Urban Land use and Transportation Planning
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Lecture-04
Comprehensive mobility plan

Welcome back. In this lecture we will talk about Comprehensive Mobility Plans.

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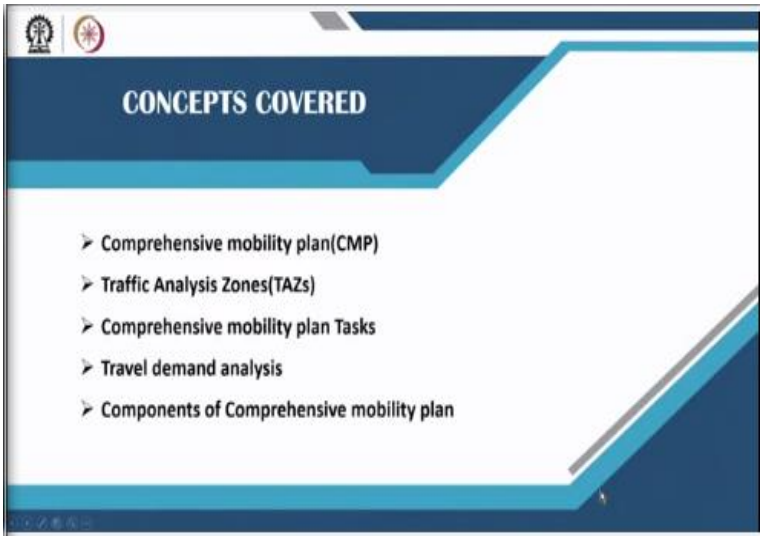

The concepts covered in this particular lecture include comprehensive mobility plans, traffic analysis zones, comprehensive mobility plan tasks, introduction to travel demand analysis, and the components of comprehensive mobility plan.

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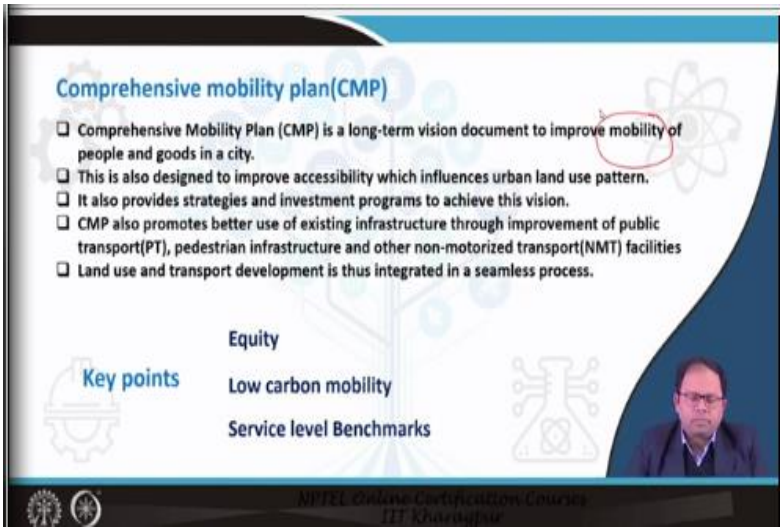

Comprehensive Mobility Plan – Introduction

Comprehensive mobility plan (CMP) for an urban area gets prepared along with development plan and deals mostly with the transportation part of a development plan. However, it is done in an integrated manner with land use and transportation infrastructure development. The primary difference between a normal transportation plan and the comprehensive mobility plan is that, the comprehensive mobility plan is a long term vision document which is specially prepared to improve mobility of people and goods in a city. It is also designed to improve accessibility and thereby influences the urban land use patterns. A CMP also includes provision of strategies and investment programs to achieve the vision of improving accessibility and mobility. Thus, CMP is not just a vision document. It also shows how to achieve that vision along with the kind of investment required to achieve the same. Improvement of public transport, pedestrian infrastructure and non-motorized transport facilities are the primary focus areas of a CMP. Land use and transportation development is also integrated in a seamless process in a comprehensive mobility plan.

