10CV843

USN 1CR14CV011

Eighth Semester B.E. Degree Examination, June/July 2018
Urban Transport Planning

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. ***Assume suitable data wherever necessary.***

PART – A

1 a. Define "System Approach". Explain with flow diagram, system approach to Transport Planning. **(10 Marks)**
b. Explain briefly the various stages involved in Transportation Planning Process. **(10 Marks)**

2 a. Define "Zone". Mention the different factors considered in dividing the whole area into zones. **(10 Marks)**
b. Explain the inventory of Transportation Facilities. **(05 Marks)**
c. Explain with sketch, about the basic movements in transportation survey. **(05 Marks)**

3 a. Explain Home – Based and Non – Home Based trip. **(05 Marks)**
b. Explain the assumptions made in categories analysis. **(06 Marks)**
c. Let the trip rate of zone is explained by the household size done from the field survey. It was found that the household size are 1,2, 3 and 4. The trip rates of the corresponding household is shown in the table below. Fit a linear equation relating trip rate and household size. **(09 Marks)**

House Hold Size (x)

	1	2	3	4
Trips	1	2	4	6
Per	2	4	5	7
Day (y)	2	3	3	4
Σ(y)	5	9	12	17

4 Write a short note on :
a. Study area.
b. Expansion of Data from samples.
c. Trip distribution.
d. Home interview surveys. **(20 Marks)**

PART – B

5 a. Explain Average growth factor methods in Trip distribution. **(05 Marks)**
b. Explain Fratar method in trip distribution. **(05 Marks)**
c. The base year trip matrix for a study area consisting of three zones is given below.

	1	2	3	O_i
1	20	30	28	78
2	36	32	24	92
3	22	34	26	82
d_j	88	96	78	252

The productions from the zone 1, 2, and 3 for the horizon year is expected to grow to 98, 106 and 122 respectively. The attractions from these zones are expected to increase to 102, 118, 106 respectively. Compute the matrix for the horizon year using doubly constrained growth factor model using Furness method. **(10 Marks)**

6 a. Define Modal split and explain in brief the factors affecting modal split. **(10 Marks)**
b. Explain advantages and disadvantages of Pre – distribution modal split. **(05 Marks)**
c. Draw the flow diagram for Modal split carried out after trip distribution. **(05 Marks)**

7 a. Explain the application of the traffic assignment. **(05 Marks)**
b. Write a flow chart of fundamental structure of Lowry Model. **(05 Marks)**
c. List the various assignment techniques and explain any two methods. **(10 Marks)**

8 Write short notes on :
a. Difficulties in transport planning for small and medium cities.
b. Quick response techniques.
c. Grain – Lowry model.
d. Furness method. **(20 Marks)**

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VTU Semester Examination –June 2018
Solutions

Sub:	Urban Transport Planning	**Code:**	10CV843
Sem:	VIII	**Branch :**	CIVIL

1. (a) Explain "Systems Approach". Explain with flow diagram, systems approach to transport planning.

SYSTEM APPROACH TO TRANSPORT PLANNING

Urban-transport planning is a continuous process involving an interactionbetween government and the urban community. The appraisal of conditionswithin the community leads to a choice among alternative actions within the government and hopefully to the alleviation of unsatisfactory conditions through the implementation of the chosen action. Some evidence has been introduced above which suggests that the transport-planning process most commonly used has not been entirely successful in the alleviation oftransport-related issues in many urban communities.

In the process the methodology was further refined and applied to various planning contexts. Steps involved in applying the original methodology after the conduct of planning inventories and surveys (e.g., land-use data, economic investigations, and travel surveys) and the postulation and calibration of models forecasting land use and travel demand to fit local conditions.

Step 1: Forecasts for the target year of the regional population and economic growth for the subject metropolitan area.

Step 2: Allocation of land uses and socioeconomic projections to individual analysis zones according to land availability, local zoning and related public policies.

Step 3: Specification of alternative transportation plans partly based on the results of step1 & 2

Step 4: Calculation of the capital and maintenance costs of each alternative plan.

