CMR
INSTITUTE OF
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Internal Assessment Test –III Nov 2018
Solution

Sub: Urban Transport Planning **Code:** 15CV751

Sem: VII **Branch:** CIVIL

1. The trip rate (y) and the corresponding household sizes (x) from a sample are shown in table below. Compute the trip rate if the average household size is 3.25.

	Householdsize(x)			
	1	2	3	4
Trips	1	3	4	5
per	3	4	5	8
day(y)	3	5	7	8

$$\Sigma x = 3\times 1 + 3\times 2 + 3\times 3 + 3\times 4 = 30$$

$$\Sigma x^2 = 3\times(1^2) + 3\times(2^2) + 3\times(3^2) + 3\times(4^2) = 90$$

$$\Sigma y = 7 + 12 + 16 + 21 = 56$$

$$\begin{aligned}\Sigma xy &= 1\times 1 + 1\times 3 + 1\times 3\\ &+ 2\times 3 + 2\times 4 + 2\times 5\\ &+ 3\times 4 + 3\times 5 + 3\times 7\end{aligned}$$

$$\begin{aligned}&+ 4\times 5 + 4\times 8 + 4\times 8\\ &= 163\\ \bar{y} &= 56/12 = 4.67\\ \bar{x} &= 30/12 = 2.5\\ b &= \frac{n\Sigma xy - \Sigma x\Sigma y}{n\Sigma x^2 - (\Sigma x)^2}\\ &= \frac{((12\times 163) - (30\times 56))}{((12\times 90) - (30)^2)} = 1.533\\ a &= \bar{y} - b\bar{x} = 4.67 - 1.533\times 2.5 = 0.837\\ y &= 0.837 + 1.533x\end{aligned}$$

When average household size =3.25, number of trips becomes,

$y = 0.837 + 1.533\times 3.25 = 5.819$

2. A calibrated utility function for travel in a city by automobile, bus and light rail is $U = a - 0.002X_1 - 0.05 X_2$ Where X_1 is the cost of travel and X_2 is the travel time. Calculate the modal split for the given values.

Mode	**a**	**X_1**	**X_2**
Automobile	-0.30	130	25
Bus	-0.35	75	35
Light rail	-0.40	90	40

(2) Equation :

$U = a - 0.002X_1 - 0.05X_2$

$U_{automobile} = -0.30 - (0.002 \times 130) - (0.05 \times 23)$

$= -1.81$

$U_{Bus} = -0.35 - (0.002 \times 75) - (0.05 \times 35)$

$= -2.25$

$U_{Light\ Rail} = -0.40 - (0.002 \times 90) - (0.05 \times 40)$

$= -2.38$

Modal split for modes:

$$P_{automobile} = \frac{e^{1.81}}{e^{1.81} + e^{2.25} + e^{2.38}} = 0.212$$

$$P_{Bus} = \frac{e^{2.25}}{e^{1.81} + e^{2.25} + e^{2.38}} = 0.329$$

$$P_{Light\ Rail} = \frac{e^{2.38}}{e^{1.81} + e^{2.25} + e^{2.38}} = 0.458$$

Modal split for automobile = 21.2%

Bus = 32.9%

Light Rail = 45.8%

3. Write short notes on Landuse And Transport Interaction.

Land use models seek to predict a region's future spatial distribution of households and employment, and provide key inputs to models of travel demand, emissions, and air quality. Integrated transport-land use models (ITLUMs) allow analysts to anticipate system response to new policies, preference functions, economic conditions and other scenarios. Though not nearly as complex as the human systems they seek to mimic, such model systems are very complicated.

Such complication results in multiple challenges and attendant abstractions result in many modeling limitations as well as prediction errors.

Land use comprises two elements; the nature of land use which relates to which activities are taking place where, and the level of spatial accumulation, which indicates their intensity and concentration. Central areas have a high level of spatial accumulation and corresponding land uses, such as retail, while peripheral areas have lower levels of accumulation. Most economic, social or cultural activities imply a multitude of functions, such as production, consumption and distribution. These functions take place at specific locations and are part of an activity system.