Some of the key points of a comprehensive mobility plan are:

Equity

Equity means that the plan should equally benefit all the residents of a city or rather, all the stakeholders who are involved.

Low carbon mobility

Low carbon mobility, means that the total amount of emission and the total amount of fuel use in the city should be reduced

Service level benchmarks

Service level benchmark refers to various standards including the public transit standards, the standards related with infrastructure, etc. Hence, a comprehensive mobility plan tries to improve

the different service level benchmarks for different aspects in an urban area, along with maintaining equity and achieving low carbon mobility.

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Contents of CMPs

The different contents of a CMP, involves reviewing the existing travel demand and land use of an urban area, conducting a transport demand survey, preparing future land use scenarios and understanding future transportation network and other technological scenarios.

Travel demand survey is done in order to ascertain the traffic load in the different corridors, the kind and the number of trips people make, travel distance of these trips etc. Preparation of future land use scenarios, involves understanding how the city would grow and this input may come from the development plans. Future transport network and other technological scenarios corresponds to a new transit line or new modes along with certain technological changes which may influence the land use transportation process. Once these basic datasets and target future land use scenario/s are ready, a transport demand forecast model and a network evaluation tool are developed.

Transport demand forecast model and network evolution

This refers to the preparation of a set of models which will actually be able to predict the future transport demand, the kind of effect it will have on the networks etc., such that, we can decide on

how different networks can be improved with the provision of either infrastructure or other kinds of alternatives. We also need to model carbon dioxide emissions and other air pollutants resulting from transportation, social and environmental impact assessment for the proposed CMP and finally preparation of implementation programs. Stakeholders' feedback is considered in the different steps of the planning process and also for the implementation programs.

CMPs are related with the various existing plans for an urban area.

Development plan/ Master plan

The development plan or master plan and CMP can act as both input for and output of each other. For example, the future land use scenarios or the kind of jobs that will be generated in a particular urban area may come from the master plans. So, after getting such data, one can run a transport demand model with considering certain policies for further optimization of the land use and for the achievement of the mobility goals in a CMP. This result can be given as an input back to the master plan in order to improve the master plans. So, future land use determination using CMPs should also be considered in the preparation of the development plan or master plan.

City Development plan (CDP)

City development plans were broad documents framed to focus mainly on infrastructure. CMPs focuses on mobility and considers both infrastructure and also people's travel behavior and so many other things relevant to the overall mobility improvement in an urban area.

Comprehensive Traffic and Transportation Studies

CMPs focus on mobility and its relation with the overall land use and infrastructure and assess the resulting impacts in an urban area. On the contrary, comprehensive traffic and transportation studies are mostly concerned with vehicular flows in certain corridors.

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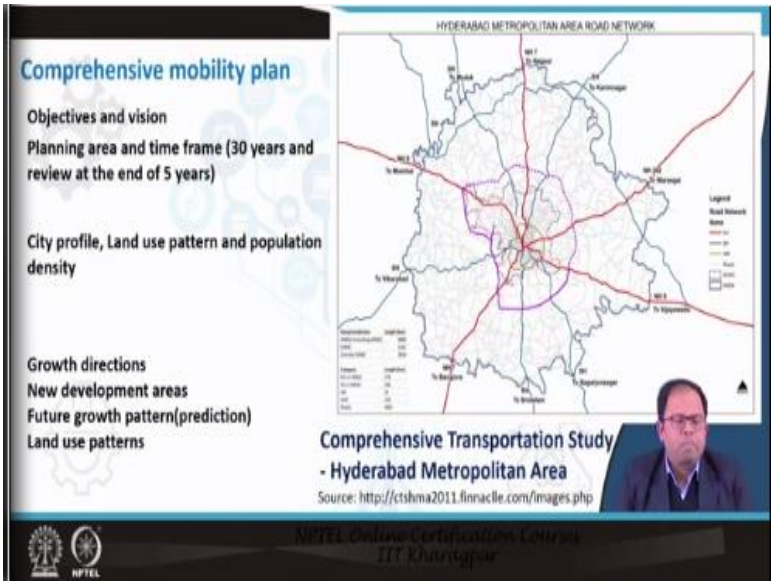

