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DISCIPLINE: MS CE

Q1: Calculate the trips distribution of each zone. Note: (Impedance exponent is 3)

Zone i		Productions	Attractiveness	Interzonal Impedance, j							
S.No	Name			1	2	3	4	5	6	7	8
1	Peshawar	67000	45	45	30	45	37	60	240	45	480
2	Charsadda	63300	37	30	30	25	30	45	220	60	500
3	Mardan	59400	24	45	25	30	15	30	195	85	535
4	Nowshera	56200	28	37	30	15	25	30	180	105	547
5	Swabi	53100	24	60	45	30	30	35	170	115	580
6	Abbottabad	50300	14	240	220	195	180	170	27	280	725
7	Kohat	47800	21	45	60	85	105	115	280	30	440
8	D.I Khan	51500	13	480	500	535	547	580	725	440	25

Solution:

Finding Q_{ij} for all the zones as:

Using C = 3,

Since $F_{ij} = 1/ W^{c}_{ij}$ so Fij would become;

$F_{ij} = 1/w_{ij}^{3}$

For i =1 (Peshawar), P_1 = 67000						
j	a_j	F_{1j}	K_{1j}	$a_j F_{1j}K_{1j}$	P_{1j}	Q_{1j}
1	45	0.0000109	1. 0	0.000491	0.163	10921
2	37	0.000037	1. 0	0.00137	0.455	30485
3	24	0.0000109	1. 0	0.00026	0.0864	5788
4	28	0.0000197	1. 0	0.000552	0.183	12261
5	24	0.00000463	1. 0	0.000111	0.0368	2465
6	14	0.0000000723	1. 0	0.00000101	0.000335	22.445

7	21	0.0000109	1. 0	0.00023	0.0764	5118
8	13	0.000000009	1. 0	0.000000117	0.0000388	2.5996
Total				0.00301	1.00	P_1=67000

For i =2 (Charsadda), P_2 = 63300						
j	a_j	F_{2j}	K_{2j}	$a_j F_{2j}K_{2j}$	P_{2j}	Q_{2j}
1	45	0.000037	1. 0	0.001665	0.1999	12653
2	37	0.000037	1. 0	0.001369	0.1643	10400
3	24	0.000064	1. 0	0.00153	0.184	11647
4	28	0.000037	1. 0	0.00104	0.125	7912
5	24	0.0000109	1. 0	0.000261	0.0316	2000
6	14	0.0000000939	1. 0	0.000001315	0.000158	10.0014
7	21	0.00000463	1. 0	0.000097	0.0116	734.28
8	13	0.000000009	1. 0	0.000000104	0.0000124	0.785
Total				0.00833	1.00	P_1=63300

Continued

For $i = 3$ (Mardan), $P_3 = 59400$						
j	a_j	F_{3j}	K_{3j}	$a_j F_{3j} K_{3j}$	P_{3j}	Q_{3j}
1	45	1.09×10^{-5}	1.00	4.938×10^{-4}	0.03806	2261.2
2	37	6.4×10^{-5}	1.00	2.36×10^{-3}	0.1825	10843.2
3	24	3.78×10^{-5}	1.00	8.88×10^{-4}	0.0685	4070.284
4	28	2.96×10^{-4}	1.00	8.29×10^{-3}	0.6395	37989.3
5	24	3.7×10^{-5}	1.00	8.88×10^{-4}	0.06852	4070.2
6	14	1.348×10^{-7}	1.00	1.88×10^{-6}	0.000146	8.645
7	21	1.628×10^{-6}	1.00	3.42×10^{-5}	0.002636	156.58
8	13	6.53×10^{-9}	1.00	8.489×10^{-8}	6.57×10^{-6}	0.388.