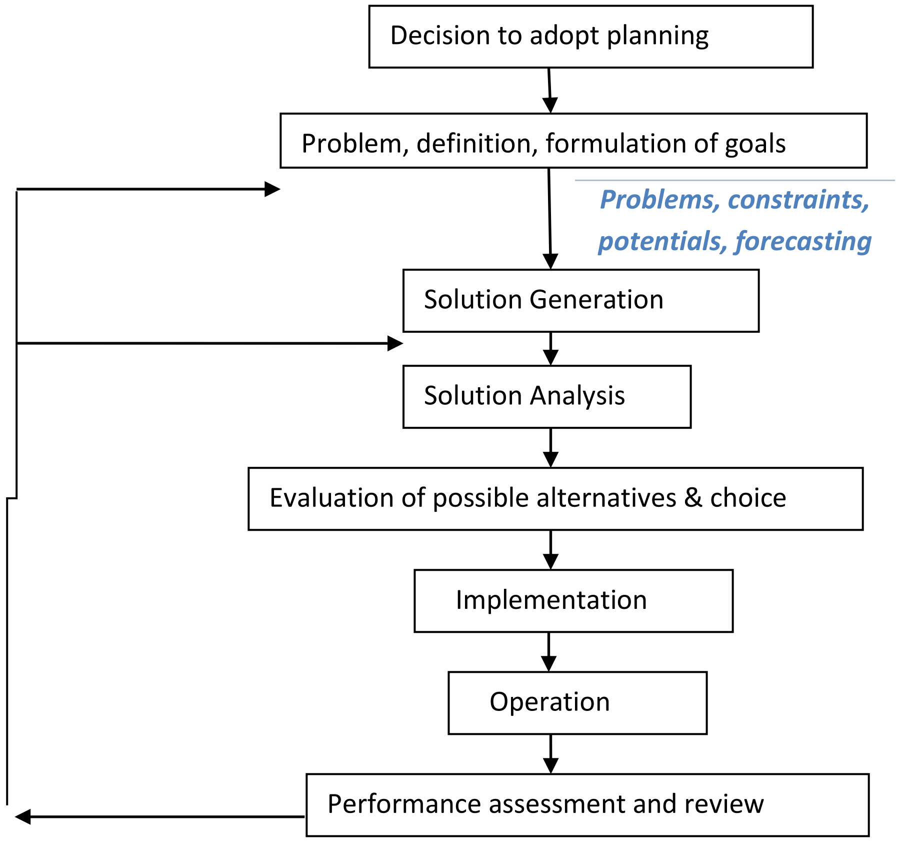
Step 5: Application of calibrated demand-forecasting models to predict the target year equilibrium flows expected to use each alternative, given the land-use and socioeconomic projections of step 2 and the characteristics of the transportation alternative (step 3).

Step 6: Conversion of equilibrium flows to direct user benefits, such as savings in travel time & travel cost attributable to the proposed plan.

Step 7: Comparative evaluation and selection of the best of the alternatives analyzed based on estimated costs (step 3) and benefits (step 6).

Step 8: Based on the step 7 once best plan is identified, then the transportation plan is implemented and operated.

This methodology was refined and expanded to cover additional social, economic, and environmental benefits and costs; to admit a wider range of multimodal transportation alternatives; to be more sensitive to the relationship between land-use and transportation planning; and to admit multiagency and public participation.



(b) Explain briefly the various stages involved in Transportation Planning process.

The first phase of the transportation planning process deals with surveys, data collection and inventory. The next phase is the analysis of the data so collected and building models to describe the mathematical relationship that can be discerned in the trip making behaviour.

Trip Generation:

Trip generation in transportation planning process is to cover the field of calculating the number of tripends in a given area. It has been pointed out that theprincipal task of the trip-generation analysis phase is to relate the intensity oftripmaking to and from land-use parcels to measures of the type and intensity ofland use.

A trip is a one-way person movement by a mechanical mode of transport, having two trip ends, an origin and a destination.

Two types of trip-generation analysis are carried out and these are normallyreferred toby the terms **trip** ***production (generation)*** and ***trip attraction.*** The term **trip** ***production (generation)***is reserved for trips generated by residential zones where these trips may be trip origins or trip destinations. The term**trip*attraction*** is used todescribe trips generated by activities at the nonhome end of a home-based tripsuch as employment, retailservices, and so on.

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 modeling. 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 responds 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 behavior 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.

Modal Split

The third stage of travel demand forecasting process has been identified as captive modal split analysis. The modal split analysis was identified as occurring after the trip distribution analysis phase. Two submarkets for public transportation services have been labelled as captive transit riders and choice transit riders. The aim of captive modal split analysis is to establish relationships that allow the trip ends estimated in the trip generation phase to be partitioned into captive transit riders and choice transit riders. The purpose of choice modal split analysis phase is to estimate the probable split of choice transit riders between public transport and car travel given measures of generalized cost of travel by two modes. The ratio of choice trip makers using a public transport system varies from 9 to 1 in small cities with poorly developed public transport systems to as high as 3 to 1 in well developed cities.

Major determinants of Public Patronage are 1. Socio economic characteristics of trip makers 2. Relative cost and service properties of the trip by car and that by public transport. Variables used to identify the status at the household level are 1. Household income or car ownership directly 2. The number of persons per household. 3. The age and sex of household members. 4. The purpose of the trip.

Traffic Assignment

The process of allocating given set of trip interchanges to the specified transportation system is usually referred to as 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 analyze 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.

2 (a) Define “Zone”. Mention the different factors considered in dividing the whole area into zones.

ZONING

The defined study area is sub-divided into smaller areas called zones. The purpose of such a sub-division is to facilitate the spatial quantification of land use and economic factors which influence travel pattern. The data collected on individual household basis cannot be conveniently considered and analysed unless they are aggregated into small zones. Sub-division into zones further helps in geographically associating the origins and destinations of travel. In large study projects, it is more convenient to divide the study area into sectors, which are sub-divided into smaller zones. A convenient system of coding of the zones will be useful for the study. One such system is to divide the study area into 9 sectors. Each sector is sub-divided into 10 zones. A sub-zone bearing a number 481 belongs to sector 4 and to zone 8 in that sector and is sub-zone 1 in that zone. Zones are modelled as if all their attributes and properties were concentrated in a single point called the zonecentroid. The centroids are connected to the nearest road junction or rail station by centroid connectors. Both centroid and centroid connectors are notional and it is assumed that all people have same travel cost from the centroid to the nearest transport facility which is the average for a zone. The intersection from outside world is normally represented through external zones.