Comprehensive mobility plans – Objective, Vision, Time frame, Planning area

Comprehensive mobility plans also include an objective and a vision for a particular urban area similar to development plans. For example, for a particular urban area, we can have a vision to reach a target in terms of the number of people using non-motorized transportation within a certain time period. Next, this vision could be broken down into smaller objectives for which several policies or infrastructure development measures can be undertaken. The timeframe for this plan could be for 30 year period with review at the end of every 5 years, so that, certain datasets and exogenous inputs can be updated. For example, the amount of new jobs estimated to form in an urban area can be updated or any change in the planning area boundary could be updated as well. Other datasets that are required are the city profile, the land use pattern and the population densities for different parts of the city.

The map of the Hyderabad metropolitan area shows 2 boundaries; the blue boundary corresponding to the Hyderabad metropolitan development Authority (HMDA) boundary and the other corresponding to the municipal corporation(GHMC) boundary. In order to execute the CMP, it may be important to consider both the boundaries. Since, it is a metropolitan area, the people living in regions outside the GHMC boundary and within the HDMA boundary will also go to the central area to work. Hence, it is necessary to take care of the transportation issues or

mobility issues that arise for people travelling from different parts of the city to other parts of the city or even to the central area. So, we cannot ignore the surrounding area outside the municipal boundary even though development in those particular area maybe sparse. Once, we decide on the extent of the area for which we will plan, the growth directions of the city has to be understood. The direction of growth can be also considered in deciding the planning area. For example, if the city is growing along a particular area because of presence of multiple highways, it can assumed that, in future this area will grow, and hence, can be considered within the planning area.

Thus, both new development areas and future growth pattern is considered to determine the planning area for the comprehensive mobility planning exercise.

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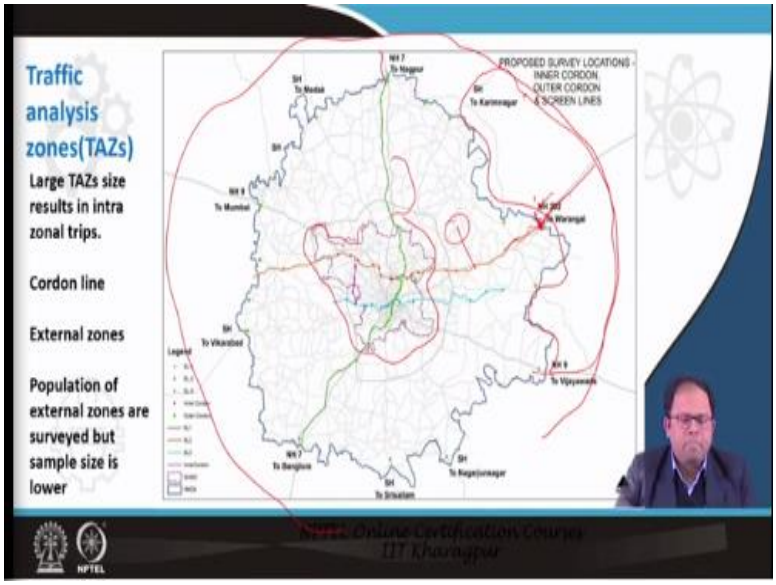

Traffic Analysis Zones

Once we decide on the overall planning area, we need to break the entire urban area into different small homogenous zones i.e., for a particular zone, residents will have same options and will experience similar kind of surroundings or accessibility influencing their choices. The zones are primarily determined based on similarity of land use, similarity of accessibility etc. and the existing administrative boundaries. Large TAZ size results in a lot of intra zonal trips i.e., trips moving in between themselves whereas, we need to understand how trips move from one zone to

another. In case, a lot of trips are inside a TAZ, then, it is difficult to predict the travel behavior of people living within that particular zone.