Total 0.0129

For i =4 (Nowshehra), P_4 = 56200						
j	a_j	F_{2j}	K_{2j}	$a_j F_{2j}K_{2j}$	P_{2j}	Q_{2j}
1	45	1.97E-05	1. 0	0.000888398	0.073595	4136.056
2	37	3.7E-05	1. 0	0.00137037	0.113522	6379.947
3	24	0.000296	1. 0	0.007111111	0.589088	33106.75
4	28	0.000064	1. 0	0.001792	0.14845	8342.901
5	24	3.7E-05	1. 0	0.000888889	0.073636	4138.344
6	14	1.71E-07	1. 0	2.40055E-06	0.000199	11.17608
7	21	8.64E-07	1. 0	1.81406E-05	0.001503	84.456
8	13	6.11E-09	1. 0	7.94294E-08	6.58E-06	0.369795
Total				0.012071388	1.00	

For i =5 (Swabi), P_2 = 53100						
j	a_j	F_{2j}	K_{2j}	$a_j F_{2j}K_{2j}$	P_{2j}	Q_{2j}
1	45	4.63E-06	1. 0	0.000208333	0.067119	3564.025
2	37	1.1E-05	1. 0	0.000406036	0.130813	6946.182
3	24	3.7E-05	1. 0	0.000888889	0.286375	15206.51
4	28	3.7E-05	1. 0	0.001037037	0.334104	17740.92
5	24	2.33E-05	1. 0	0.000559767	0.180341	9576.109
6	14	2.04E-07	1. 0	2.84958E-06	0.000918	48.74872
7	21	4.56E-08	1. 0	9.56633E-07	0.000308	16.36542

8	13	5.13E-09	1. 0	6.66284E-08	2.15E-05	1.139833
Total				0.003103935		

For i =6 (Abbottabad), P_6 = 50300						
j	a_j	F_{2j}	K_{2j}	$a_j F_{2j}K_{2j}$	P_{2j}	Q_{2j}
1	45	7.23E-08	1. 0	3.25521E-06	0.004443	223
2	37	9.39E-08	1. 0	3.47483E-06	0.004743	239
3	24	1.35E-07	1. 0	3.23674E-06	0.004418	222
4	28	1.71E-07	1. 0	4.8011E-06	0.006553	330
5	24	2.04E-07	1. 0	4.885E-06	0.006667	335
6	14	5.08E-05	1. 0	0.000711274	0.970775	48830
7	21	8.22E-08	1. 0	1.72598E-06	0.002356	118
8	13	2.62E-09	1. 0	3.41137E-08	4.66E-05	2
Total				0.000732687	1.00	P_1=63300

For i =7 (Kohat), P_2 = 51500						
j	a_j	F_{2j}	K_{2j}	$a_j F_{2j}K_{2j}$	P_{2j}	Q_{2j}
1	45	1.1E-05	1. 0	0.000493827	0.324302	15502
2	37	4.63E-06	1. 0	0.000171296	0.112492	5377
3	24	1.63E-06	1. 0	3.908E-05	0.025664	1227
4	28	8.64E-07	1. 0	2.41875E-05	0.015884	759
5	24	6.58E-07	1. 0	1.57804E-05	0.010363	495

6	14	4.56E-08	1. 0	6.37755E-07	0.000419	20
7	21	3.7E-05	1. 0	0.000777778	0.510775	24415
8	13	1.17E-08	1. 0	1.52611E-07	0.0001	5
Total				0.001522739		

For i =8 (DI Khan), P_1 = 67000						
j	a_j	F_{1j}	K_{1j}	$a_j F_{1j} K_{1j}$	P_{1j}	Q_{1j}
1	45	9.04E-09	1. 0	4.06901E-07	0.000488	25
2	37	8E-09	1. 0	0.000000296	0.000355	18
3	24	6.53E-09	1. 0	1.56729E-07	0.000188	10
4	28	6.11E-09	1. 0	1.71079E-07	0.000205	11
5	24	5.13E-09	1. 0	1.23006E-07	0.000148	8
6	14	2.62E-09	1. 0	3.67379E-08	4.41E-05	2
7	21	1.17E-08	1. 0	2.46525E-07	0.000296	15
8	13	0.000064	1. 0	0.000832	0.998276	51411
Total				0.000833437		

We get the following Distributions

A1	**54322**
A2	**72128**
A3	**73472**
A4	**84670**
A5	**22793**
A6	**48948**
A7	**29288**

A8 51423

Solution # 2

Q:2

Sol: Finding Utilities for all modes:

1) Autos:

Given utility function is;

$$U_{(AUTO)} = 3.2 - 0.85C - 0.015A - 0.5W - 0.035R$$

∵ Putting the given values of $C = 300, A = 6, W = 4$ and $R = 25$,

We get;

$$U_{(Auto)} = 3.2 - 0.85(300) - 0.015(6) - 0.5(4) - 0.035(25)$$

$$= 3.2 - 255 - 0.09 - 2 - 0.875$$

$$U_{(Auto)} = -254.765$$

2) Light Circular Rail:

Given utility function is;

$$U_{(LCR)} = 1.0 - 0.35C - 0.025A - 0.7W - 0.055R$$

Putting the given values of C, A, W, R,

We get.

$$U_{(LCR)} = 1.0 - 0.35(70) - 0.025(7) - 0.7(10) - 0.055(30)$$

$$= 1.0 - 24.5 - 0.175 - 7 - 1.65$$

$$U_{(LCR)} = -32.325$$

3) Local Buses:

Given utility function is;

$$U_{(LB)} = 1.7 - 0.15C - 0.075A - 0.9W - 0.075R$$

∴ Putting the given values of C, A, W, R we get;

$$U_{(LB)} = 1.7 - 0.15(50) - 0.075(10) - 0.9(15) - 0.055(40)$$

$$= 1.7 - 7.5 - 0.75 - 13.5 - 3$$

$$U_{(LB)} = -23.05$$

4) Riding Bikes:

Given utility function is;

$$U_{(RB)} = 1.3 - 0.17C - 0.012A - 0.0W - 0.095R$$

Putting the given values of C, A, W, R we get;

$$U_{(RB)} = 1.3 - 0.17(45) - 0.012(1) - 0 - 0.095(20)$$

$$= 1.3 - 7.65 - 0.012 - 1.9$$

$$U_{(RB)} = -8.262$$

5) Rapid Rail:

Given utility function is;

$$U_{(R.R)} = 1.5 - 0.25C - 0.095A - 0.6W - 0.025R$$

Putting the given values of C, A, W, R,
We get;

$$U_{(R.R)} = 1.5 - 0.25(90) - 0.095(5) - 0.6(20) - 0.025(15)$$

$$= 1.5 - 22.5 - 0.475 - 12 - 0.375$$

$$U_{(R.R)} = -33.85$$

Finding probabilities for all modes:

1) Auto:

Formula for finding probability of a mode(k) is;

$$P_{(k)} = \frac{e^{U_k}}{\sum_x e^{U_x}}$$

Putting values:

$$P_{(Auto)} = \frac{e^{-254.765}}{e^{-254.765} + e^{-32.325} + e^{-23.05} + e^{-8.262} + e^{-33.85}}$$

Since $e^{-254.765} = 0$

So $P_{(Auto)} = 0$

2) Light Circular Rail:

$$P_{(LCR)} = \frac{e^{-32.325}}{e^{-254.765} + e^{-32.325} + e^{-23.05} + e^{-8.262} + e^{-33.85}}$$

$$= \frac{9.15 \times 10^{-15}}{2.58 \times 10^{-4}}$$

$P_{(LCR)} = 3.54 \times 10^{-11}$

3) Local Buses:

$$P_{(LB)} = \frac{e^{-23.05}}{2.58\times10^{-4}}$$

$$P_{(LB)} = 3.78\times10^{-7}$$

4) Riding Bikes:

$$P_{(RB)} = \frac{e^{-8.262}}{2.58\times10^{-4}}$$

$$P_{(RB)} = 1.0005$$

5) Rapid Rail:

$$P_{(RR)} = \frac{e^{-33.85}}{2.58\times10^{-4}}$$

$$P_{RR} = 7.718\times10^{-12}$$

Number of Individuals choosing a particular mode are:

Total Population = 30,000

Auto = 30,000 × 0 = 0

Light Circular Rail = $30{,}000 \times 3.54\times10^{-11} = 1.06\times10^{-6}$

Local Buses = $30{,}000 \times 3.78\times10^{-7} = 0.01134$

Riding Bikes = $30{,}000 \times 1.0005 = 30015$

Rapid Rail = $30{,}000 \times 7.718\times10^{-12} = 2.315\times10^{-7}$

The question couldn't be solved any further due to irregularities in the given data.