The external zones are defined by the catchment area of the major transport links feeding to the study area. Although the list is not complete, few guidelines are given below for selecting zones.

1. Zones should match other administrative divisions, particularly census zones.

2. Zones should have homogeneous characteristics, especially in land use, population etc.

3. Zone boundaries should match cordon and screen lines, but should not match major roads.

4. Zones should be as smaller in size as possible so that the error in aggregation caused by the assumption that all activities are concentrated at the zone centroids is minimum.

5. The zones should have a homogenous land use.

6. Natural or physical barriers such as canals, rives etc can form convenient zone boundaries.

7. Zones boundaries should preferably be water-shed of trip making.

8. The zones should preferably have regular geometric form for easily determining the centroid which represents the origin and termination of travel.

9. Sectors should represent the catchment of trips generated on a primary route.

10. Land-use is the most important factor in establishing zones for a transportation survey. It is only when the origin and destination zones reflect properly the land-use can traffic generated within the zones be predicted, measured and quantified accurately.

(b) Explain the inventory of transportation facilities.

Inventory of Transport Facilities

The inventory of existing transport facilities should be under taken to identify the deficiencies in the present system and the extent to which they need to be improved. The inventory consists of:

1. Inventory of streets forming the transport network
2. Traffic volume, composition, peak and off-peak
3. Studies on travel time by different modes
4. Inventory of public transport buses
5. Inventory of rail transport facilities
6. Parking inventory
7. Accident data

Inventory of streets:
An understanding of the extent and quanlity of the road network is very important to formulate plans for future. The inventory should cover details such as classification of the street system, length, cross-sectional dimensions, type and condition of the surface, capacity, intersections, control devices, structures, street furniture, etc.

Traffic volume:
Data pertaining to traffic volume and its composition will be needed to check on the survey data collected by the home-interview and cordon surveys. The variation of the traffic volume over different hours of the day, different days of the week and different months of the year is also needed.

Travel time studies:
An estimate of travel times between different zones by various modes is necessary for transport planning. Travel times are usually measured for the peak-hour conditions and non-peak hour conditions.

Inventory of public transport buses:

The inventory of public transport buses includes information on the total number of buses, their capacity, schedules, routes, operating speeds, terminals, number of passengers carried, economic picture of the public transport system and the fare structure.

Inventory of rail transport facilities:
The inventory of rail transport facilities should include the length, capacity, schedules, operating speeds, stations, number of passengers carried, economic picture of the rail transport undertaking and the fare structure.

Parking Inventory:
The parking inventory should collect information on the existing on-street and off-street parking facilities, the parking demand and utilization of existing facilities. Data on parking charges and the system used for charging should also be collected.

Accident data:
Accident data over the past years will help to understand the nature and extent of the hazards inherent in the present system and the need to improve the situation.

(c) Explain with neat sketch about the basic movements in transportation survey.

Types of Surveys

The basic movements for which survey data are required are:

1. Internal to Internal
2. Internal to External
3. External to Internal
4. External to External

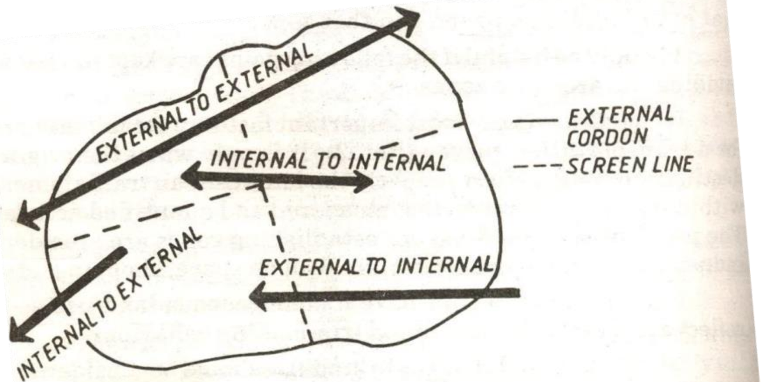
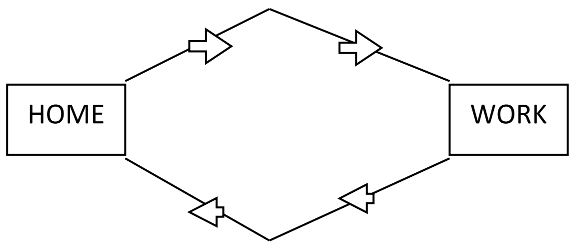


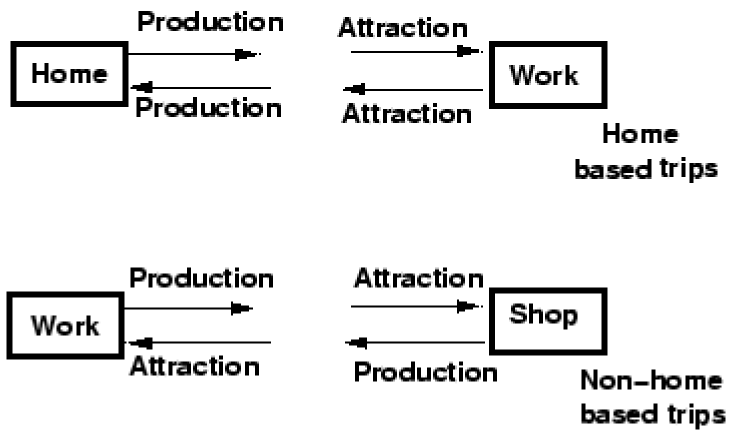
Fig. 30·1. Basic movements in a transportation survey.