The concept of 'cordon line' helps in limiting the study area to a certain boundary and in deciding on the different types of zones. For example, for the central area of Hyderabad, i.e., the municipal area, the zone sizes could be smaller considering the high density and the administrative boundary of the wards. For the outer area, which is characterized by sparse development, we can have larger zones. So, this could be one of the criteria for deciding on the TAZ sizes and also deciding on the kind of cordon line. For example, considering the images, it can be observed that, many highways extend beyond the planning area bounded by the HDMA boundary. People coming from outside this boundary use these highways to reach either the central core or the area within the two boundaries for work. So, we need to have a cordon point at locations adjacent to the planning area boundary to decide on how many people are entering from outside the city into the urban area or even the urban city core.

Presence of this imaginary cordon line allows us to limit the size of the transportation planning area and also allow us to have *external zones.* As observed from the images, these are the zones in the surrounding area of the city, which is external to the planning area boundary. People travel from these large external zones to the different smaller zones inside the urban area. External zone can be considered as a single big zone. However, it is better to divide it into 4 or 5 zones such that each external zone contributes to the traffic to the nearby state highway or national highway which carries the traffic to the urban area.

Population of external zones are also surveyed however, sample size considered is much lower compared to the number of samples that is collected from the inner part of the city.

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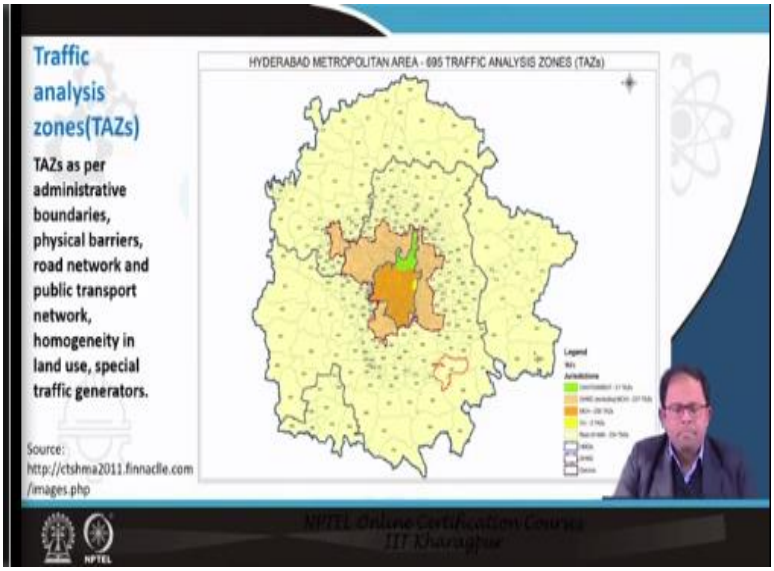

The above image shows the different TAZs that have been adopted in this recent study completed by the Hyderabad metropolitan area. It can be observed that, the TAZs vary in size with the central area having TAZs of small size and the outer area having TAZs of larger size.

To summarize, it can be stated that, TAZs are determined based on administrative boundary, physical barriers, road network and public transit network, homogeneity in land use, spatial traffic generators and so on.

Comprehensive Mobility Plans Tasks (based on Terms of reference)

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While, preparing a comprehensive mobility plan, there are certain tasks which are mandatory because these are part of the terms of reference set by the government of India. These are used by the government to evaluate any plan, infrastructure or any project that is proposed and to release funds for development.

For each TAZ

For any TAZ, total number of people, total number of houses and also the different kinds of household are estimated. Each of the households in a particular TAZ will generate trips and it is important to understand how these people travel from their TAZ/zone to all the other zones. This also considers that, the individuals or households in a particular TAZ will share the same set of transportation choices. For example, if there is a transit stop such as a bus stop or a railway station located in a TAZ, all of the trips from that TAZ would be assigned to that particular transit stop. Thus, based on the location of bus stops, the public transit network and also considering the existing administrative boundaries (as the census data and other data are available primarily based on the administrative boundaries), TAZs are identified. TAZs become the primary area based on which we conduct analysis.