Solution # 3:

Link array for the given network:

Zone **(i / j)**	A	B	C	D	1	2	3	4	5	6	7	8	9
A					4								
B							3						
C											5		
D													4
1						3		3					
2					3		4		4				
3		3				4				12			
4					3				5		7		
5						4		5		7		8	
6							12		7				9
7			5					7				10	
8									8		10		12
9				4						9		12	

Continued

Calculating Impedance from Zone-1 to all other zones and nodes:

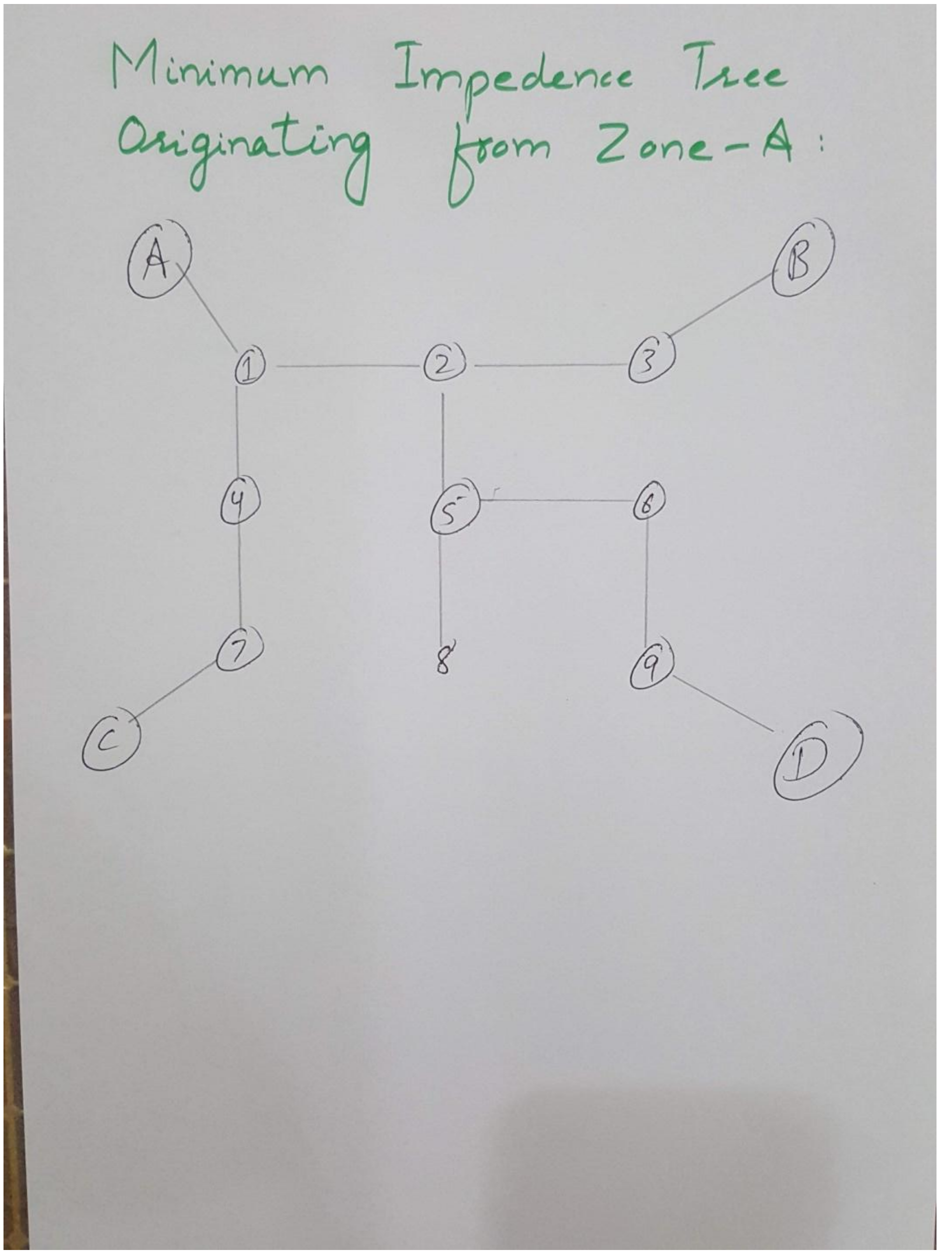
Stage N	**Link**		**Compute new path impedance**			**Compare to tree table Stage N-1**	**Decision**
	i	**j**					
I	A	1	0	4	4	4< Infinity	Accepted
II	1	2	4	3	7	7 < Infinity	Accepted
	1	4	4	3	7	7 < Infinity	Accepted
III	2	3	7	4	11	11 < Infinity	Accepted
	2	5	7	4	11	11 < Infinity	Accepted
	4	5	7	5	12	12 > 11	Rejected
	4	7	7	7	14	14< Infinity	Accepted
IV	3	B	11	3	14	15< Infinity	Rejected
	3	6	11	12	23	23 >18	Rejected
	5	6	11	7	18	18< Infinity	Accepted
	5	8	11	8	19	19< Infinity	Accepted
	7	C	14	5	19	19< Infinity	Accepted
	7	8	14	10	24	24 > 19	Rejected
V	6	9	19	9	29	19< Infinity	Accepted
	8	9	19	12	31	31 > 29	Rejected
VI	9	D	31	4	35	35< Infinity	Accepted

