that the first activity is at a primary destination and then the tour is built up in the outward direction.

So at first, primary destination will be determined. Then, the tour will be built in the outward direction. In this way, the modeler can keep on adding till the time is over. Otherwise, the overall duration is fixed, and then the tour can be organized inwards i.e. first work is scheduled followed by shopping. Then dining is scheduled accordingly. So, either it could be gradually building up the tour or it could be fixing the entire time period and then filling in the gaps. Both approaches are fine.

Once the schedules are fixed, the destination choices of primary activities are determined using location choice models and additional stops can be added based on the available time periods and the available modes to reach those particular alternatives. From this, choice of trip mode, conditional on tour mode and also conditional on other upstream choices etc can be obtained. Upstream choices are the destination choice, activities schedule and so on. If there are multiple destinations and every destination can be reached using different modes, an hierarchical logit structures can also be applied.

There are different models that have been developed which have adopted different strategies, different processes, but this is the basic theory behind developing an activity based model.

(Refer Slide Time: 29:28)



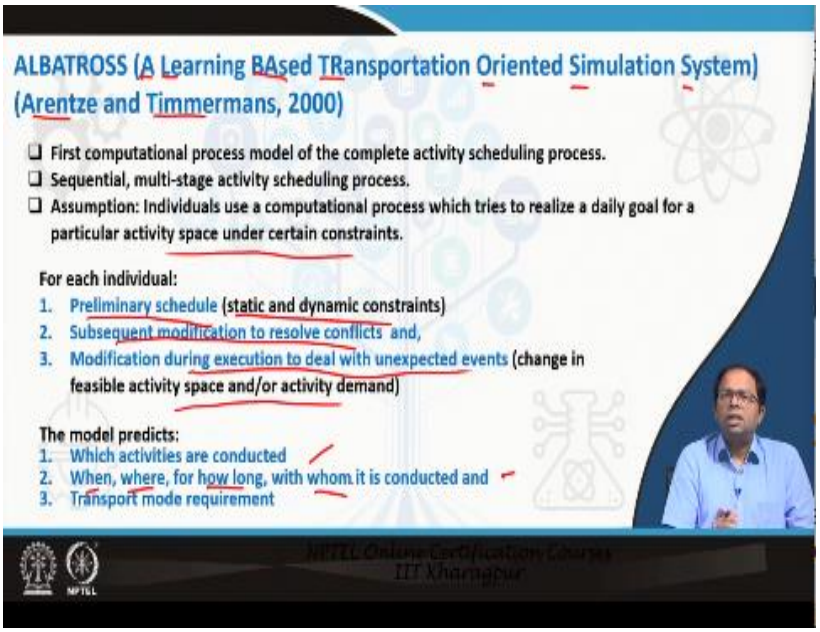
Daily activity pattern generation options

Some of the questions that can be asked are whether the activities are mandatory or non-mandatory or generated in sequence or jointly. i.e. it can be done in sequence like mandatory activities are decided first followed by non-mandatory or a person can decide all of them together. Each model can assume different strategies and all activities lead to tours. Either, all the activities can be decided together followed by the tour or it may be tour based i.e. at first decide on the major tours related to main activity followed by secondary activity.

All tours can be jointly modeled considering substitution or separately i.e. there can be substitution between two tours. E.g. One can first go to office and then come back to home then go for shopping or he can go to shop in between. So, there will be substitution in between tours. All tours may be jointly modelled or separately. Then for household maintenance tours this also can be modelled based on individual or coordinated household pattern.

Looking at the consistencies, constraints etc., it is decided whether this can be modelled jointly or not. In joint models, the overall utility can be maximized. These are the questions that different modellers have answered in different ways. It may also be decided based on the sample data, the local context, the culture and the way people do certain things etc.