Thus, for each TAZ, relevant details regarding population, households, income categories etc. are required. Populations and household data can be sourced from census data whereas, it is very difficult to get income data and determine the different income categories. Household assets or per capita floor area can act as an indicator for the income category of a particular household and hence becomes a proxy for the actual income categories characterizing a particular TAZ. Other data required includes percentage of land under different land uses, for each of the TAZs. There are 42 land use categories as mentioned in the previous lecture. Similarly, residential density, job density data is also required for a TAZ. Data on the floor space index is also required and it may be different along different roads or different areas for a particular TAZ. Usually, a uniform value is adopted which can be applied for the entire TAZ. There is also a need to understand the floor space used per activity and the building use.

Existing transportation system (modes, services, and infrastructure)

In the next step, data is collected using both primary surveys and secondary sources for different transportation systems which include the different modes, services and infrastructure that are available. Detail information about road widths, location of bridges, public transit corridors, location of bus stops, para-transit routes etc. are required.

Travel behaviour survey

Finally, a travel behavior survey is conducted to supplement the other datasets, which involves going to selected (sample) households and conducting surveys of every member of the family. The travel patterns of all the members are recorded. Trips made by households are analyzed as per trip purpose and as per the socio economic group of the household. In addition to trips, there is a need to understand tours or the activity pattern undertaken by households. For example, when a person goes to office and then, goes for shopping and finally, comes back from office, it completes a tour and it's likely that he will use the same mode (may be a car) for all the 3 trips even though another mode would have been convenient for one of the intermediate trips. Thus, along with trips which are characterized by their origin and destination, we can also keep record of the tour that is being conducted. Similarly, we can also look at the activity pattern of that particular person all throughout the day because land use is related with activity and different kinds of land uses result in different kinds of activities. Need to perform an activity leads to requirement of trips or tours to be undertaken.

Along with this household survey which is sometimes called as a 'travel diary' survey (will be discussed in detail in a later lecture), surveys are conducted which relate to people's perception for various modes of transport. Time, cost, comfort, safety and security are the primary attributes to be considered when we define choices for different modes in an urban area or a transportation system. Time and cost could be obtained from secondary data sources whereas, data regarding attributes like comfort, safety and security can be obtained by surveying people and recording their perception with respect to these attributes for a particular bus routes or a transportation service.

The number of household surveys that needs to be conducted in an urban area is 1 to 2% of the population, depending on the city size for preparing a comprehensive mobility plan. Considering the Indian scenario, which is characterized by densely populated cities, if a higher percentage is considered, then it will become both time consuming and expensive. Surveying techniques, sample sizes etc. for smaller transportation projects and other kinds of transportation surveys will be covered later.

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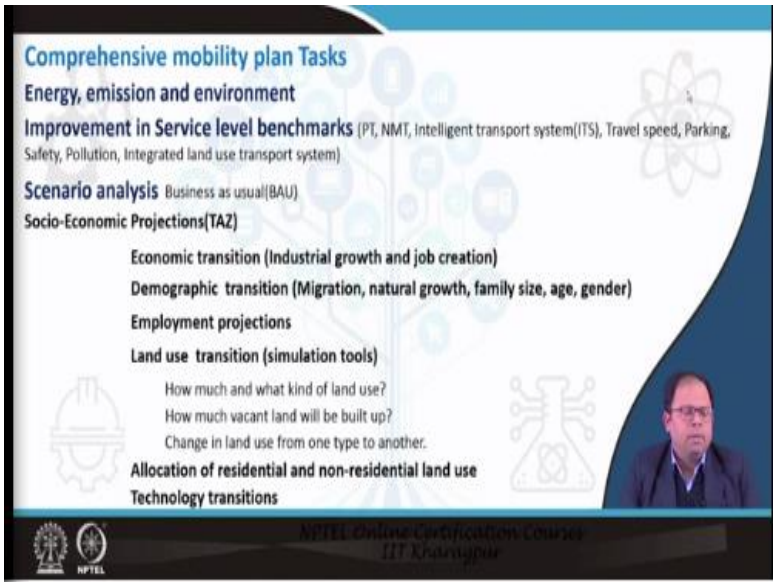

Energy, emission and environment

We also require information about the energy, emission and the environment of an urban area for preparing CMPs.

