HIGHAY ENGINEERING ASSIGNMENT 1

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Factor Affecting Traffic Flows

1. Transportation systems analysis

1.1 Goal of Transportation System Analysis

In the last couple of decades transportation systems analysis (TSA) has emerged as a recognized profession. More and more government organizations, universities, researchers, consultants, and private industrial groups around the world are becoming truly multi-modal in their orientation and are as opting a systematic approach to transportation problems. I have added stuff here.

1.1.1 Characteristics

1. *Multi-modal:* Covering all modes or transport; air, land, and sea and both passenger and freight.
2. *Multi-sector:* Encompassing the problems and viewpoints of government, private industry, and public.
3. *Multi-problem:* Ranging across a spectrum of issues that includes national and international policy, planning of regional system, the location and design of specific facilities, carrier management issues, regulatory, institutional and financial policies.
4. *Multi-objective:* National and regional economic development, urban development, environment quality, and social quality, as well as service to users and financial and economic feasibility.
5. *Multi-disciplinary:* Drawing on the theories and methods of engineering, economics, operation research, political science, psychology, other natural and social sciences, management and law.

1.1.2 Context

1. *Planning range:* Urban transportation planning, producing long range plans for 5-25 years for multi-modal transportation systems in urban areas as well as short range programs of action for less than five years.
2. *Passenger transport:* Regional passenger transportation, dealing with inter-city passenger transport by air, rail, and highway and possible with new modes.

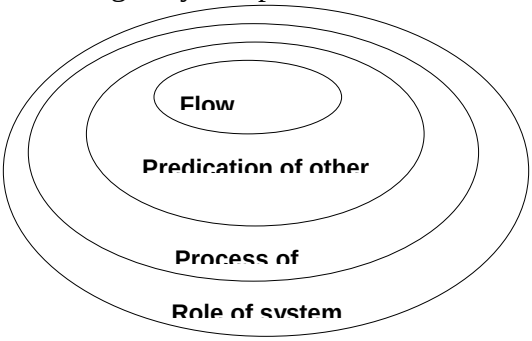

Figure 1:1: Role of transportation system analyst

3. *Freight transport:* routing and management, choice of different modes of rail and truck.
4. *International transport:* Issues such as containerization, inter-modal co-ordination.

1.1.3 Goal of TSA

In spite of the diversity of problems types, institutional contexts and technical perspectives there is an underlying unity: a body of theory and set of basic principles to be utilizes in every analysis of transportation systems. The core of this is the transportation system analysis approach. The focus of this is the interaction between the transportation and activity systems of region. This approach is to *intervene, delicately and deliberately in the complex fabric of society to use transport effectively in coordination with other public and private actions to achieve the goals of that society*. For this the analyst must have substantial understanding of the transportation systems and their interaction with activity systems; which requires understanding of the basic theoretical concepts and available empirical knowledge.

1.1.4 Role of TSA

The methodological challenge of transportation systems is to conduct a systematic analysis in a particular situation which is valid, practical, and relevant and which assist in clarifying the issues to debate. The core of the system analysis is the *prediction of flows*, which must be complemented by the *predication for other impacts*. Refer Fig. 1:1 Predication is only a part of the process of analysis and technical analysis is only a part of the broader problem, and the role of the professional transportation system analysis is to model the process of bringing about changes in the society through the means of transport.

1.1.5 Influence of TSA: Applications

Transportation system analysis can lead to different application specialties and they include:

1. highway engineering
2. freight transportation
3. marine transportation
4. transportation management
5. airport planning
6. port planning and development
7. transportation regulation
8. transportation economics
9. environmental impacts

1.1.6 Influence of TSA: Methodologies

Transportation system analysis can also lead to different methodological specialties and they include:

1. Demand analysis, estimation and forecasting
2. Transportation system performance like delays, waiting time, mobility, etc.
3. policy analysis and implementation
4. urban planning and development
5. land-use management

1.1.7 Influence of TSA: Methodologies

Finally, transportation system analysis can lead to different professional specialties and they include:

1. technical analyst
2. project managers
3. community interaction
4. policy analyst

2. Demand Modelling

Travel demand modelling aims to establish the spatial distribution of travel explicitly by means of an appropriate system of zones. Modelling of *demand* thus implies a procedure for predicting what travel decisions people would like to make given the generalized travel cost of each alternatives. The base decisions include the choice of destination, the choice of the mode, and the choice of the route. Although various modelling approaches are adopted, we will discuss only the classical transport model popularly known as four-stage model (FSM).