For large urban areas, the internal to internal travel is heavy whereas for small areas having a small population the internal to internal travel is insignificant. The internal to internal travel is best studied by the home interview technique with checks by screen-line surveys. The internal to external, external to internal and external to external travels can be studied by cordon surveys and also be surveyed by home interview technique.

3. (a) **Explain Home-based and Non-home based trip.**

Consider a trip from home to work and return trip from work to home. Both these trips are home based, because one end of the trips is home. Both these trips are considered to have been generated at the home zone and attracted to the work zone. Thus have two work purpose trip ends generations in the home zone and two work purpose attractions in the work zone.





trip types

Consider another example of the trip from the place of work to shop and return to the place of work, as it is usual during the lunch recess. Both these trips are non-home based, because neither end of the trip is the home of the person making the trip. Both these trips are considered to have been generated at the work zone and attracted to the shop zone. Thus have two shopping purpose trip end generation (production) in the work zone and two shopping purpose attraction in the shopping zone.

(b) **Explain the assumptions made in category analysis**.

Assumptions Made in Category analysis

- The Household is the fundamental unit in the trip generation process & most journeys begins or End in response to requirements of family
- The trips generated by the household depend upon the characteristics of that household and its location relative to its required facilities. such as Schools, Shops & work place.
- House holds with one set of characteristics generate different rates of trips from households with other set of characteristics
- only three factors as Car-ownership, Income and household Structures are affecting the amount of household travel. a ~~household hoods~~
- within Each of above three factors, a limited no. of ranges can be Established so as to describe limited trip generating Capacity of household by limited no. of Categories.

(C) Let the trip rate of a zone is explained by the household size done from the fiels survey. It was found that the household size are 1,2 ,3 and 4. The trip rates of the corresponding household are shown in the table below. Fit a linear equation relating trip rate ad household size.

Household size(x)				
	1	2	3	4
Trips	1	2	4	6
per	2	4	5	7
day(y)	2	3	3	4
Σy	5	9	12	17

Solution The linear equation will have the form $y = bx + a$ where y is the trip rate, and x is the household size, a and b are the coefficients. For a best fit, b is given by

$$
\begin{aligned}
b &= \frac{n\Sigma xy - \Sigma x \Sigma y}{n\Sigma x^2 - (\Sigma x)^2} \\
a &= \bar{y} - b\bar{x} \\
\Sigma x &= 3 \times 1 + 3 \times 2 + 3 \times 3 + 3 \times 4 = 30 \\
\Sigma x^2 &= 3 \times (1^2) + 3 \times (2^2) + 3 \times (3^2) + 3 \times (4^2) = 90
\end{aligned}
$$

$$
\begin{aligned}
\Sigma y &= 5+9+12+17=43 \\
\Sigma xy &= 1\times 1+1\times 2+1\times 2 \\
&+ 2\times 2+2\times 4+2\times 3 \\
&+ 3\times 4+3\times 5+3\times 3 \\
&+ 4\times 6+4\times 7+4\times 4 \\
&= 127 \\
\bar{y} &= 43/12 = 3.58 \\
\bar{x} &= 30/12 = 2.5 \\
b &= \frac{n\Sigma xy - \Sigma x\Sigma y}{n\Sigma x^2 - (\Sigma x)^2} \\
&= \frac{((12\times 127)-(30\times 43))}{((12\times 90)-(30)^2)} = 1.3 \\
a &= \bar{y} - b\bar{x} = 3.58 - 1.3\times 2.5 = +0.33 \\
\bar{y} &= 1.3x - 0.33
\end{aligned}
$$

Hence the linear equation is $\bar{y} = 1.3x - 0.33$

4. Write short notes on:

(a) Study area :

Transportation planning can be at the national level, regional level or at the urban level. For planning at the urban level, the study area should embrace the whole conurbation containing the existing and potential continuously built-up areas of the city. The imaginary line representing the boundary of the study area is termed as the 'external cordon'. The area inside the external cordon line determines the travel pattern to a large extent and as such is surveyed in great detail.

(b) Expansion of data from samples:

In order to derive the travel characteristics of the whole population from the data derived from sampling, certain expansion factors have to be used. For the home-interview surveys, the expansion factor is calculated on a zonal basis as follows:

Expansion factor

$$= \frac{A-\left(C+\frac{C}{B}*D\right)\frac{A}{B}}{B-C-D}$$

Where, A = Total number of addresses in the original list.

B = Total number of addresses selected as original sample.

C = Number of sample addresses that are ineligible.

D = Number of sample addresses where no response is obtained.

(c) **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 modeling. 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 responds 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 behavior 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.

(d) **Home interview surveys**

Home-Interview survey is one of the most reliable type of surveys for collection of origin and destination data.

The survey is essentially intended to yield data on the travel pattern of the residents of the household and the general characteristics of the house-hold influencing trip-making. The information on travel pattern includes number of trips made, their origin and destination, purpose of trip, travel mode, time of departure from origin and time of arrival at destination and so on. The information on household characteristics includes type of dwelling unit, number of residents, age, sex, race, vehicle ownership, number of drivers, family income and so on. Based on these data it is possible to relate the amount of travel to household and zonal characteristics and develop equations for trip generation rates.

