CBCS SCHEME

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17CV751

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Urban Transportation and Planning

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Explain briefly the various stages involved in Transportation Planning Process. **(10 Marks)**

b. Explain the problems in the Urban transportation in the present scenario. **(10 Marks)**

OR

2 a. Explain the system approach to transport planning using a flow chart. **(10 Marks)**

b. Write a note on the following :
i) BRTS ii) Metro Train. **(10 Marks)**

Module-2

3 a. Define External cordon line. What factors should be given due weightage in the selection of external Cordon line? **(10 Marks)**

b. What is Zoning? Discuss the points to be kept in mind while doing Zoning. **(10 Marks)**

OR

4 a. Mention the different types of transport surveys. Explain various inventories that are needed for providing transport facilities. **(10 Marks)**

b. What are the methods of Origin and destination study? Explain Home interview method in detail. **(10 Marks)**

Module-3

5 a. What are the factors governing Trip Generation and Attraction Rates? Explain each factor. **(10 Marks)**

b. Explain Multiple Linear Regression Analysis [MLR] and list the assumptions in Multiple Linear Analysis. **(10 Marks)**

OR

6 a. What is Trip Distribution? Explain the methods of Trip Distribution. **(10 Marks)**

b. Estimate the future trip distribution by Furness Method (Upto two Iterations) from the following data : **(10 Marks)**

O \ D	1	2	3	4	Future Trips
1	8	3	16	15	147
2	6	9	8	5	42
3	10	8	3	8	29
4	2	4	7	12	25
Future Trips	39	24	68	120	

Module-4

7 a. Explain the Gravity Model of Trip Distribution. **(08 Marks)**

b. A Self contained town consists of four residential areas A, B, C and D and two Industrial estates 'X' and 'Y'. Generation equations show that for the design year in question, the trips from how to work generated by each residential area per 24 hour day are as follows :

A - 1000 ; B - 2250 ; C - 1750 ; D - 3200.

There are 3700 Jobs in Industrial estate 'X' and 4500 Jobs in Industrial estate 'Y'. It is known that the attraction between zones in inversely proportional to the square of the Journey times between zones. The Journey times in minutes from home to work are :

Zones	X	Y
A	15	20
B	15	10
C	10	10
D	15	20

Calculate and tabulate the inter zonal trips for Journeys from Home to work. **(12 Marks)**

OR

8 a. The Total trips produced in and attracted to the three Zones A, B and C of a survey area in the design year are tabulated as :

Zones	Trips produced	Trips attracted
A	2000	3000
B	3000	4000
C	4000	2000

It is known that the trips between two Zones are inversely proportional to the second power of the travel time between Zones, which is uniformly 20 minutes. If the trip interchange between Zones B and C is known to be 600. Calculate the trip Interchange between Zones A & B , A & C , B & A and C & B. **(10 Marks)**

b. Define Model Split. Explain in brief the factors affecting Model Split. **(10 Marks)**

Module-5

9 a. Explain the concept of Quick Response Technique. **(10 Marks)**

b. Explain the difficulties in transport planning for Small and Medium Cities. **(10 Marks)**

OR

10 Write short notes on :

a. Capacity Restraint Technique.

b. Diversion curves.

c. Equilibrium Assignment.

d. Lowry Model. **(20 Marks)**

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FEB/Mar 2022

Urban Transportation and Planning 17cv751

Module 1

1 a. Explain briefly the various stages involved in transportation planning process.

Sol : **Situation definition**: Inventory transportation facilities, Measure travelϖ patterns, Review prior studies.

Problem definition: Define objectives (e.g., Reduce travel time),ϖ Establish criteria (e.g., Average delay time), Define constraints,Establish design standards

Search for solutions: Consider options (e.g., locations and types,ϖ structure needs, environmental considerations)

Analysis of performance: For each option, determine cost, traffic flow,ϖ impacts

Evaluation of alternatives: Determine values for the criteria set forϖ evaluation (e.g., benefits vs. cost, cost-effectiveness, etc)

Choice of project: Consider factors involved (e.g., goal attainability,ϖ political judgment, environmental impact, etc.

Specification and construction: Once an alternative is chosen, designϖ necessary elements of the facility and create construction plans

URBAN MASS TRANSPORTATION SYSTEMS "Mass Transit, also referred to as public transit, is a passenger transportation service, usually local in scope that is available to any person who pays a prescribed fare " Mass Transit System is designed to move large numbers of people at one time.

b. Explain the problems in the urban transportation in the present scenario.