Improvement in Service level benchmarks

There is also a need to understand the service level benchmarks for a particular urban area and how a CMP can result in improvement with respect to public transit, non-motorized transportation, ITS, travel speed, parking, safety, pollution, integrated land use transport system etc.

Scenario Analysis and socio-economic projections

Next, there is a need to develop different scenarios to decide how the urban area is going to grow over a period of time.

The first scenario is the Business as usual scenario, where nothing special is done to the urban area with respect to infrastructure development, improvement in public transport system etc. In this scenario, the evolution of the existing infrastructure, transportation system and the land use system is ascertained using socio economic projections for each TAZ and then determining their travel behavior.

For each TAZ, change in characteristics of the population, change in the number of jobs, change in the pattern of the household sizes etc. i.e. both economic and demographic transition is determined. Economic transition refers to new industries and job creation whereas, demographic transition includes population growth either from natural growth or due to migration due to availability of jobs. These results in change in the distribution of family size, age, gender etc. Land use transition is also determined by estimating the amount of vacant land consumed and by determining the change in the quantum and type of land use of an urban area.
Another major step is the allocation of residential and non-residential land use and buildings. Allocation of people to new residential buildings will change the demographic characteristics of a particular TAZ. Additionally, technology transitions are also considered which involve knowledge of new modes, new growth areas and other issues that arise out of new technologies.

Travel demand analysis (four stage model)

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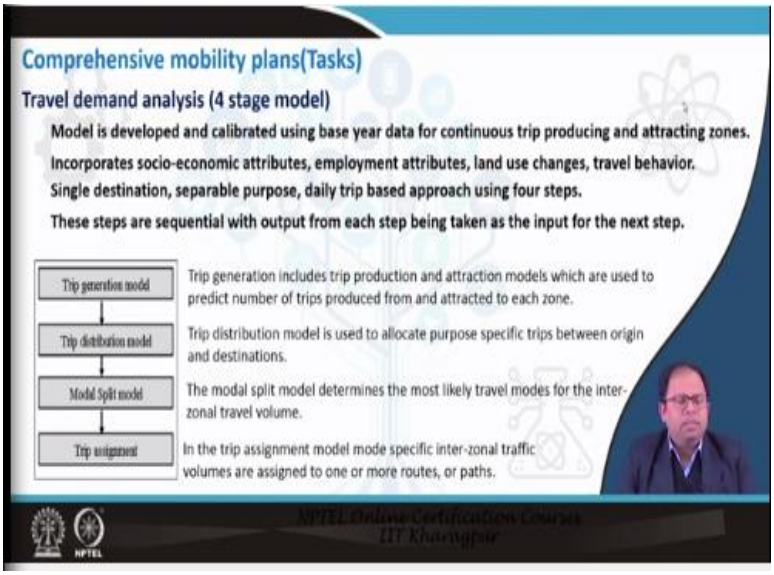

Travel demand analysis is conducted after socio economic projections. While, this could be conducted in different ways, as per the TOR or the terms of reference of a CMP, a 4 stage model including trip generation, trip distribution, model split and trip assignment needs to be developed and calibrated using the base year data. The model is built using data from household surveys and secondary sources and then the model is run to check how much it matches with the existing traffic flows on the road. The model is modified till the point when the prediction or the outcome of the model matches the actual traffic flow and this process is known as the calibration of the model. The calibrated model can be used for predicting traffic flows for future years. Socio economic attributes, employment attributes, land use attributes and the travel behavior of people are incorporated in the development of a 4 stage model.