(Refer Slide Time: 31:15)



ALBATROSS (A Learning BAsed TRansportation Oriented Simulation System)

ALBATROSS is the most famous computational choice process based activity based model. As it is a learning based model and depends on certain learning algorithms. It was developed in Netherlands by Arentze and Timmermans.

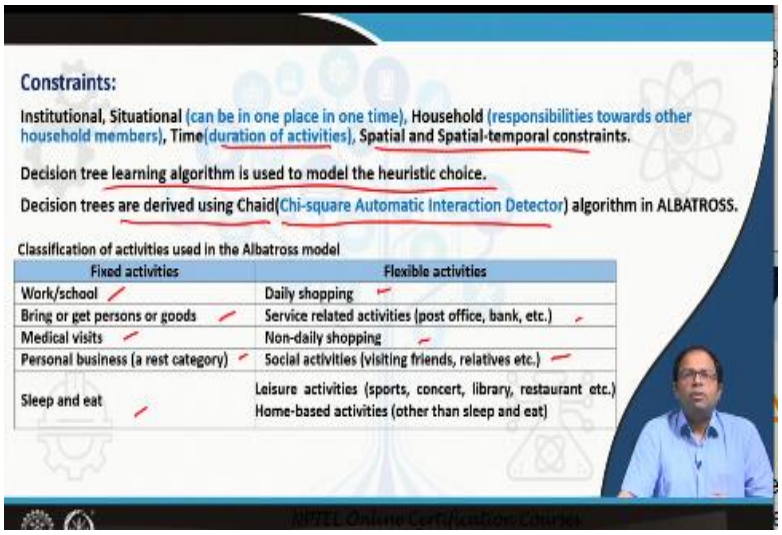
It is the first computational process model that consists of a complete activity scheduling process. It is a sequential multi-stage activity scheduling process and it predicts in stages instead of doing jointly. In this model, it is assumed that individuals use a computational process, which tries to realize a daily goal for a particular activity space under certain constraints. Hence there is a need to develop the overall activity pattern for a particular day considering certain constraints.

A preliminary schedule is developed for each individual based on static and dynamic constraints. Certain constraints are considered. Then during execution subsequent modifications are done to resolve conflicts or to deal with unexpected events because some constraints may come into play. E.g., changing feasible activity space or activity demand because of the travel feedback. Ths, if certain things change, some tours can be changed during the execution process.

This model predicts which activities are conducted, when (i.e., time of the day) and where (i.e. location choice), for how long (i.e., activity period) and with whom (i.e., joint activity or

not) it is conducted. These are the decisions that are taken and what is the final transport mode required to support this kind of activities is decided.

(Refer Slide Time: 33:27)

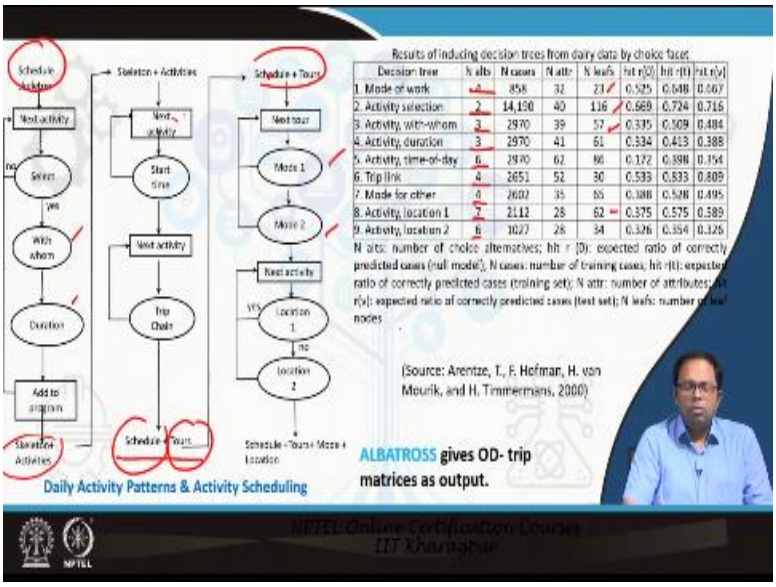


The constraints considered in this model are institutional constraints, situational constraints, time constraints, spatial constraints and spatial-temporal constraints.