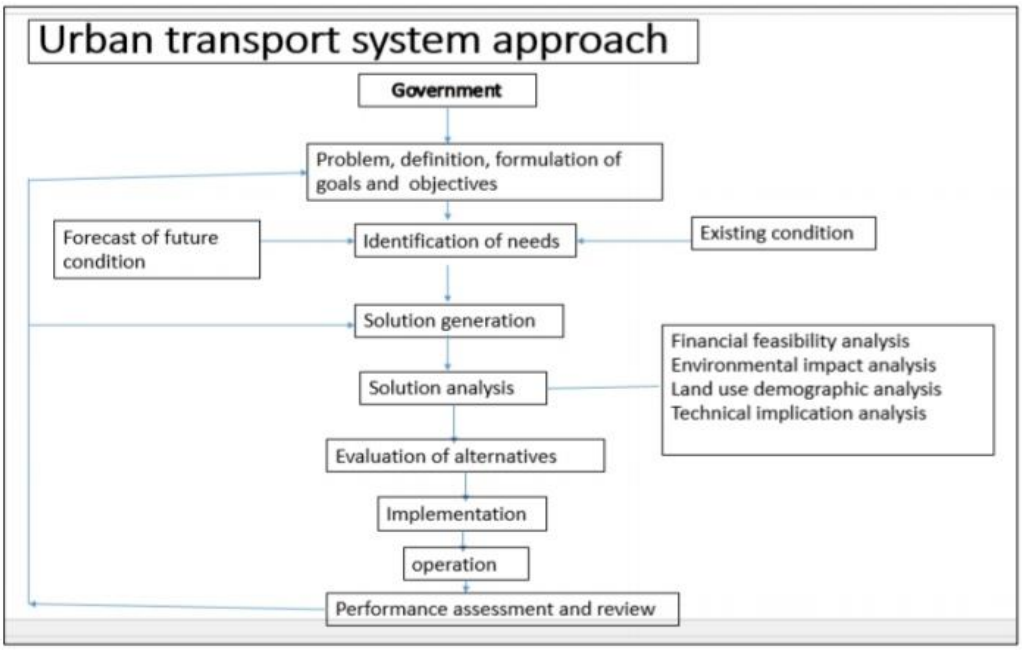
Sol: 1. Road congestion :As populations increase, the average travel distances as well as intensity are expected to increase as there is a direct correlation between the two indicators (See Figure 3). Average trips lengths for metro cities including Bengaluru are over 8 km, while it is 6 km or less for all other metro cities. This trend in trip length and frequency is only expected to increase with increasing income levels, migration, participation of women and a service-oriented economy. As more people travel over longer distances on regular basis for employment and education purposes, will inevitably lead to road congestion.

2. Parking problems :The acute shortage of parking spaces both on and off the streets in Indian cities increases the time spent searching for a parking spot and induces traffic congestion. Available data shows that a high proportion of Indian streets are faced with on-street parking issue. This problem is especially acute in smaller, compact Indian cities. On-street parking is perversely incentivized because it is either free or priced lower than off-street parking. Even if cities invest in multilevel car parks in prime areas, the parking rates are not expected to recover the costs.

3. Air pollution : The severity of air pollution in Indian cities is judged based on CPCB's (Central Pollution Control Board) air quality classification. According to available air quality data of 180 Indian cities, there is a wide variation in the pollution concentration and severity across cities. Cities are considered critically polluted if the levels of criteria pollutants are more than 1.5 times the standard. Results show that half of the residential areas in cities monitored by CPCB are at critical levels of air pollution .The danger is especially pronounced when diesel vehicles are operating, as diesel emissions are known to trigger adverse respiratory health effects. Metro cities that have initiated pollution control action have witnessed either stabilization or dip in the pollution levels, however, in other cities, the situation has been observed to be getting worse. Toxic air and its effects on health are seriously compromising the 'livability' of Indian cities.

4. Deteriorating road safety : The high dependence of migrants on non-motorised transport modes such as walking and cycling causes traffic mix in common roads where fast-moving motorised traffic shares the roads with slow-moving modes leading to an increasing number of fatalities and road accidents. In Urban transport planning 15CV751 DEPT OF CIVIL . SRI VENKATESHWARA COLLEGE OF ENGINEERING Page 8 most Indian cities, non-motorised modes like cycling and walking presently share the same right of way as cars and two-wheelers leading to unsafe conditions for all. The number of fatalities is also increasing in relation to the increasing motorisation and higher slow-moving vehicles in the traffic stream. While progress has been made towards protecting people in cars, the needs of vulnerable groups of road users, primarily cyclists and pedestrians, are not being met. Pedestrian fatalities constitute a significant share of total fatalities and the magnitude is in fact much higher in cities that lack adequate pedestrian facilities.

2 a. Explain the system approach to transportation planning using a flow chart.



Problem definition /objectives: To develop a transport system that caters to all sections of society. To develop a transportation system that is primarily sustainable in nature. To minimize system costs. For Example: Goal: Reducing travel time of people between Mysore and Bangalore Objectives: To maximize the accessibility to activities by public transport

To improve connectivity

To improve state economy

Identification of need:

Solution Generation and Analysis Based on problem definition, transportation planners have to identify various alternatives and make choice about various modes like roadway ,railway, waterways or airways.

The technological aspect - such as high speed train, raised monorails underground transit system, driver information system.

Traffic engineering aspect - such as changing or improving flow pattern by making certain road one way, reducing delay on arterial street by improving signalization or grade separated intersection, disallowing certain movement at intersection Regulatory aspect - such as reserving land for only high occupancy vehicles, disallowing high polluting vehicles, imposing speed limit.

For example, to travel from Kanpur to Delhi following alternatives can be worked out.

• Facilitate train leaving Kanpur at 6:30 am and reaching Delhi at 10:30 am and again leaving Delhi at 5:30pm and reaching Kanpur at 10:30pm.

• Developing existing airport at Kanpur

• Improve the existing road facilities providing operating speed 120 kmph.

Evaluation of possible alternatives Compare the various alternatives and select the best plan based on estimated cost and benefits.

Implementation and assessment Once the best plan is selected and becomes operational, the performance is assessed and monitored regularly for further improvement. Based on the performance assessment it may be necessary to go back to certain stages of planning and repeat the process.

b. Write a note on the following:

i) BRTS ii) Metro Train

i) BRTS :Bus based public transport system. It delivers comfortable and cost effective urban mobility, providing high capacity and consuming cleaner fuels. It is comfortable and having luxurious facilities with high technology functions for faster and safer travel. Exclusive busway, convenient stations and comfortable buses, Intelligent Transportation Systems (ITS)(e.g., signal priority system, automatic fare system, Global Positioning System (GPS), bus arrival broadcast information etc. are some of its features. BRTS is reliable, convenient and faster than regular bus services. With the right features, BRT is able to avoid the causes of delay that typically slow regular bus services, like being stuck in traffic and queuing to pay on board.