Usually, the model is for a single destination, which means we predict trips for one single destination, that is, from one TAZ to another TAZ and for separate purposes which means, each trip corresponds to a particular purpose like a work trip, recreation trip, school trip, a return to home trip or a non-home based trip. A person going from office to a meeting is a non-home based trip. Each separate trip purpose is considered while developing the models for trip generation, trip distribution and modal choice. All the 4 steps of the model are sequential and the output from one step is taken as the input for the next step.

The trip generation model includes both trip production and the attraction model. In the trip production model, the total number of trips produced for a particular trip purpose from each of the different kinds of households or individuals are predicted for each TAZ. The number of trips attracted to each TAZ depends on the kind of trip, for example, a work trip depends on the kind of business or retail or offices that are there in a particular zone or the number of jobs that are available in the TAZ, whereas, a school trip depends on the number of institutions or schools or colleges that are there in that particular TAZ.

In the trip distribution model, trips are allocated between origins and destinations, i.e., we need to determine which trip goes to which destination. If a TAZ is producing 100 trips and out of that 20 trips are work trips, then, we need to determine the zones where each of these work trips are destined for. Trip distribution has to be done for each type of trip purpose separately to determine inter zonal travel volume. Next step involves the modal split model where, the most likely travel mode is determined for each inter zonal travel volume. Finally, the route or path along which a person travels is determined in the Trip Assignment model. After the assignment of all the trips, traffic flows are generated along road stretches and corridors which can be matched with actual flows in the real corridors while we calibrate the model. Traffic assignment leads to a feedback i.e., when too many trips are assigned to a corridor, it may actually increase travel time which may even result in change in modal choice or even change in the trip generation process.

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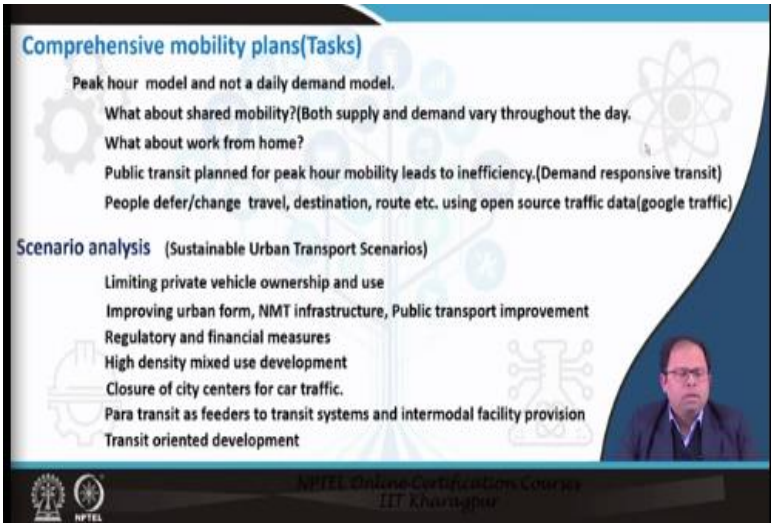

The TOR specifies that, the four stage model needs to be be designed for peak hour periods. Thus, trip choices and route assignments are predicted for peak hours which will determine the maximum load on the existing transit and road infrastructure. Designing for peak hours theoretically takes care of non-peak hours. However, in case of shared mobility where taxi-cabs carry passengers based on their request sent through mobile phones, both the supply i.e., the number of people driving for such taxi-cab companies and the demand i.e., the number of people wishing to use this mode varies throughout the day. Thus, to manage supply and demand a full daily travel demand model is required. Similarly, when a company gives its employees the option to work from home, the employees may shift their travel from the peak hour to a non peak hour or even cancel their travel. This is only possible to be predicted if the travel demand is predicted for the full day. Similarly, if public transit is planned for only peak hour mobility, it will cater the maximum load efficiently. However, certain buses and other infrastructure will remain idle all throughout the day leading to inefficiency. A full daily demand model will be also useful for designing a demand responsive transit where buses are provided as per the requirement and shared between different routes which improve their utilization and the overall transit experience. Thus, a full day travel demand model can be also taken up for future plans.