The general form of the four stage model is given in Figure 2:2. The classic model is presented as a sequence of four sub models: trip generation, trip distribution, modal split, and trip

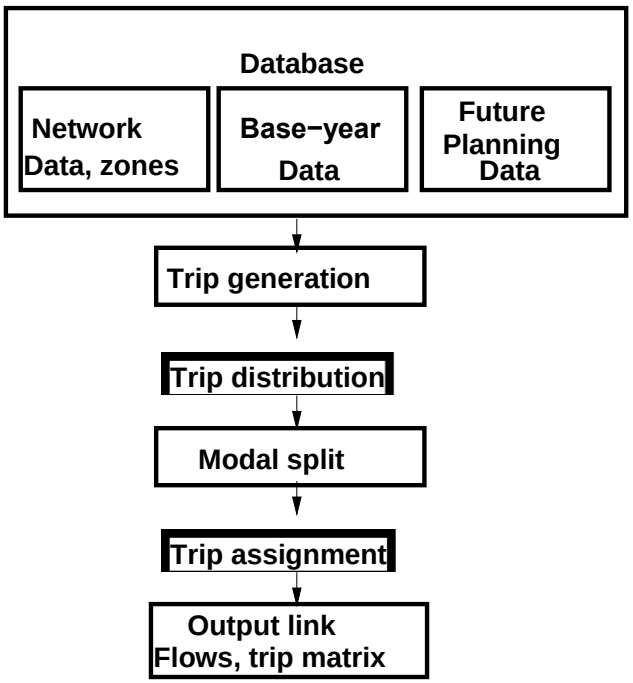

Figure: General form of the four stage modelling

Assignment. The models starts with defining the study area and dividing them into a number of zones and considering all the transport network in the system. The database also include the current (base year) levels of population, economic activity like employment, shopping space, educational, and leisure facilities of each zone. Then the *trip generation* model is evolved which uses the above data to estimate the total number of trips generated and attracted by each zone. The next step is the allocation of these trips from each zone to various other destination zones in the study area using *trip distribution* models. The output of the above model is a trip matrix which denote the trips from each zone to every other zones. In the succeeding step the trips are allocated to different modes based on the modal attributes using the *modal split* models. This is essentially slicing the trip matrix for various modes generated to a mode specific trip matrix. Finally, each trip matrix is assigned to the route network of that particular mode using the *trip assignment models*. The step will give the loading on each link of the network.

The classical model would also be viewed as answering a series of questions (decisions) namely how many trips are generated, where they are going, on what mode they are going, and finally which route they are adopting. The current approach is to model these decisions using discrete choice theory, which allows the lower level choices to be made conditional on higher choices. For example, route choice is conditional on the mode choice. This hierarchical choices of trip is shown in Figure 2:3 The highest level to find all the trips T_i originating from a zone is calculated based on the data and aggregate cost term C_i***. Based on the aggregate travel cost C_{ij}** from zone i to the destination zone j, the probability $p_{m|ij}$ of trips going to zone j is computed and subsequently the trips T_{ij}** from zone i to zone j by all modes and all routes are computed. Next, the mode choice model compute the probability $p_{m|ij}$ of choosing mode m based on the travel cost C_{jm}* from zone i to zone j, by mode m is determined. Similarly, the

route choice gives the trips T_{ijmr} from zone i to zone j by mode m through route r can be computed. Finally the travel demand is loaded to the supply model, as stated earlier, will

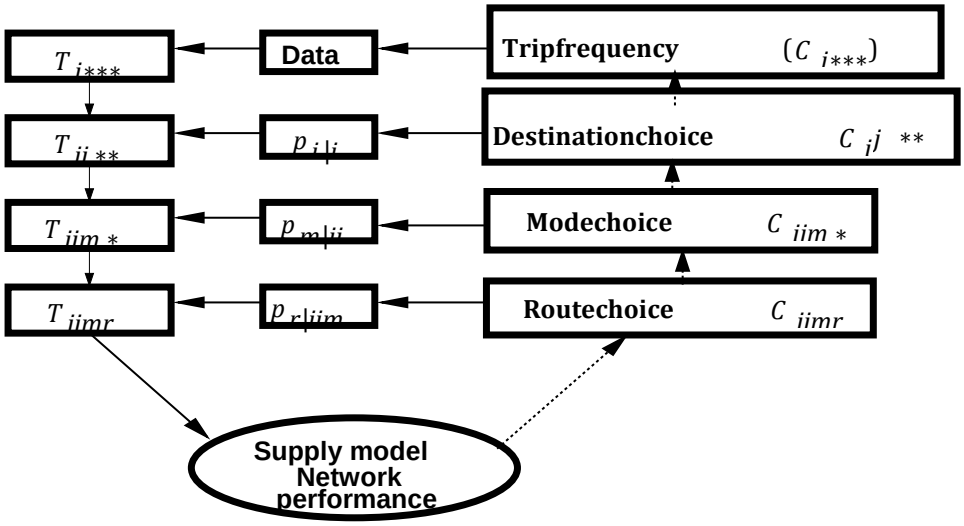

Figure: Demand supply equilibrium

produce a performance level. The purpose of the network is usually measured in travel time which could be converted to travel cost. Although not practiced ideally, one could feed this back into the higher levels to achieve real equilibrium of the supply and demand.