It is impractical and unnecessary to interview all the residents of the study area. Since travel patterns tend to be uniform in a particular zone, it is sufficient if a sampling procedure is employed. The size of the sample is usually determined on the basis of the population of the study area.

B.P.R.(Bureau of Public Roads) standards for Sampling Size for Home Interview Survey

Population of Study Area	Sample Size
Under 50,000	1 in 5 households
50,000 – 150,000	1 in 8 households
150,000 – 300,000	1in 10 households
300,000 –500,000	1 in 15 households
500,000 – 1,000,000	1 in 20 households
Over 1,000,000	1 in 25 households

The above standards are perhaps too costly to practice. In any case, the sample size should not be less than given in table

Minimum Sampling Size for Home Interview Survey

Population of Study Area	Minimum sample size
Under 50,000	1 in 10 households
50,000 to 150,000	1 in 20 households

150,000 to 300,000	1 in 35 households
300,000 to 500,000	1 in 50 households
500,000 to 1,000,000	1 in 70 households
Over 1,000,000	1 in 100 households

PART- B

5 (a) Explain Average growth factor methods in Trip Distribution.

In this method an average of two zonal growth factors is applied to the base year trips to arrive at a forecast for the design year.

$$T_{ij}^{h} = t_{ij}^{b} * \frac{F_i + F_j}{2}$$

Where F_i & F_j are growth factors for zone i&j respectively.

(c) Explain Fratar Method in trip distribution.

Several naive trend or simple growth factor models have been developed for use in special situations. Among these the Fratar model is often used to estimate external trips. That

is trips that are either produced and/or are attracted outside the boundaries of the region under study from outlying areas whose character is not explicitly analyzed. The Fratar growth-factor method uses the following expression to synthesize horizon year trip- interchange magnitudes:

$$T_{ij}^{h} = T_{ij}^{b} * F_i * F_j * \frac{L_i + L_j}{2}$$

Where, $$L_i = \frac{\sum_j T_{ij}^{b}}{\sum_j T_{ij}^{b} * F_j}$$

$$L_j = \frac{\sum_i T_{ij}^{b}}{\sum_i T_{ij}^{b} * F_i}$$

T_{ij}^{h} = The number of vehicle trips between zones i& j in the horizon year.

T_{ij}^{b} = The number of vehicle trips between zones i & j observed in the base year.

F_i , F_j = the growth factor for zones i& j which reflect the growth in trip productions and trip attractions expected between the base and horizon years where

L_i , L_j = the locational factors

(C) The base year trips matrix for a study area consisting of three zones is given below.

	1	2	3	Oi
1	20	30	28	78
2	36	32	24	92
3	22	34	26	82

Di	88	96	78	252

The productions from the zone 1, 2 and 3 for the horizon year is expected to grow to 98, 106 and 122 resp. The attractions form the zones are expected to increase to 102, 118 and 106 resp. Compute the matrix for the horizon year using doubly constrained growth factor model using Furness method.

Solution The sum of the attractions in the horizon year, i.e. $\Sigma O_i = 98+106+122 = 326$. The sum of the productions in the horizon year, i.e. $\Sigma D_j = 102+118+106 = 326$. They both are found to be equal. Therefore we can proceed. The first step is to fix $b_j = 1$, and find balancing factor a_i. $a_i = O_i/o_i$, then find $T_{ij} = a_i \times t_{ij}$

So $a_1 = 98/78 = 1.26$

$a_2 = 106/92 = 1.15$

$a_3 = 122/82 = 1.49$ Further $T_{11} = t_{11} \times a_1 = 20 \times 1.26 = 25.2$. Similarly $T_{12} = t_{12} \times a_2 = 36 \times 1.15 = 41.4$. etc. Multiplying a_1 with the first row of the matrix, a_2 with the second row and so on, matrix obtained is as shown below.

	1	2	3	o_i
1	25.2	37.8	35.28	98
2	41.4	36.8	27.6	106
3	32.78	50.66	38.74	122
d_j^1	99.38	125.26	101.62	
D_j	102	118	106	

Also $d_j^1 = 25.2 + 41.4 + 32.78 = 99.38$

In the second step, find $b_j = D_j/d_j^1$ and $T_{ij} = t_{ij} \times b_j$. For example $b_1 = 102/99.38 = 1.03$, $b_2 = 118/125.26 = 0.94$ etc.,$T_{11} = t_11 \times b_1 = 25.2 \times 1.03 = 25.96$ etc. Also $O_i^1 = 25.96 + 35.53 + 36.69 = 98.18$. The matrix is as shown below:

	1	2	3	o_i	O_i
1	25.96	35.53	36.69	98.18	98
2	42.64	34.59	28.70	105.93	106
3	33.76	47.62	40.29	121.67	122
b_j	1.03	0.94	1.04		
D_j	102	118	106		

	1	2	3	O_i^1	O_i
1	25.96	35.53	36.69	98.18	98
2	42.64	34.59	28.70	105.93	106
3	33.76	47.62	40.29	121.67	122
d_j	102.36	117.74	105.68	325.78	
D_j	102	118	106	326	

Therefore error can be computed as ; $Error = \Sigma|O_i - O_i^1| + \Sigma|D_j - d_j|$

$$\text{Error} = |98.18-98| + |105.93-106| + |121.67-122| + |102.36-102| + |117.74-118| + |105.68-106| = 1.32$$

6 (a) Define Modal Split and explain in brief the factors affecting Modal Split.