Characteristics Separate lane is exclusively dedicated to BRTS. The median and the inner most lane or the left most lane can be dedicated to the bus. BRTS is a relatively inexpensive mode and can be implemented more widely. In case of cost consideration for construction of BRTS approximately about 5-20 crores per km whereas in metro rails about 125 to 220 crores per km. It has advanced Traveler Information System (ATIS) and Automatic tracking of buses. In BRTS commuters can only cross at the zebra crossings. Fatality rates will come down drastically.

ii) Metro Train Consists of large four-axle electrically powered rail vehicles that operate in trains of upto 10 cars on fully controlled A row with full signal control. This ensures high speed, reliability, capacity, rapid boarding In case of driver's error or inability the train stops automatically. Some automated operation without driver. Line haul transport Several doors on either side without fare collection delay Requires higher investment cost than any other transit mode.

Modue 2

2 a. Define External cordon line. What are factors should be given due weightage in the selection of external cordon line?

Sol: The imaginary line representing the boundary of the study area is termed as external cordon.

Selection of External Cordon Line:

- The selection of the external cordon line for an urban transportation study should be done with due weightage to the following factors:
- The external cordon line should cover the area which is already built up and also likely to be¬ developed during the design period.
- The external cordon line should contain all areas of systematic daily life of the people oriented¬ towards the city centre and should in effect be the 'Commuter shed'.
- The external cordon line should be compatible with previous studies of the area of studies¬ planned for the future.
- The external cordon line should be continuous and uniform in its course so that movements cross¬ it only once.
- The line should intersect roads where it is safe and convenient to carry out traffic surveys.
- The external cordon line should be compatible with previous studies of the area and of studies¬ planned for the future

B What is zoning? Discuss the points to be kept in mind while doing zoning.

Sol: The defined study area is sub-divided into smaller areas called zones or traffic zones.

- The zones should have a homogenous land use so as to reflect accurately the associated trip making behaviour.
- Anticipated change in land use should be considered when sub- dividing the study area into zones.
- It would be advantages, if the subdivision follows closely that adopted by other bodies (e.g. census department) for data collection. This will facilitate correlation of data.
- The zones should not too large to cause considerable errors in data. At the sometime, they should not be too small either to cause difficulty in handling and analyzing the data.

- As a general guide, a population of 1000-3000 may be the optimum for a small area, and a population of 5000- 10000 may be the optimum for large urban areas. In residential areas, the zones may accommodate roughly 1000 households.
- The zones should preferably have regular geometric form for easily determining the centroid, which represent the origin and destination of travel.
- The sectors should represent the catchment of trips generated on a primary route.
- Zones should be compatible with screen lines and cordon lines. Zone boundaries should preferably be watersheds of trip making.
- Natural or physical barriers such as canals, rivers, etc. can form convenient zone boundaries.
- In addition to the external cordon lines, there may be a number of internal cordon lines arranged as concentric rings to check the accuracy of survey data.

4a. Mention the different types of transport surveys. Explain various inventories that are needed for providing transport facilities

sol :1. Home - interview survey.

2. Commercial vehicles surveys.

3. Intermediate public transport surveys.

4. Public transport surveys.

5. Road –side – interview surveys.

6. Post- card- questioner surveys.

7. Registration- number surveys.

8. Tag- on- vehicle surveys.

b What are the methods of origin and destination study? Explain home interview method in detail.

Sol: 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 household influencing trip making. The information on the 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. The size of the sample is usually determined on the basis of the population of the study area. And the standards given by the Bureau of Public Roads.

Module – 3

5 a what are the factors governing trip generation and attraction rates ? explain each factor.

Soln :

Factors influencing Trip Generation and Attraction

1. Income
Family income which represents its ability to pay for a journey affects the number of trips generated by a household. A general trend is that the higher the income the higher is the trip generation rate.

2. Car ownership

A car represents easy mobility, and hence a car owing household will generate more trips than a non-car-owing household. By the same reasoning, the more cars there are in the household, the more the number of trips generated. Of course, number of cars owned is itself related to the income of the family, which has been listed earlier as a factor.

3. Family size and composition

The bigger the family, the more trips there are likely to be generated. Apart from the size, the composition of the family itself is important. For instance, if both the husband and wife are employed, the trips generated will be more than when only the husband is employed. If there are many school-going children, the number of school-purpose trips will be large. The age structure of the family also governs the trip rates. Old persons are not expected to generate as many trips as younger ones.

4. Land use Characteristics

Different land uses produce different trip rates. For example, a residential area with a high density of dwellings can produce more trips than one with a low density of dwellings. On the other hand, low density areas may represent dwellings of the well-off society, which may produce a large number of private car trips. The rateable value of the dwelling and type of dwelling units affect the trip generation rates. The most important assumption made in transportation planning is that the amount of travel is dependent on land use.

5. Distance of the zone from the town center

The distance of the zone from the town center is an important determinant of the amount of travel that people might like to make to the town center. The farther the town center, the less the number of trips are likely to be.

6. Accessibility to public transport system and its efficiency

The accessibility to a public transport system and its efficiency determine to some extent the desire of persons to make trips. An easily accessible and efficient public transport system generates more trips.