We get;

Minimum Impedance from Zone-1 to all other zones and nodes after removal of rejected links

Stage N	**Link**		**Compute new path impedance**			**Compare to tree table Stage N-1**	**Decision**
	i	**j**					
I	A	1	0	4	4	4< Infinity	Accepted
II	1	2	4	3	7	7 < Infinity	Accepted
	1	4	4	3	7	7 < Infinity	Accepted
III	2	3	7	4	11	11 < Infinity	Accepted
	2	5	7	4	11	11 < Infinity	Accepted
	4	7	7	7	14	14< Infinity	Accepted
IV	3	B	11	3	14	15< Infinity	Rejected
	5	6	11	7	18	18< Infinity	Accepted
	5	8	11	8	19	19< Infinity	Accepted
	7	C	14	5	19	19< Infinity	Accepted
V	6	9	19	9	29	19< Infinity	Accepted
VI	9	D	31	4	35	35< Infinity	Accepted

The minimum impedence tree originating from zone 1 is drawn below:


Minimum Impedence Tree
Originating from Zone-A:
A
B
C
D
1
2
3
4
5
6
7
8
9

Continued:

Solution# 4

Sol # 04

Finding Net Present Value for all alternative modes:

1) For CNG Bus:

We have the formula as;

$NPV = \text{Initial cost} + A_c(P/A_c, 7\%, 11) - A_R(P/A_R, 7\%, 11)$

Putting values

$= 60 + 24.038(7.499) - 32.04(7.499)$

$= 60 + 180.260 - 240.267$

$= 0.007$

So **NPV for CNG Bus = 0**

2) For Bus Rapid Transit:

Using formula

$NPV = \text{Initial cost} + A_c(P/A_c, 7\%, 11) - A_R(P/A_R, 7\%, 11)$

Putting Values

$$NPV = 50 + 31.705(7.943) - 38(7.943)$$
$$= 50 + 251.8 - 301.8$$
$$NPV = 0$$

3) For Light Rail:
Using the same formula;
We get:

$$NPV = 66 + 35.554(8.863) - 43(8.863)$$
$$= 0.006$$

So NPV for Light Rail = 0

4) For Fast Train:
Using the same formula;

$$NPV = 95 + 50.477(8.244) - 57(8.244)$$

$$NPV = 41.22$$

5) For Metro:

Using the same formula;

We get;

$$NPV = 70 + 44.535(10.828) - 51(10.828)$$

$$NPV = 0.003$$

Which is considered as zero;

So <u>NPV for Metro is 0</u> //

Remarks:

After Net Present Value analysis of all the alternatives we can conclude that the Fast Train is the most expensive, than the rest of the alternatives. The rest of the alternatives are approximately zero net present value.

Keeping in perspective, the socio-economic conditions of our country, it is recommented the government focus on Bus Rapid Transit.