3. Trip Generation

Trip generation is the first stage of the classical first generation aggregate demand models. The trip generation aims at predicting the total number of trips generated and attracted to each zone of the study area. In other words this stage answers the questions to "how many trips" originate at each zone, from the data on household and socioeconomic attributes. In this section basic definitions, factors affecting trip generation, and the two main modelling approaches; namely growth factor modelling and regression modelling are discussed.

Factors affecting trip generation

The main factors affecting personal trip production include income, vehicle ownership, house hold structure and family size. In addition factors like value of land, residential density and accessibility are also considered for modelling at zonal levels. The personal trip attraction, on the other hand, is influenced by factors such as roofed space available for industrial, commercial and other services. At the zonal level zonal employment and accessibility are also used. In trip generation modelling in addition to personal trips, freight trips are also of interest. Although the latter comprises about 20 percent of trips, their contribution to the congestion is significant. Freight trips are influenced by number of employees, number of sales and area of commercial firms.

4. Trip Distribution

The decision to travel for a given purpose is called trip generation. These generated trips from each zone is then distributed to all other zones based on the choice of destination. This is called trip distribution which forms the second stage of travel demand modelling. There are a number of methods to distribute trips among destinations; and two such methods are growth factor model and gravity model. Growth factor model is a method which respond only to relative growth rates at origins and destinations and this is suitable for short-term trend extrapolation. In gravity model, we start from assumptions about trip making behaviour and the way it is influenced by external factors. An important aspect of the use of gravity models is their calibration that is the task of fixing their parameters so that the base year travel pattern is well represented by the model.

5. Modal split

The third stage in travel demand modelling is modal split. The trip matrix or O-D matrix obtained from the trip distribution is sliced into number of matrices representing each mode. First the significance and factors affecting mode choice problem will be discussed. Then a brief discussion on the classification of mode choice will be made. Two types of mode choice models will be discussed in detail. ie binary mode choice and multinomial mode choice. The chapter ends with some discussion on future topics in mode choice problem.

Factors influencing the choice of mode

The factors may be listed under three groups:

1. **Characteristics of the trip maker** : The following features are found to be important:
   (a) car availability and/or ownership;
   (b) possession of a driving license;
   (c) Household structure (young couple, couple with children, retired people etc.);
   (d) income;
   (e) decisions made elsewhere, for example the need to use a car at work, take children to school, etc.;
   (f) Residential density.
2. **Characteristics of the journey**: Mode choice is strongly influenced by:
   (a) The trip purpose; for example, the journey to work is normally easier to undertake by public transport than other journeys because of its regularity and the adjustment possible in the long run;
   (b) Time of the day when the journey is undertaken.
   (c) Late trips are more difficult to accommodate by public transport.
3. **Characteristics of the transport facility**: There are two types of factors. One is quantitative and the other is qualitative. Quantitative factors are:
   (a) relative travel time: in-vehicle, waiting and walking times by each mode;

(b) relative monetary costs (fares, fuel and direct costs);

(c) availability and cost of parking

Qualitative factors which are less easy to measure are:

(a) comfort and convenience

(b) reliability and regularity

(c) protection, security

A good mode choice should include the most important of these factors.

Types of modal split models

Trip-end modal split models

Traditionally, the objective of transportation planning was to forecast the growth in demand for car trips so that investment could be planned to meet the demand. When personal characteristics were thought to be the most important determinants of mode choice, attempts were made to apply modal-split models immediately after trip generation. Such a model is called trip-end modal split model. In this way different characteristics of the person could be preserved and used to estimate modal split. The modal split models of this time related the choice of mode only to features like income, residential density and car ownership.

The advantage is that these models could be very accurate in the short run, if public transport is available and there is little congestion. Limitation is that they are insensitive to policy decisions example: Improving public transport, restricting parking etc. would have no effect on modal split according to these trip-end models.

Trip-interchange modal split models

This is the post-distribution model; that is modal split is applied after the distribution stage. This has the advantage that it is possible to include the characteristics of the journey and that of the alternative modes available to undertake them. It is also possible to include policy decisions. This is beneficial for long term modeling.

Aggregate and disaggregate models

Mode choice could be *aggregate* if they are based on zonal and inter-zonal information. They can be called *disaggregate* if they are based on household or individual data.

6. Trip Assignment

The process of allocating given set of trip interchanges to the specified transportation system is usually referred to as trip assignment or traffic assignment. The fundamental aim of the traffic assignment process is to reproduce on the transportation system, the pattern of vehicular movements which would be observed when the travel demand represented by the trip matrix, or matrices, to be assigned is satisfied. The major aims of traffic assignment procedures are:

1. To estimate the volume of traffic on the links of the network and obtain aggregate network measures.
2. To estimate inter zonal travel cost.
3. To analyse the travel pattern of each origin to destination (O-D) pair.
4. To identify congested links and to collect traffic data useful for the design of future junctions.