7. Employment opportunities, floor space in the industrial and shopping units and offices
The employment potentially of an industrial or shopping unit or an office establishment directly governs the trip attraction rate. Similarly, another factor to which the trip attraction rate can be related is the floor space in the premises of industries, shops and offices.

b Explain multiple linear regression analysis [MLR] and list the assumptions in multiple linear analysis

The most common technique employed in establishing trip generation is multiple linear regression which fits mathematical relationships between dependent and independent variable. In the case of trip generation equation, the dependent variable is the number of trips and the independent variable are the various measurable factors that influence trip generation like land use and socio-economic characteristics. The general form of the equation can be expressed in the following form:

Yp=a1X1+a1X2+a3X3+.....anXn+U

- ✓ Yp= number of trips for specified purpose p
- ✓ X1, X2, X3,....., Xn=independent variables relating to for example, land-use, socio economic factors etc.
- ✓ a1, a2, a3,....., an= Coefficients of the respective independent variables X1, X2, X3,....., Xn, obtained by linear regression analysis
- ✓ U= Distribution term, which is a constant and representing that portion of the value of Yp not explained by the independent variables.

The equation of the above form is developed from the present-day data pertaining to independent variables and dependent variables and the dependent variables, using statistical techniques of "least squares "fitting. The equation thus developed is used for determining the future values of trips, knowing the estimated future values of the independent variables.

Example:
Y = 2.18 + 3.404 A + 0.516 H + 0.0119 X1 – 0.343 X2
Where,
Y= average trips per occupied dwelling unit
A= car ownership

H=household size
X1= social rank index
X2= urbanization index

Assumptions in Multiple Linear Regression Analysis and their validity in trip generation analysis

The statistical theory of Multi linear regression analysis is based on the following important assumptions

1. All the variables are independent of each other
2. All the variables are normally distributed
3. All the variables are continuous
4. A liner relationship exists between the dependent variable and the independent variable:
5. Influence of independent variable is additive that is the inclusion of each variable in the equation contributes a distinct portion of trip numbers.

6 a. What is trip distribution? Explain the methods of trip distribution

Soln:

TRIP DISTRIBUTION

The decision to travel for a given purpose is called trip generation. After having obtained an estimate of the trips generated from and attracted to the various zones, it is necessary to determine the direction of travel. Trip distribution models begin with the number of trip ends generated by each zone and answer the question, "What zone are the trips going to and coming from?" The number of trips generated in every zone of the area under study has to be apportioned to the various zones to which these trips are attracted. 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.

METHODS OF TRIP DISTRIBUTION

In trip distribution, two known sets of trip ends are connected together, without specifying the actual route and sometimes without reference to travel mode, to form a trip matrix between known origins and destinations.

There are two types of trip distribution methods,

1. Growth factor methods

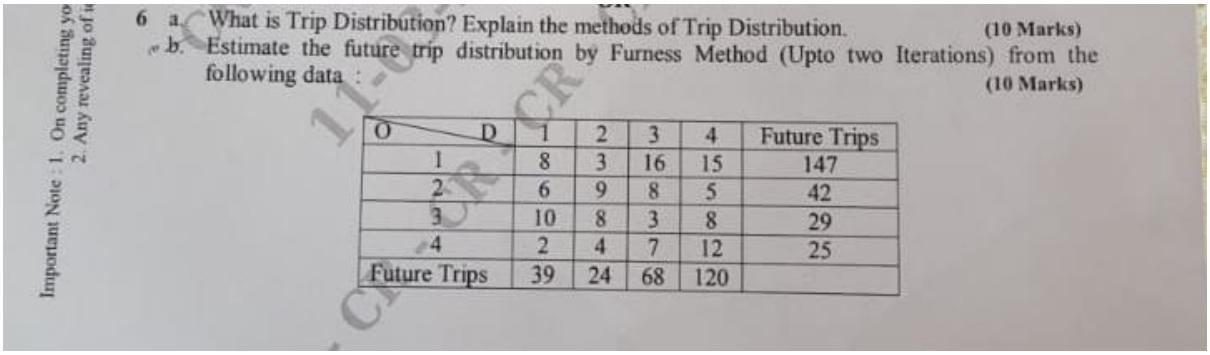
2. Synthetic methods

The growth factor methods are based on the assumption that the present travel patterns can be projected to the design year in the future by using certain expansion factors. It assume that in the future the trip-making pattern will remain substantially the same as today but that the volume of trips will increase according to the growth of the generating and attracting zones. These methods are simpler than synthetic methods and for small towns where considerable changes in land-use and external factors are not expected, they have often been considered adequate. Growth factor methods have been used in earlier studies but have yielded place now to the more rational synthetic models. The following are the important growth factor methods:

1. Uniform factor method
2. Average factor method
3. Fratar method
4. Furness method

In synthetic models of trip distribution, an attempt is made to discern the underlying causes of movements between places, and relationships are established between trips and measures of attraction, generation and travel resistance. Synthetic models have an important advantage that they can be used not only to predict future trip distribution but also to synthesis the base-year flows. The necessity of having to survey every individual cell in the trip matrix is thus obviated and the cost of data collection is reduced. The synthetic methods are as give below:

B



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2. Any revealing of i

6 a. What is Trip Distribution? Explain the methods of Trip Distribution. **(10 Marks)**

b. Estimate the future trip distribution by Furness Method (Upto two Iterations) from the following data : **(10 Marks)**