Modal split is a process of separating person trips by the mode of travel. It is expressed as a fraction, ratio or percentage of total number of trips. It refers to the trips made by private car as opposed to public transport and useful to understand the future transportation pattern.

Factors affecting Modal split

6.1.1 Socioeconomic characteristic of the trip makers

a. House hold income or car ownership directly increase the travel mode options available to the members of the family
b. The family size, especially the dependent members and the money available per person for travel needs
c. The age and sex of the family members especially the lower age members have more chance to use transit systems

6.1.2 Characteristics of the trip

a. Trip distance
b. Time of the day
c. Trip purpose is one of the major factors, e.g. person choosing mass transit to travel at work place in a day time would prefer to use private automobile, if available, for social trips at night.

6.1.3 Characteristics of the transportation system

a. Travel time

In-vehicle travel time, which is more especially in big cities when using say road vehicle than the rail transport

Out-of-vehicle travel time, which defines the access condition related to the transit system.

b. Travel cost associated with the mode i.e. vehicle operating cost, parking cost, transit fares, etc.
c. Reliability, an important factor explaining the confidence level user can have in mode frequencies, on time movement, all weather operations, etc.
d. Comfort and convenience

(B) Explain the advantages and disadvantages of Pre-distribution modal split.

Advantages:

Less difficult and less costly

Separate public transport and private car distribution afforded by this method is desirable

Reflects factors like income, car-ownership, family structure, employment

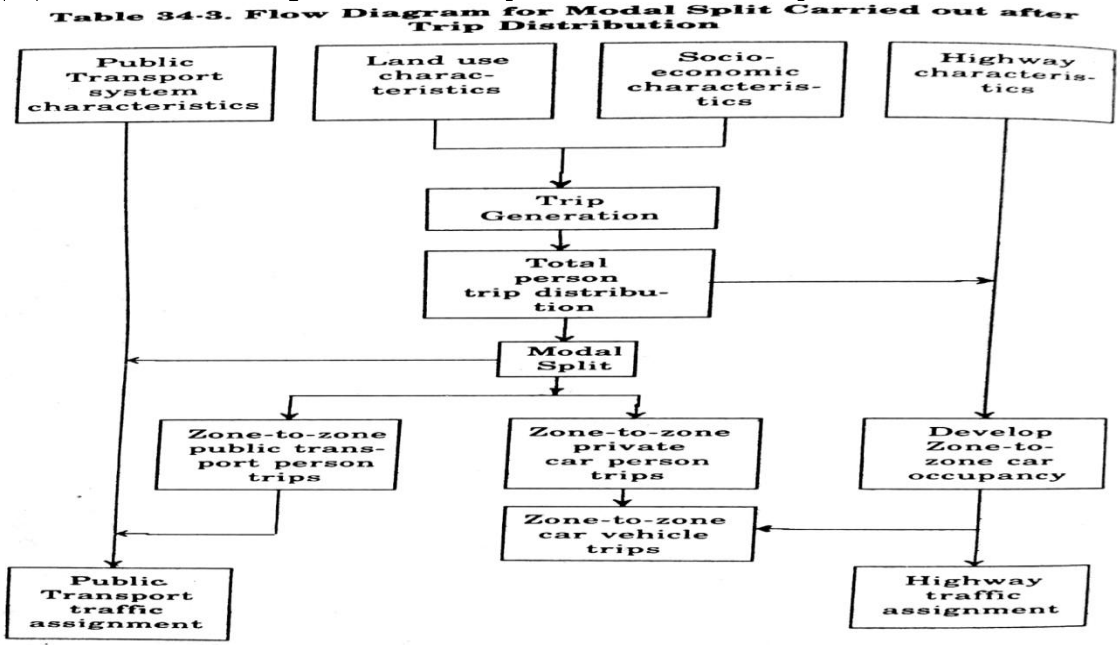
Dis Advantages:

Linked with existing and historical levels of public transport service

But inappropriate to studies involving planning of improvements to public transport systems where different LOS are contemplated

Characteristics based on average area – wide basis no zone-zone combination
Does not consider the trip generation characteristics
Insensitive to future developments

(C) Draw the flow diagram for modal split carried out after trip distribution.



7 (a) Explain the application of traffic assignment.

Applications of Trip Assignment

Some of the applications of traffic assignment analysis to the network are:

1. To determine the deficiencies in the existing transport system by assigning the future trips to the existing transport system.
2. To evaluate the effects of limited improvements and additions to the existing transport system by assigning estimated future trips to the improved networks.
3. To develop construction priorities by assigning estimated future trips for the intermediate years to the transport system proposed for those years.
4. To test alternative transportation system proposals by systematic and readily repeatable procedures.
5. To provide design hour volumes on highway and turning movements at junctions.

