TRANSPORTATION PLANNING AND MANAGEMENT

Final Examination Paper

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Q1: Calculate the trips distribution of each zone. Note: (Impedance exponent is 3) (15)

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

Ans:

Zone,+D8:M22 i	**Name**	**Trip Productions, P_i**	**Attractiveness, A_i**
1	peshawar	67000	45
2	Charsada	63300	37
3	Mardan	59400	24
4	Nowshera	56200	28
5	swabi	53100	24
6	Abbot abad	50300	14
7	Kohat	47800	21
8	DI khan	51500	13

	for I=Peshawar P1=67000								
Zone i		Interzonal impedance W_{ij}							
		Zone j							
		1	2	3	4	5	6	7	8
1	peshawar	45	30	45	37	60	240	45	480
2	Charsada	30	30	25	30	45	220	60	500
3	Mardan	45	25	30	15	30	195	85	535
4	Nowshera	37	30	15	25	30	180	105	547
5	swabi	60	45	30	30	35	170	115	580
6	Abbot abad	240	220	195	180	170	27	280	725
7	Kohat	45	60	85	105	280	230	30	440
8	DI khan	480	500	535	547	580	725	440	25

for I=Peshawar P1=67000							
j		a_j	F_{1j}	K_{1j}	$a_j F_{1j}K_{1j}$	P_{1j}	Q_{1j}
1	peshawar	45	1.1E-05	1	0.0004938	0.1634	10945
2	Charsada	37	4E-05	1	0.0013704	0.4533	28694
3	Mardan	24	1E-05	1	0.0002634	0.0871	5175
4	Nowshera	28	2E-05	1	0.0005528	0.1829	10276
5	swabi	24	5E-06	1	0.0001111	0.0368	1952
6	Abbot abad	14	7E-08	1	0.0000010	0.0003	17
7	Kohat	21	1E-05	1	0.0002305	0.0762	3644
8	DI khan	13	9E-09	1	0.0000001	4E-05	2
Total					0.0030	1	60705

For i =Charsada P_3 = 63300							
j		a_j	F_{3j}	K_{3j}	$a_j F_{3j}K_{3j}$	P_{3j}	Q_{3j}
1	peshawar	45	3.7E-05	1	0.00166667	0.2791	17666
2	Charsada	37	3.7E-05	1	0.00137037	0.2295	13630
3	Mardan	24	0.000064	1	0.001536	0.2572	14454
4	Nowshera	28	3.7E-05	1	0.00103704	0.1736	9221
5	swabi	24	1.1E-05	1	0.00026337	0.0441	2218
6	Abbot abad	14	9.39E-08	1	1.3148E-06	0.0002	11
7	Kohat	21	4.63E-06	1	9.7222E-05	0.0163	838
8	DI khan	13	8E-09	1	1.04E-07	2E-05	1
					0.00597209		

For i =Mardan P_3 = 59400							
j		a_j	F_{3j}	K_{3j}	$a_j F_{3j}K_{3j}$	P_{3j}	Q_{3j}
1	peshawar	45	1.1E-05	1	0.0004938 3	0.0381	2261. 3
2	Charsada	37	0.00006 4	1	0.002368	0.1825	10843
3	Mardan	24	3.7E-05	1	0.0008888 9	0.0685	4070. 3
4	Nowshera	28	0.00029 6	1	0.0082963	0.6396	37989
5	swabi	24	3.7E-05	1	0.0008888 9	0.0685	4070. 3
6	Abbot abad	14	1.35E-07	1	1.8881E-06	0.0001	8.645 7
7	Kohat	21	1.63E-06	1	3.4195E-05	0.0026	156.5 8
8	DI khan	13	6.53E-09	1	8.4895E-08	7E-06	0.388 7
					0.0129720 7		

For i =Nowshera, P_4= 56200							
j		a_j	F_{3j}	K_{3j}	$a_j F_{3j}K_{3j}$	P_{3j}	Q_{3j}
1	peshawar	45	1.97E-05	1	0.0008884	0.0736	4136
2	Charsada	37	3.7E-05	1	0.0013703 7	0.1135	6379
3	Mardan	24	0.00029 6	1	0.0071111 1	0.5891	33107
4	Nowshera	28	0.00006 4	1	0.001792	0.1485	8342
5	swabi	24	3.7E-05	1	0.0008888	0.0736	4138
6	Abbot abad	14	1.71E-07	1	2.4005E-06	0.0002	11
7	Kohat	21	8.64E-07	1	1.8141E-05	0.0015	84.
8	DI khan	13	6.11E-09	1	7.9429E-08	7E-06	0.369 8
					0.0120713 9		