O \ D	1	2	3	4	Future Trips
1	8	3	16	15	147
2	6	9	8	5	42
3	10	8	3	8	29
4	2	4	7	12	25
Future Trips	39	24	68	120	

Soln :

SOLUTION:

O/D	1	2	3	4	Total predicted trips	Predicted future trips	Origin growth factor
1	8	3	16	15	42	147	3.5
2	6	9	8	5	28	42	1.5
3	10	8	3	8	29	32	1.1
4	2	4	7	12	25	30	1.2
Total predicted trips	26	24	34	40	124		
Predicted future trips	39	24	68	120		251	
Destination growth factor	1.5	1	2	3			

Each column is multiplied by that columns destination growth factor

New OD matrix:

O/D	1	2	3	4	Total predicted trips	Predicted future trips	Origin growth factor
1	12	3	32	45	92	147	1.6
2	9	9	16	15	49	42	0.86
3	15	8	6	24	53	32	0.60
4	3	4	14	36	57	30	0.5
Total predicted trips	39	24	68	120	251		
Predicted future trips	39	24	68	120		251	
Growth factor	1	1	1	1			

Each row is multiplied by that rows origin growth factor

O/D	1	2	3	4	Total predicted trips	Predicted future trips	Origin growth factor
1	19.20	4.80	51.20	72	147.2	147	0.99
2	7.74	7.74	13.76	12.9	42.14	42	0.9
3	9	4.80	3.60	14.40	31.80	32	1.0
4	1.59	2.12	7.42	19.08	30.21	30	1.0
Total predicted trips	37.53	19.46	75.98	118.38	251.35		
Predicted future trips	39	24	68	120		251	

Module 4

7a Explain the gravity model of trip distribution.

Soln :

1. Gravity model

One of the well-known synthetic models is the Gravity Model. Based in Newton's concept of gravity, the model as proposed by Voorhees assumes that the interchange of trips between zones in an area is dependent upon the relative attraction between the zones and the spatial separation between them as measured by an appropriate function of distance. This function of spatial separation adjusts the relative attraction of each zone for the ability, desire or necessity of the trip maker to overcome the spatial separation. Whereas the trip interchange is directly proportional to the relative attraction between the zones, it is inversely proportional to the measure of spatial separation.

A simple equation representing the above relationship is of the following form:

$$T_{i-j} = \frac{KP_i A_j}{d_{ij}^n}$$

Where,
Ti-j = Trips between zones i and j
Pi = Trips produced in zone i
Aj = Trips attracted to zone j
dij = Distance between zone i and j, or the time or cost of traveling between them
K = A constant, usually independent of i
n = An exponential constant, whose value is usually found to lie 1 & 3
k = Total number of zones
The following formulation was also used in earlier studies dispersing with the proportionality constant:

$$\left[T_{(i-j)m} = \frac{P_i A_{jm} F_{i-j} C_{i-j}}{\sum_{x=1}^{k} A_{km} F_{(i-k)} K_{(i-k)}} \right]_p$$

Where,
Ti-j = Trips produced in Zone i and attracted to zone j
Pi = Trips produced in zone i
Aj = Trips attracted to zone j
Fi-j = Empirically derived travel time factor which expresses the average area-wide effect of spatial separation on trip interchange between zones i and j
Ki-j = A specific zone-to-zone adjustment factor to allow for the incorporation of the effect on travel patterns of defined social or economic linkages not otherwise accounted for in the gravity model formulation
k = Total number of zones
m = Iteration number
p = Trip purpose

The above relationship can be used for determining the trip interchange for each trip purpose and each mode of travel.

7 b

b. A Self contained town consists of four residential areas A, B, C and D and two industrial estates 'X' and 'Y'. Generation equations show that for the design year in question, the trips from how to work generated by each residential area per 24 hour day are as follows :
A - 1000 ; B - 2250 ; C - 1750 ; D - 3200.
There are 3700 Jobs in Industrial estate 'X' and 4500 Jobs in Industrial estate 'Y'. It is known that the attraction between zones in inversely proportional to the square of the Journey times between zones. The Journey times in minutes from home to work are :

Zones	X	Y
A	15	20
B	15	10
C	10	10
D	15	20

Calculate and tabulate the inter zonal trips for Journeys from Home to work. **(12 Marks)**

Zones	X	Y
A	15	20
B	15	10
C	10	10
D	15	20

Calculate and tabulate the interzonal trips for journeys from home to work.

Solution:

$$T_{i\text{-}j}=\frac{Pi\frac{Aj}{(di-j)2}}{\sum\frac{Ai}{(di-j)}}$$

$$T_{A\text{-}X}=\frac{1000X\frac{3700}{(15X15)}}{\frac{3700}{15X15}+\frac{4500}{(20X20)}}=\frac{1000X16.5}{16.5+11.25}=604$$

$$T_{A\text{-}Y}=\frac{1000X\frac{4500}{(20X20)}}{\frac{3700}{(15X15)}+\frac{4500}{(20X20)}}=\frac{1000X11.25}{16.5+11.25}=396$$

$$T_{B\text{-}X}=\frac{2250X\frac{3700}{(15X15)}}{\frac{3700}{(15X15)}+\frac{4500}{(10X10)}}=\frac{2250X16.5}{16.5+45}=604$$

$$T_{B\text{-}Y}=\frac{2250X\frac{4500}{(10X10)}}{\frac{3700}{(15X15)}+\frac{4500}{(10X10)}}=\frac{2250X45}{16.5+45}=1646$$