Thus the assignment processes is applicable for both transport planners and highway facility design engineers. The main need of traffic assignment processes is to evaluate:

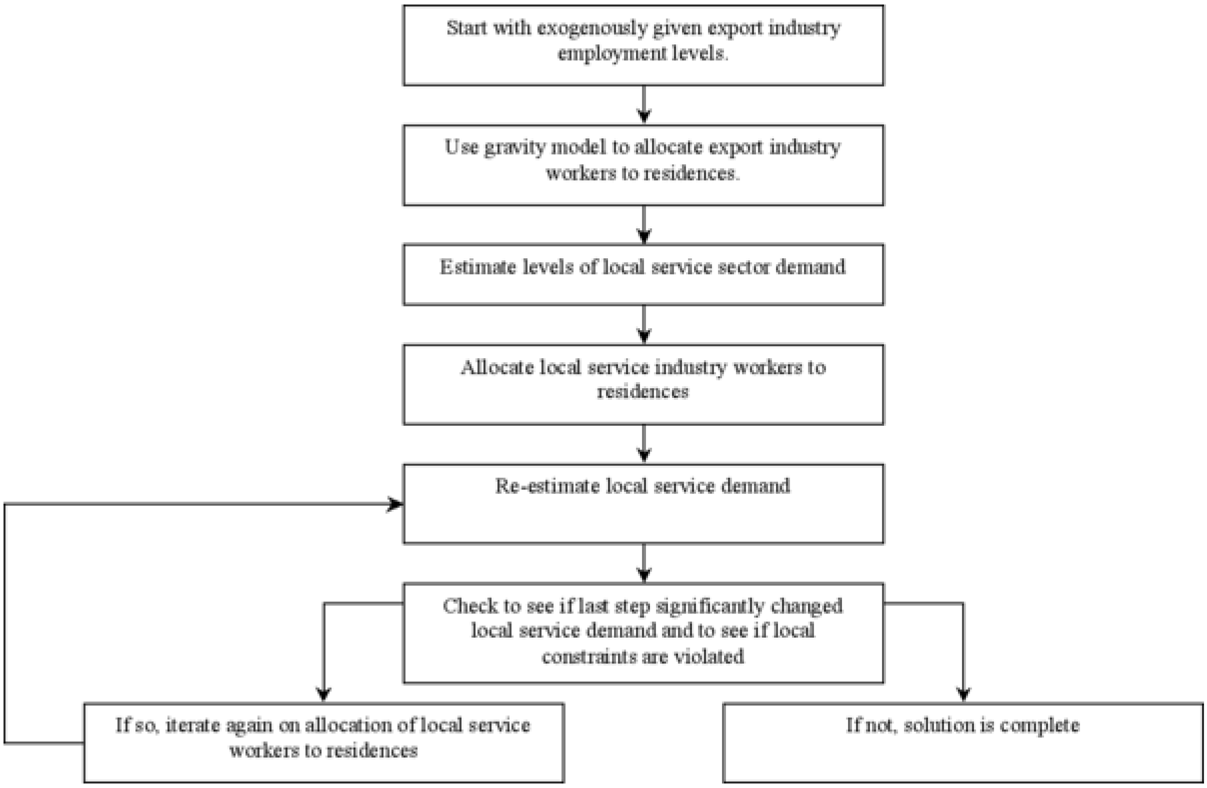
 How the proposed transport system will work presently, and to the latter date.
 For the geometric design of highways and intersections.

Developments in computer technology made it possible to facilitate traffic assignment techniques computations so laborious. A computer network assignment procedure requires:

 A way of coding the modal network for computer processing.
 An understanding of the factors affecting the trip-maker’s path preferences.
 A computer algorithm that is capable of producing the trip-maker’s preferred paths.

For computer analysis, the network is coded, key punched and stored in the computer memory.

(b) Write a flow chart of fundamental structure of Lowry Model.



(c) List the various assignment techniques and explain any two methods.

The following are the various techniques of assignment available.

- All or nothing assignment
- Multiple route assignment
- Capacity restraint assignment
- Diversion curves

Diversion Curves:

Diversion curve models was developed in early 1950s to know how many drivers would be diverted from arterial streets to a proposed freeway in order to make decisions related to the geometric design and capacity of proposed urban freeways. This model employs empirically derived curves to compute the percentage of trips that would use the freeway in route between two points on some measure of relative impedance between the freeway route and the fastest arterial route between the two points.

California diversion curves

These curves used travel-time and travel-distance differences between two alternative paths to estimate the percentage of trips that would use the freeway.

The formula for determining percentage usage of the freeway in route between two points is given by

$$P = 50 + \frac{50(d + 0.5t)}{[(d - 0.5t)^2 + 4.5]^{0.5}}$$

Where

p = percentage usage,

d = distance saved in miles,

t = time saved in minutes,

The diversion curve developed by California diversion curve method is shown in figure 8.4.