For i= SwabiP5=53100							
j		a_j	F_{3j}	K_{3j}	$a_j F_{3j}K_{3j}$	P_{3j}	Q_{3j}
1	peshawar	45	4.63E-06	1	0.00020833	0.0671	3564
2	Charsada	37	1.1E-05	1	0.00040604	0.1308	6946
3	Mardan	24	3.7E-05	1	0.0008889	0.2864	15207
4	Nowshera	28	3.7E-05	1	0.0010370 4	0.3341	17741
5	swabi	24	2.33E-05	1	0.0005597 7	0.1803	9576
6	Abbot abad	14	2.04E-07	1	2.8496E-06	0.0009	48
7	Kohat	21	4.56E-08	1	9.5663E-07	0.0003	16
8	DI khan	13	5.13E-09	1	6.6628E-08	2E-05	2
					0.0031039		

For i=AbbotabdP6=50300							
j		a_j	F_{3j}	K_{3j}	$a_j F_{3j}K_{3j}$	P_{3j}	Q_{3j}
1	peshawar	45	7.23E-08	1	3.2552E-06	0.0044	223
2	Charsada	37	9.39E-08	1	3.4748E-06	0.0047	239
3	Mardan	24	1.35E-07	1	3.2367E-06	0.0044	222
4	Nowshera	28	1.71E-07	1	4.8011E-06	0.0066	330
5	swabi	24	2.04E-07	1	4.885E-06	0.0067	335
6	Abbot abad	14	5.08E-05	1	0.00071127	0.9708	48830
7	Kohat	21	8.22E-08	1	1.726E-06	0.0024	118
8	DI khan	13	2.62E-09	1	3.4114E-08	5E-05	2
					0.00073269		

For i= Kohat=47800							
j		a_j	F_{3j}	K_{3j}	$a_j F_{3j}K_{3j}$	P_{3j}	Q_{3j}
1	peshawar	45	1.1E-05	1	0.0004938 3	0.3243	15502
2	Charsada	37	4.63E-06	1	0.0001713	0.1125	5377
3	Mardan	24	1.63E-06	1	3.908E-05	0.0257	1227
4	Nowshera	28	8.64E-07	1	2.4187E-05	0.0159	759
5	swabi	24	6.58E-07	1	1.578E-05	0.0104	495
6	Abbot abad	14	4.56E-08	1	6.3776E-07	0.0004	20
7	Kohat	21	3.7E-05	1	0.0007777 8	0.5108	24415
8	DI khan	13	1.17E-08	1	1.5261E-07	0.0001	5
					0.0015227 4		

For i=DI Khan P8=51500							
j		a_j	F_{3j}	K_{3j}	$a_j F_{3j}K_{3j}$	P_{3j}	Q_{3j}
1	peshawar	45	9.04E-09	1	4.069E-07	0.0005	25
2	Charsada	37	8E-09	1	2.96E-07	0.0004	18
3	Mardan	24	6.53E-09	1	1.5673E-07	0.0002	10
4	Nowshera	28	6.11E-09	1	1.7108E-07	0.0002	11
5	swabi	24	5.13E-09	1	1.2301E-07	0.0001	8
6	Abbot abad	14	2.62E-09	1	3.6738E-08	4E-05	2
7	Kohat	21	1.17E-08	1	2.4653E-07	0.0003	15
8	DI khan	13	0.00006 4	1	0.000832	0.9983	51411
					0.0008334 4		

Total trip A1	54322
A2	72128
A3	73472
A4	84670
A5	22793
A6	48948
A7	29288
A8	51423

Q2: The choice transport modes of a city includes: Autos (A), Light Circular Rail (LCR), Local Buses (LB), Riding Bikes (RB) and Fast Rail (FR). The utility functions of each mode are:

S.No	Mode	Utility functions	C	A	W	R
1	Autos	3.2 - 0.85C - 0.015A - 0.5W - 0.035R	300	6	4	25
2	Light Circular Rail	1.0 - 0.35C - 0.025A - 0.7W - 0.055R	70	7	10	30
3	Local Buses	1.7 - 0.15C - 0.075A - 0.9W - 0.075R	50	10	15	40
4	Riding Bikes	1.3 - 0.17C - 0.012A - 0.0W - 0.095R	45	1	0	20
5	Rapid Rail	1.5 - 0.25C - 0.095A - 0.6W - 0.025R	90	5	20	15

Where C is the cost in Rupees, A, W & R are access, waiting & riding times in minutes respectively.

a. Based on an estimate a population of 30,000 individuals will head for CBD each morning to run there business, how many individuals will choose a particular transport mode & what amount of revenue will be generated? (5)

b. If the government subsidizes Light Circular Rail by 30%, Local Buses by 20% and Rapid Rail by 10% what will be the model split and how much revenue will be generated? (5)

c. If the government also introduce a subway train in combination with above subsidized rates (As in part-b) having utility function as U = 1.2 - 0.22C - 0.015A - 0.65W - 0.020R & other attributes as C=80, A=4, W=5 and R=10 and also increase the autos and riding bike cost by 15% and 5% respectively. Will there be any effect on revenue generation? (5)