Some are routine activities, because they occur regularly and are thus predictable, such as commuting and shopping. Others are institutional activities that tend to be irregular, and are inspired by lifestyle (e.g. sports and leisure) or by special needs (e.g. healthcare). Others are production activities that are related to manufacturing and distribution, whose linkages may be local, regional or global. The behavioral patterns of individuals, institutions and firms have an imprint on land use in terms of their locational choice.

At the global level, cities consume about 3% of the total land mass. Although figures can vary considerably depending on the city, residential land use is the most common, occupying between 65 and 75% of the surface of a city. Commercial and industrial land uses occupy 5-15% and 15-25% of the surface respectively. Land use, both in formal and functional representations, implies a set of relationships with other land uses. For instance, commercial land use involves relationships with its supplier and customers. While relationships with suppliers will dominantly be related with movements of freight, relationships with customers would include movements of people. Thus, a level of accessibility to both systems of circulation must be present. Since each type of land use has its own specific mobility requirements, transportation is a factor of activity location, and is therefore associated intimately with land use.

Within an urban system each activity occupies a suitable, but not necessarily optimal location, from which it derives rent. Transportation and land use interactions mostly consider the retroactive relationships between activities, which are land use related, and accessibility, which is transportation related. These relationships have often been described as difficult to identify the triggering cause of change; do transportation changes precede land use changes or vice-versa.

There is a scale effect at play as large infrastructure projects tend to precede and trigger land use changes while small scale transportation projects tend to complement the existing land use pattern. Further, the expansion of urban land uses takes place over various circumstances such as infilling (near the city center) or sprawl (far from the city center) and where in each case, transportation plays a different role.

Urban transportation aims at supporting transport demands generated by the diversity of urban activities in a diversity of urban contexts. A key for understanding urban entities thus lies in the analysis of patterns and processes of the transport / land use system. This system is highly complex and involves several relationships between the transport system, spatial interactions and land use:

- **Transport system**. Considers the set of transport infrastructures and modes that support urban movements of passengers and freight. It generally expresses the level of accessibility.

· **Spatial interactions**. Consider the nature, extent, origins and destinations of the urban movements of passengers and freight. They take into consideration the attributes of the transport system as well as the land use factors that are generating and attracting movements.

· **Land use**. Considers the level of spatial accumulation of activities and their associated levels of mobility requirements. Land use is commonly linked with demographic and economic attributes.

4. Write short notes on various Traffic Assignment techniques.

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.

Multipath traffic assignment:

Mclaughlin developed one of the first multipath traffic assignment techniques. A driver route selection criterion is used by Mclaughlin which is a function of travel time, travel cost, and accident potential. The minimum resistance paths between each origin and destination pair are calculated with all the link resistances set to values which correspond to a zero traffic volume.

The minimum resistance value between an origin and destination pair with resistance values less than this maximum value are identified.

Mclaughlin used certain principles of linear graph theory to accomplish the multipath assignment. Using an electrical analogy it is possible to identify through variable y that corresponds to current, or traffic flow. An across variable x may be identified that corresponds to potential difference, or traffic pressure.

Two postulates from linear graph theory may be introduced that are known as the vertex and circuit postulates. At any vertex

Where e = the number of oriented terminal graphs, or elements

Y_i = the through variable of the ith element

a_i = 0 if the ith element is not connected to V

= 1 if the ith element is oriented away from V

= -1 if the ith element is oriented toward V

For any circuit,

Where X_i = the through variable of the ith element

b_i = 0 if the ith element is not in the jth circuit

= 1 if the ith element orientation is the same as the jth circuit

= -1 if the ith element orientation is opposite to the jth circuit

A subgraph is then established for each origin and destination pair with these representing two vehicles. The connecting elements are the acceptable paths between the verticles plus one flow driver element that corresponds to the car travel demand between the origin and destination pair.

The travel demand is assigned among the potential paths in accordance with the path resistance values calculated during the path building phase. The traffic assigned to each path must be such that the alternative paths have an equal across variable value.
The across variable X, the resistance value R(y) and the through variable y for each path are assumed to be related as follows:

$X = R(y)y$

Equation is analogous to Ohm’s law in that potential is equal to the resistance times the flow. In this case the resistance along a path is assumed to be a function of the flow along that path.