$$T_{C\text{-}X}=\frac{1750X\frac{3700}{(10X10)}}{\frac{3700}{(10X10)}+\frac{4500}{(10X10)}}=\frac{1750X37}{37+45}=790$$

$$T_{C\text{-}Y}=\frac{1750X\frac{4500}{(10X10)}}{\frac{3700}{(10X10)}+\frac{4500}{(10X10)}}=\frac{1750X45}{37+45}=960$$

$$T_{D\text{-}X}=\frac{3200X\frac{3700}{(15X15)}}{\frac{3700}{(15X15)}+\frac{4500}{(15X15)}}=\frac{3200X16.5}{16.5+11.25}=1980$$

$$T_{D\text{-}Y}=\frac{3200X\frac{4500}{(20X20)}}{\frac{3700}{(15X15)}+\frac{4500}{(20X20)}}=\frac{3200X11.25}{16.5+11.25}=1220$$

The results are tabulated in the matrix below:

	X	Y	$T_{i\text{-}j}$ for origin zones A, B, C, D
			Total Productions
A	604	396	1000
B	604	1646	2250
C	790	960	1750
D	1980	1220	3200
Total calculated	3978	4222	8200
Attractions, C_j			
Total predirected	3700	4500	8200
Attractions, A_j			

It will be seen that as a result of the distribution, the total attractions do not tally with the predicted attractions. An iterative procedure is necessary to balance out both the predicted attractions and the productions. For this purpose, the total attractions are first adjusted as follows:

$$A_{j\text{-}k}=\frac{Aj}{Cj(m-1)}XAj(m-1)$$

For the destination zones X and Y

Where A_{jm}=Adjusted attraction factor, iteration m

A_j=Desired attraction

$A_{j(m-1)}$=Attraction factor, iteration m-1

$C_{j(m-1)}$=Actual attraction factor, iteration m-1

For the second iteration, m=2

A_{j2} for Zone X $= \frac{3700}{3978} X 3700 = 3440$

A_{j2} for Zone Y $= \frac{4500}{4222} X 4500 = 4800$

Recalculating,

$$T_{A\text{-}X} = \frac{1000X\frac{3440}{(15X15)}}{\frac{3400}{15X15}+\frac{4800}{(20X20)}} = \frac{1000X15.3}{15.3+12} = 560$$

$$T_{A\text{-}Y} = \frac{1000X\frac{4800}{(20X20)}}{\frac{3440}{(15X15)}+\frac{4800}{(20X20)}} = \frac{1000X12}{15.3+12} = 440$$

$$T_{B\text{-}X} = \frac{2250X\frac{3400}{(15X15)}}{\frac{3400}{(15X15)}+\frac{4800}{(10X10)}} = \frac{2250X15.3}{15.43+48} = 540$$

$$T_{B\text{-}Y} = \frac{2250X\frac{4800}{(10X10)}}{\frac{3440}{(15X15)}+\frac{4800}{(10X10)}} = \frac{2250X48}{15.3+48} = 1710$$

$$T_{C\text{-}X} = \frac{1750X\frac{3440}{(10X10)}}{\frac{3440}{(10X10)}+\frac{4800}{(10X10)}} = \frac{1750X34.4}{34.4+48} = 730$$

$$T_{C\text{-}Y} = \frac{1750X\frac{4800}{(10X10)}}{\frac{3440}{(10X10)}+\frac{4800}{(10X10)}} = \frac{1750X48}{34.4+48} = 1020$$

$$T_{D\text{-}X} = \frac{3200X\frac{3440}{(15X15)}}{\frac{3440}{(15X15)}+\frac{4800}{(20X20)}} = \frac{3200X15.3}{15.3+12} = 1790$$

$$T_{D\text{-}Y} = \frac{3200X\frac{4800}{(20X20)}}{\frac{3440}{(15X15)}+\frac{4800}{(20X20)}} = \frac{3200X12}{15.3+12} = 1410$$

The results are tabulated in the matrix below:

O\D	X	Y	Ti-j for origin zones A, B, C, D (Total Production)
A	560	440	1000
B	540	1710	2250
C	730	1020	1750
D	1790	1410	3200

$T_{i\text{-}I}$ for destination zones X, Y (Total attraction)	3620	4580	8200
Total predicted attractions	3700	4500	8200

It will be seen that the results are now closer to the total predicted attractions. If more accuracy is needed, further iterations can be done.

8a

17. The total trips produced in and attracted to the three zones A, B and C of a survey area in the design year are tabulated as:

Zone	Trips produced	Trips attracted
A	2000	3000
B	3000	4000
C	4000	2000

It is known that the trips between two zones are inversely proportional to the second power of the travel time between zones, which is uniformly 20 minutes. If the trip interchange between the zones B and C is known to be 600, calculate the trip interchange between zones A and B, A and C, B and A, C and B.

Solution:

$T_{i\text{-}j}=\frac{K.Pj.Aj}{tn}$

$T_{B\text{-}C}=\frac{K.PB.AC}{tn}$

$600=\frac{KX3000X2000}{20X20}$, $K=\frac{600X20X20}{3000X2000}=\frac{1}{25}$

$T_{A\text{-}B}=\frac{1}{25}X\frac{2000X4000}{20X20}=800$

$T_{A\text{-}C}=\frac{1}{25}X\frac{2000X2000}{20X20}=800$

$T_{B\text{-}A}=\frac{1}{25}X\frac{3000X3000}{20X20}=900$

$T_{C\text{-}A}=\frac{1}{25}X\frac{4000X3000}{20X20}=900$

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$T_{A\text{-}B}=\frac{1}{25}X\frac{4000X4000}{20X20}=1600$

B . define model split. Explain in brief the factors affecting model split

Soln :

Modal split is the process of separating person-trips by the mode of travel. It is usually expressed as a fraction, ratio or percentage of the total number of trips. In general, modal split refers to the trips made by private car or public transport (road or rail). An understanding of modal split is very important in transportation studies. Further transportation pattern can only be accurately forecast if the motivations that guide the traveler in his choice of the transportation modes can be analyzed. Though the factors that govern the individual choice of mode are complex, a study of the same is of great utility.