A decision tree learning algorithm is used to model the heuristic choice. A decision tree algorithm i.e., the Chaid (chi square automated interaction detected) algorithm is used. Other algorithms can be used as well which will be explained in the next lecture. Classification of activities that have been used in the Albatross model is work and school, bring or get person or goods, medical visits, personal business, sleep, and eat. Work and school are considered as fixed activities.

Flexible activities are daily shopping, service-related activities, non-daily shopping, social activities, leisure activities like sports concerts. In this model, activities are divided into fixed and flexible activities instead of mandatory and non-mandatory activities. It depends from modelar to modelar, but the concept should be something on those lines.

(Refer Slide Time: 35:06)

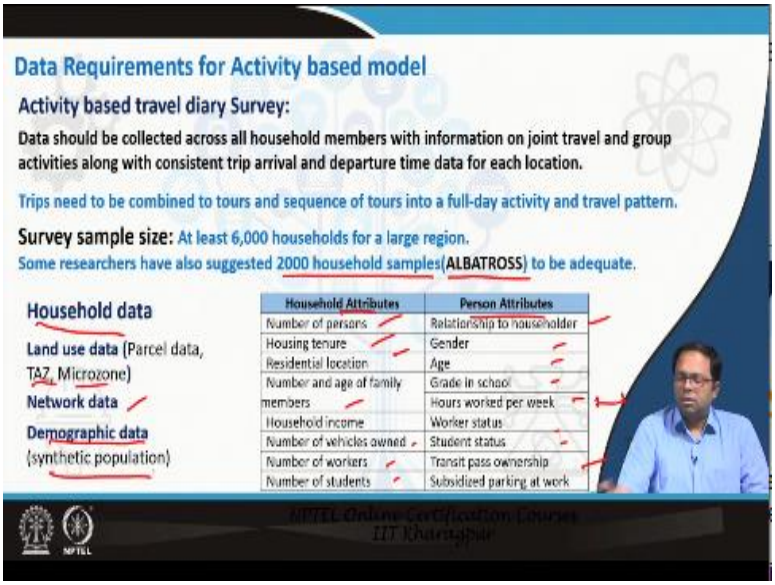


In this model first, a skeleton schedule is being prepared and then the activities are decided. Next it is decided if another activity is there or not and with whom that activity is done and what is the duration of the activity.

After the formulation of a skeleton framework with the major activities are done, other additional flexible activities are decided. Next, trip chains can be developed resulting in a daily schedule and tours. The next level of choice heuristics or decision heuristics is the mode choice and loctation choice.

This is how it chooses one alternative over another. ALBATROSS use many decision trees for each of these decisions. There are 23 options for mode of work. There are 116 activity combinations. There are 57 combinations related to ‘with whom’ the activities are performed. Leaves in a decision tree are the final outcome or alternatives. In Albatross, the final output is OD trip matrices.

(Refer Slide Time: 37:43)