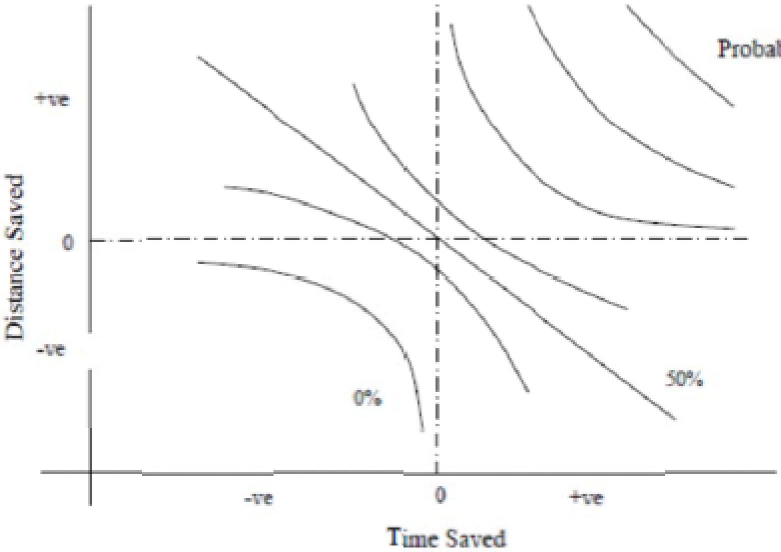


Figure 8.4 California diversion curves

All-or-nothing assignment:

In this method the trips from any origin zone to any destination zone are loaded onto a single, minimum cost, path between them. This model is unrealistic as only one path between every OD pair is utilised even if there is another path with the same or nearly same travel cost. Also, traffic on links is assigned without consideration of whether or not there is adequate capacity or heavy congestion; travel time is a fixed input and does not vary depending on the congestion on a link. However, this model may be reasonable in sparse and uncongested networks where there are few alternative routes and they have a large difference in travel cost. This model may also be used to identify the desired path: the path which the drivers would like to travel in the absence of congestion. In fact, this model's most important practical application is that it acts as a building block for other types of assignment techniques. It has a limitation that it ignores the fact that link travel time is a function of link volume and when there is congestion or that multiple paths are used to carry traffic.

8. Write short notes on :

   (a) **Difficulties in transportation planning for small and medium cities**

   Small and medium-sized communities face a variety of transportation planning challenges around the country. Four issues that nearly all small and medium-sized communities share are

   - Lack of resources to meet planning requirements;
   - Education for staff and stakeholders;
   - Communications and information overload; and
   - Technology, both in-house and applications.

(b) Quick response technique

Quick Response transport planning techniques are those that depend upon minimum of data requirement & simplified approach to Estimate travel demand.

- This can be achieved by a household survey which can yield the trip generation ratio.
- this rate can be broken into home-based work trip, home based non-work trip and non-home based trips.
- Given the population for horizon year, these trip generation rates will then yield the number of various types of trips from Each zone.
- The trip distribution can be achieved by gravity Model using simple friction factors
- The whole procedure can be handled Manually without the use of Computers. the appeal of this technique lies in its simplicity and relatively low cost.

(c) Garin- Lowry model

Lowry-Garin Model

Garin proposed a formulation of Lowry's model which prevents the need for the iterative solution to the equations described above.

Garin has proposed a formulation of the Lowry model, which obviates the need for the iterative solution of to the equations. The following equations can be written:

$$P^b = e^b A$$

$$e^{s(1)} = P^b B = e^b (AB) \text{ -- }\mathbf{(1)}$$

$$P^{s(1)} = e^{s(1)} A = e^b (AB) A$$

$$e^{s(2)} = P^{s(1)} B = e^{s(1)} (AB) = e^b (AB)(AB) = e^b (AB)^2$$

Successive iterations will yield:

$$e^{s(x)} = e^b (AB)^x$$

$$P^{s(x)} = e^b (AB)^x A$$

Total employment and total population vectors are given by:

$$e = e^b + e^{s(1)} + \ldots + e^{s(x)} + \ldots = e^b \left[I + AB + (AB)^2 + \ldots + (AB)^x + \ldots \right]$$

$$P = P^b + P^{s(1)} + \ldots + P^{s(x)} + \ldots = e^b \left[I + AB + (AB)^2 + \ldots + (AB)^x + \ldots \right] A$$

Garin has shown that under certain conditions on the product matrix AB will converge to the inverse of the matrix $(I - AB)$ and the resulting equations will be:

$$e = e^b (I - AB)^{-1} \text{ -- }(2)$$

$$p = e^b (I - AB)^{-1} A \text{ -- }(3)$$

where

I =identity matrix

Garin argues that if this were not the case then an infinite amount of population serving employment would be generated by a finite number basic employment.

(d) Furness method

When information is available on the growth in the number of trips originating and terminating in each zone, we know that there will be different growth rates for trips in and out of each zone and consequently having two sets of growth factors for each zone. This implies that there are two constraints for that model and such a model is called doubly constrained growth factor model. One of the methods of solving such a model is given by Furness who introduced balancing factors a_i and b_j as follows: $T_{ij} = t_{ij} \times a_i \times b_j$. In such cases, a set of intermediate correction coefficients are calculated which are then appropriately applied to cell entries in each row or column. After applying these corrections to say each row, totals for each column are calculated and compared with the target values. If the differences are significant, correction coefficients are calculated and applied as necessary. The procedure is given below: 1. Set $b_j = 1$ 2. With b_j solve for a_i to satisfy trip generation constraint. 3. With a_i solve for b_j to satisfy trip attraction constraint. 4. Update matrix and check for errors. 5. Repeat steps 2 and 3 till convergence. Here the error is calculated as: $E = \Sigma|O_i - O1_i| + \Sigma|D_j - D1_j|$ where O_i corresponds to the actual productions from zone i and $O1_i$ is the calculated productions from that zone. Similarly D_j are the actual attractions from the zone j and $D1_j$ are the calculated attractions from that zone.