FACTORS AFFECTING MODAL SPLIT (MODAL SPLIT ANALYSIS)

Factors influencing mode choice of urban travelers:

1. Characteristics of the trip.

2. Household characteristics.

3. Zonal characteristics.

4. Network characteristics.

1.Characteristics of trip

i) Trip purpose: the choice of mode is guided to a certain extent by the trip purpose. To give an example, home based school trips have a high rate of usage of public transport. On the other hand, home based shopping journeys can have a higher rate of private car usage, for the simple reason that it is more convenient to shop when travelling in a personalized transport.

ii) Trip length: the length can govern an individual's choice of a particular mode. A measure of the trip length is also possible by the travel time and the cost of travelling.

2. Household characteristics

i) Income: the income of a person is a direct determinant of the expenses he is prepared to incur on a journey. Higher income groups are able to purchase and maintain private cars, and thus private car trips are more frequent as the income increase.

ii) Car ownership: car ownership is determined by the income and for this reason both income and car ownership are inter-related in their effect on modal choice. In general, families which own a car prefer private car trips, and in contrast families without car patronize public transport in the absence of any other alternative.

iii) Family size and composition: the number of persons in the family, the number of school-going children, the number of wage earns, the number of unemployed, the age-sex structure of the family, and some other factors connected with the socio- economic status of the family profoundly influence the modal choice. Some of these factors are responsible for certain captive trips in public transport, such as those due to old age pensioners, school children, crippled and infirm persons and those who do not wish to drive.

3. Zonal characteristics

i) Residential density

ii) Concentration of workers

iii) Distance from CBD

The use of public transport increases as the residential density increases. This is because of the fact that areas with higher residential density are inhabited by persons with lower income, lower levels of car ownership. It is also found that higher density areas are served well by public transport system and such areas are oriented towards a better use of public transport system.

4. Network characteristics

i) Accessibility Ratio

It is a measure of the relative accessibility of that zone to all other zones by means of mass transit network and highway network.

$$acci = \sum_{i=1}^{n} a_j f_{ij}$$

Where:

acci: accessibility index for zone i.

a_j: number of trips attractions in zone j.

f_{ij}: travel time factor for travel from zone i to zone j for the particular mode being considered.

n: number of zones in the urban area.

ii) Travel Time Ratio (TTR)

The ratio of the travel time by public transport and travel time by private car gives a measure of the attractiveness or otherwise of public transport system.

$$TTR = \frac{a+b+c+d+e}{f+g+h}$$

where:

a: time spent in the public transport vehicle.

b: transfer time between public –transport vehicles.

c: time spent waiting for public transport vehicle.

d:walking time to public transport vehicle.

e:walking time from public transport vehicle.

f: car driving time.

g: parking delay at destination.

h: walking time from parking place to destination.

iii) Travel Cost Ratio (TCR)

The ratio of cost of travel by public transport and cost of travel by car is one of the most important factors influencing modal choice. The importance of travel cost is related to the economic status. People with high incomes are unmindful of cost and prefer most expensive modes.

$$CR = \frac{i}{(j+k+0.5l)/m}$$

where:

i: public transport fare.

j: cost of petrol.

k: cost of oil, lubricants, etc.

l: parking cost at destination, if any.

m: average car occupancy.

iv) Service Ratio (SR)

The relative travel service was characterized by the ratio of the travel excess travel times by public transport and car. The excess travel time was defined as the time spent outside the vehicle during a trip. Thus, the Service Ratio was defined as follows:

$$SR = \frac{b+c+d+e}{g+h}$$

then, using TTR, CR, and SR, modal split curves were developed for work trips.

Module 5

9 a. Explain the concept of quick response technique.

B . Explain the difficulties in transportation planning for small and medium cities.

10 write a short note on

a. Capacity restraint technique.
b. Diversion curve
c. Equilibrium assignment
d. Lowry model

Soln :

3. Capacity restraint assignment techniques

This is the process in which the travel resistance of a link is increased according to a relation between the practical capacity of the link and the volume assigned to the link. This model has been developed to overcome the inherent weakness of all-or-nothing assignment model which takes no account of the capacity of the system between a pair of zones. This method clearly restrains the number of vehicles that can use in any particular corridor. The whole system, if assigned with volumes which are beyond the capacity of the network, then it redistributes the traffic to realistic alternative paths.

Steps:

- ✓ Here the procedure is similar to all-or-nothing assignment as far as the initial data input are concerned. The additional data fed is the capacity of each link. The best paths are determined in the same way as in all-or-nothing assignment by building the minimum path trees.
- ✓ Traffic is then assigned to the minimum paths, either fully or in stages.
- ✓ As the assigned volume on each link approaches the capacity of the link, a new set of travel time on the link is calculated.
- ✓ This results in a new network with a different minimum path tree, differing significantly from the earlier minimum path tree. As a consequence, assigning the inter-zonal volumes to the new tree produces a new volume on each link.
- ✓ This iterative process is repeated until a satisfactory balance between volume and speed is achieved.