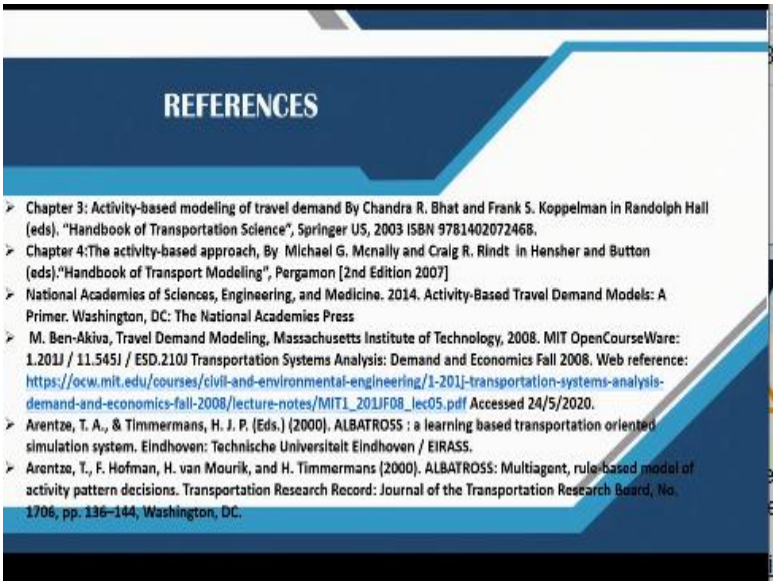
Data requirements for activity based model

The data required for activity based model has to be collected using a travel diary survey. Data should be collected across all household members with information on joint travel and group activities along with consistent trip arrival and departure time data for each location.

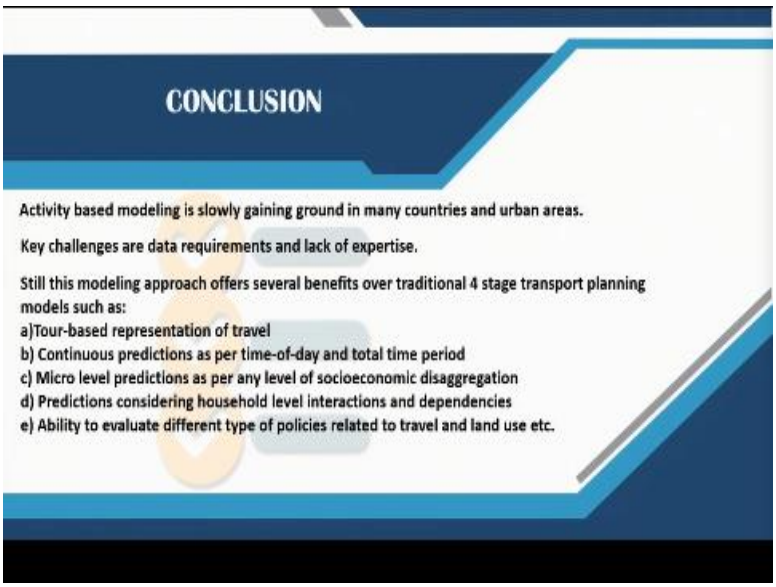
This detailed data is required otherwise probabilities of trip arrival times or departure times or location can not be predicted. Trips need to be combined to tours and sequence of tours into full-day activities and travel patterns from the survey itself. Many researchers have suggested that the sample size should be at least 6000 households for a large region.

Some researchers have also suggested 2000 house samples like in the case of Albatross. The researchers say that 2000 house samples are good enough for running Albatross model. Household data is standard household data like household attributes and personal attributes, number of persons in household, household tenure, residential location, number of family members, vehicle owned, number of workers, students, personal attributes like relation to the householder, gender, age, grade in school, hours worked per week, worker status with information like how much time one spends in his office etc., student's data, transit pass ownership. Landuse data TAZ wise or micro-zone wise, network data like in a standard transportation model and demographic data for creating synthetic population are also required.

(Refer Slide Time: 39:38)



(Refer Slide Time: 39:42)



Conclusion

Activity based modelling is slowly gaining ground in many countries in urban areas.

Key challenges are of course data requirements and lack of expertise.

Activity based modelling approach offers several key benefits over traditional 4 stage models such as

a. Tour based representation of travel, continuous prediction as per the time of day and total time period.

b. Micro level predictions as per any level of socio-economic disaggregation

c. Predictions considering household level interactions and dependencies

d. Ability to evaluate different types of policies related to travel and landuse.

These are the key benefits and that is why in the future, there is a lot of scope for developing this activity based model also in the Indian context.

Thank you.