5. Explain with a flowchart the two types of modal split.

Table 34-2
Flow Diagram for Modal Split Carried out between Trip Generation and Trip Distribution.

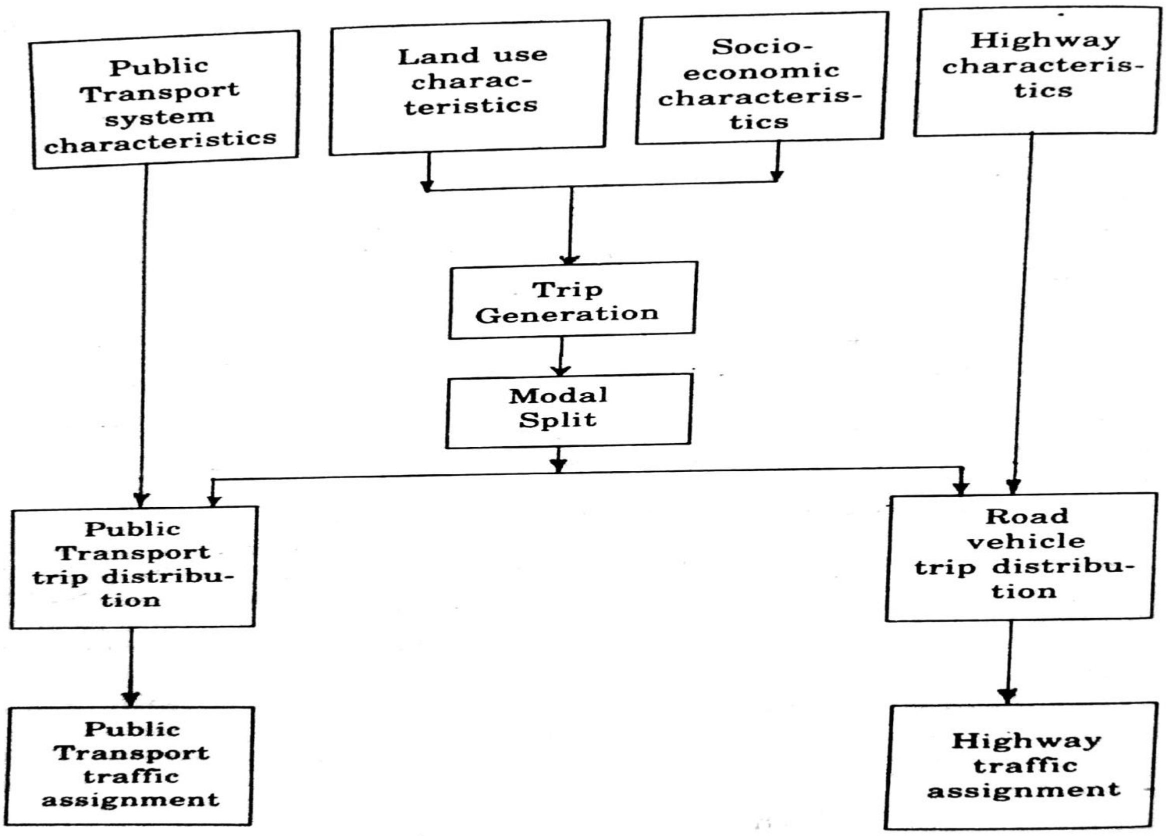
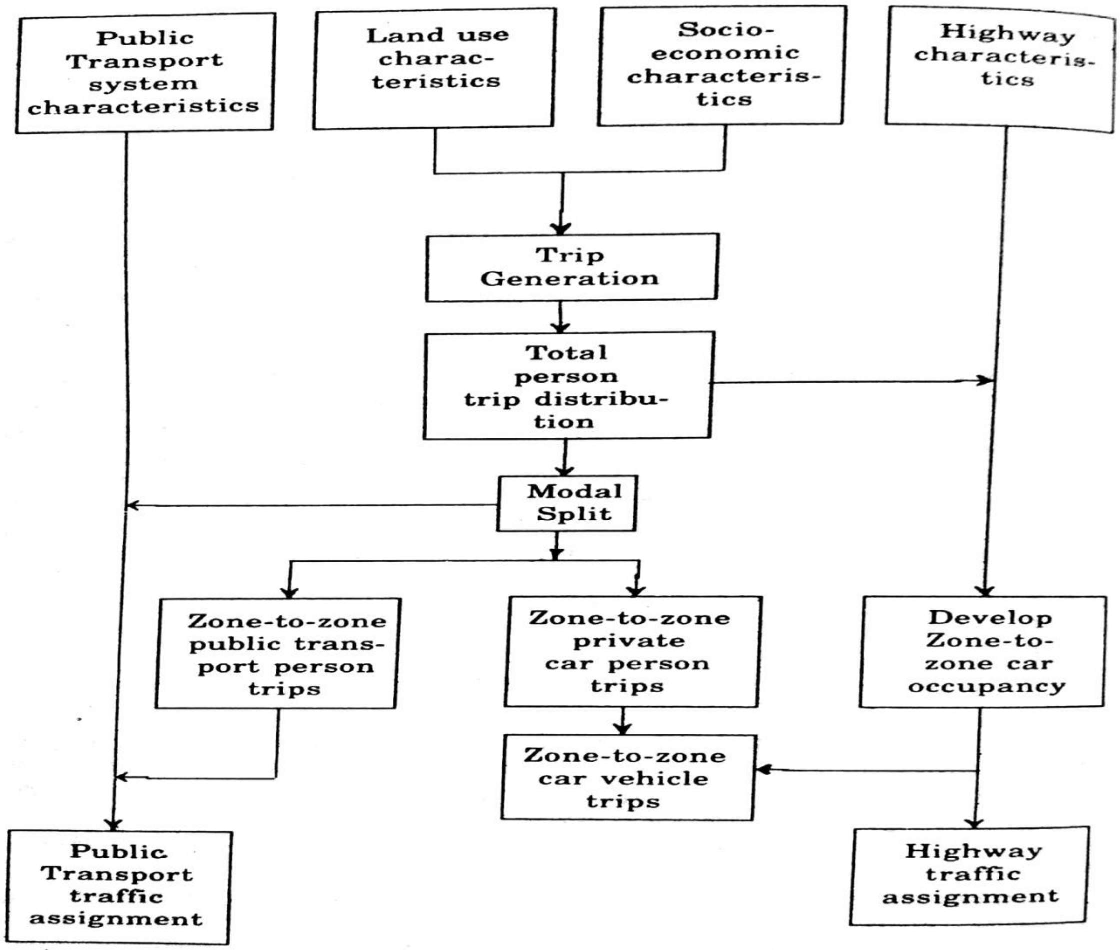