Real time traffic information data such as Google traffic on congestion etc. has made travel behavior more dynamic. People use this information to choose alternative routes or alternative

travel time or alternative destinations. This kind of feedback are not considered in the preparation of comprehensive mobility plans currently but could be considered in future.

Scenario Analysis (Sustainable Urban Transport Scenarios)

In addition to the business as usual scenario, there is a need to develop alternative scenarios which would actually result in sustainable transportation services and transportation networks and will make the overall transportation system sustainable.

Some of these scenarios listed in the comprehensive mobility plan include limiting private vehicle ownership; improving the urban form such that it reduces the use of gasoline; increasing the use of non-motorized infrastructure and introducing different regulatory and financial measures such as pricing policies which affect the transportation system. The other scenarios include high density mixed use development, closure of the city centers for car traffic, adopting para transit as feeders to transit system and transit oriented development.

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Components of Comprehensive Mobility Plan

The components that needs to be delivered in a comprehensive mobility plan includes; a Integrated land use and urban mobility plan, Public transport improvement plan, Road network

development plan, Non-motorized transportation facility improvement plan, Freight movement plan and Mobility management measures. Along with these, details regarding the fiscal measures, Implementation programs, prioritization of projects, funding sources and also the monitoring of the implementation of the CMP are also required.

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CMPs for smaller cities

While, for the large cities(for the cities with a population more than 0.5 million), we need to develop the CMP as described, smaller cities having a population of less than 0.5 million, neither have the financial resources to execute a CMP nor do they need the full detail plan. Usually there is no public transit network in such cities and people depend on bicycling and walking. Thus, for such small cities, detail computer based model may be avoided and an indicator based approach may be followed. Future travel demand can be estimated based on the total trips generated from each zone and the total trip lengths and then projecting this data using standards. Finally, CO2 emission and air quality dispersion modelling is also optional for smaller cities.

References

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So, these are the 2 documents that can be studied, one is the toolkit which will help in preparing a comprehensive mobility plan and the second is the terms of reference for preparation of a comprehensive mobility plan.

Conclusion

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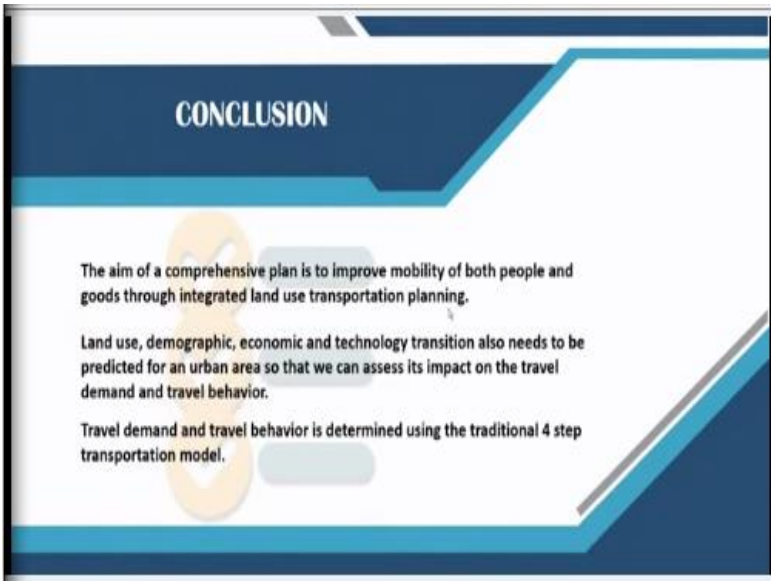

We can conclude this particular lecture by saying that:

The aim of a comprehensive mobility plan is to first improve mobility of both people and goods through integrated land use transportation planning,

Second, land use, demographic, economic and technology transition also needs to be predicted for an urban area. So that we can assess it is impact on the travel demand and travel behavior.

And finally travel demand and travel behavior is determined using the traditional 4 step transportation model.

Thank you.