4. Diversion Curves

Diversion curves methods are one of the frequently used assignment techniques. Diversion curves represent empirically derived relationship showing the proportion of traffic that is likely to be diverted on a new facility (bypass, new expressway, new arterial street, etc.) once such a facility is constructed. The curve is constructed by the data collected from the pattern of road usage in the past.
The curves are generally constructed using variables such as:

i. travel time saved,
ii. distance saved,
iii. travel time ratio

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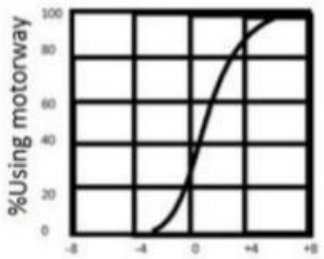
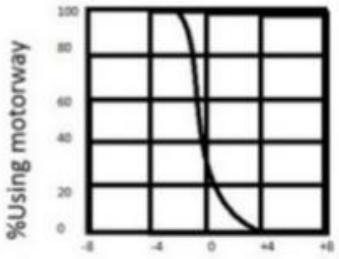
iv. travel distance ratio
v. travel time and distance saved
vi. distance and speed ratio
vii. travel cost ratio

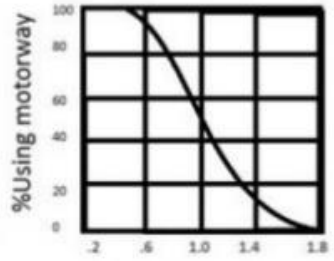
Examples of diversion curve using single variable are given below.



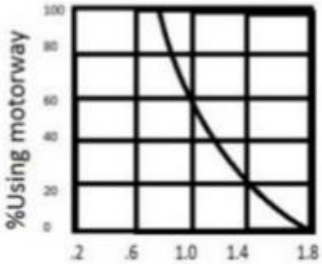
Travel time saved
min



Distance saved
min



Travel time ratio



Distance ratio

A well-known example of diversion curve using travel time ratio to determine the traffic diverted to expressway is the Bureau of Public Roads curve is shown below. The curve is "S" shaped.

Lowery Derivative Model

The Lowery derivative models have many of the above attributes. They are simple to use, require modest data, are comprehensive and economical, have good response to change in input variabl have simple causal structure. They have therefore been used extensively and successfully in a num studies. The fundamental structure of the model is illustrated in Figure.

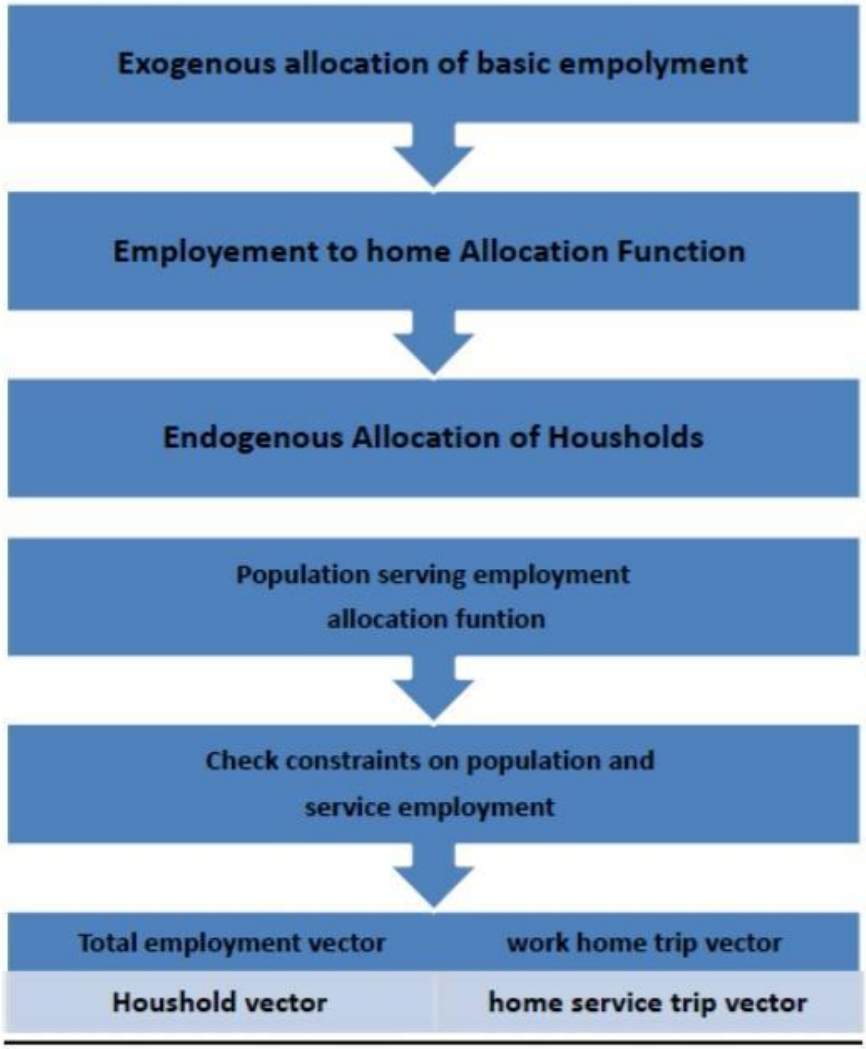


Figure (1): Structure of Lowery Model.

The Lowery model relates the three principle components of the urban area:
1. Population.
2. Employment.
3. Communication between population and employment.