Table 34-3. Flow Diagram for Modal Split Carried out after Trip Distribution



6. Give a brief description about Opportunity Models.
    - ✖ Assumed that the trip interchange between an origin and destination zone is equal to the total trips emanating from the origin zone multiplied by the probability that each trip will find an acceptable terminal at the destination
    - ✖ Probability that a destination will be acceptable depends on two zonal characteristics
    - ✖ Characteristic 1 – size of the destination
    - ✖ Characteristic 2 – order in which it is encountered as trips proceed from the origin
    - ✖ Probability function is expressed as the difference between
    - ➢ probability that trips origin at i will find a suitable terminal in one of the destinations, ordered by closeness to i, up to and including j
    - ➢ probability that trips origin at I will find a suitable terminal in one of the destinations, ordered by closeness to i, up to but excluding j

$$T_{i-j} = O_i(e^{-LB} - e^{-LA}) \quad \ldots(32{\cdot}10)$$

T_{i-j} = predicated number of trips from zone i to j

Q_i = total number of trips originating in zone i

L = probability density (probability per destination) of destination acceptability at the point of consideration

A = number of destinations between i and j (including j) when arranged in order of closeness

B = number of destinations between i and j (excluding j) when arranged in order of closeness.

It may be noted that :

$$A = B + D_j$$

Competing opportunities model:

- **Adjusted probability of a trip ending in a zone is the product of *two independent probabilities***
- **probability of a trip being attracted to a zone and the probability of a trip finding a destination in that zone**

$$T_{i-j} = \frac{P_j \dfrac{A_i}{\sum_j A_j}}{\sum \left(\dfrac{A_j}{\sum_j A_j} \right)}$$