ANS: #2:

Parts I) To calculate utility function from hiven data

U(Auto)=3.2-.85(300)-.015(60)-.5(4)-.035(25)

=-254.765

U(LC)= 10-.35(70)-.025(7)-.7(10)-.05(30)

=-32.32

U(LB)= 1.7-.15(50)-.075(10)-.9(15)-.075(40)

= -23.5

U(RB)=13-.17(45)-.012(1)-0.0(0)-.093(20)

=-7.3

U(RR)=1.5-.25-.95(A)-.6(W)-.025(R)

=1.5-.25(90)-.95(5)-.6(20)-.025(15)

=-33.85

As we know that

P(K)=e*uk/Exe*ux

P(Auto)=e*-254.765/e-254.76+e*-23.5+e*-7.3+e*-33.85

=0.00

P(LCR)=e*-32.9/6.75x10*-4

=0

P(LB)=e*-23.5/6.75x10*-4=00

P(RB)=e*-7.3/6.75x10*-4=0

P(R Rail)=e*-33.85/6.75x10*-4=0

Caculating the number of indiuviduals using facilty

Q(ij)k=No of individual *P(K)

for all mode of transportation Number of individual using different mode is zero so revenue will also be zero

Ans#2 Part B): When give 30 subsidy

Autos	C	A	W	R
Light Circular Rail	210	6	4	25
Local Buses	49	7	10	30
Riding Bikes	35	10	15	40
Rapid Rail	63	5	20	15

Utility function for Autos

=3.2-.85C-.015A-.5W-.035R

Putting the Values

=3.2-.85(210)-.015(49)-.5(4)-.035(25)

=-177.16

U(L Rail)= 10-.35C-.025A-.7W-.055R

=1-.35(49)-.025(10)-.7(10)-.055(30)

=-.25.05

U Local bus= 1.7-.15C-.075A-9W-.075R

=1.7-(.15x35)-.075(10)-.9(15)-.075(40)

=-20.8

U riding bikes = 1.3- .17(31.5)-.012(1)-(.0*0)-.095(20)

=-5.967

U R rail = 1.5-.25C-1.95A-.6W-.25(03)-.09(50)-.6x20-.025x15

=-27.1

So as per formula

P(Auto)= e*-177.16/e*-177.16+e*-25.05+e*-20.8+e*-5.967+e*-27.1

=[0]=1.149x10*-77/2.56x10*-5

P(Auto)=0

P(LCR)=0

P(P(LB)=0

P(BB)=0

P(RR)=0

and as other values are zero for all modes of transportation

Part c:A sub way is introduced and and the cost of auto and bike are increases respectively 15 and 5%

	C	A	W	R
Autos	345	6	4	25
Light Circular Rail	70	7	10	30
Local Buses	50	10	15	40
Riding Bikes	47	1	0	20
Rapid Rail	90	5	20	15
Sub way bus	80,	4,	5	10

U = 1.2 - 0.22C - 0.015A - 0.65W - 0.020R

So by putting the values to calculate the utility function

U(a)=	-293.825
U(LCR)=	-46.805
U(RT)=	-37.1
U(RB)=	-39.5775
U(RR)=	-62.65
U(Sub bus)	-69.76

P(a) =	0.0
P(LCR) =	21.0
P(RT) =	0.0
P(RB) =	0.0
P(RR) =	0.0
P(Su Busb) =	0.0

Individuals	(Auto) =	0	individuals/day
	(LCR) =	-983	individuals/day
	(RT) =	0	individuals/day
	(RB) =	0	individuals/day
	(RR) =	0	individuals/day
	Sub way bus	0	individuals/day

Revenue		
	(Auto) =	-3.3644E-104
	(LCR) =	-29501142.83
	(RT) =	-8.5935E-11
	(RB) =	-5.77787E-21
	(RR) =	-8.72933E-31
	Sub way bus	-5.28828E-25

Note:The calculation has been also done in excel using standard procedure and formula and we have got the same result there are some attach screen shots

Attributes	C	A	W	R	ak
Automobile	300	60	4	25	3.2
LCR	70	7	10	30	1
LBUs	50	10	15	40	1.7
Rdidng Bikes	45	1	0	20	1.3
Rapid railk	90	5	20	15	1.5
U(a)= -255.575					
U(LCR)= -64.655					
U(RT)= -49.85					
U(RB)= -37.665					
U(RR)= -85.6					
P(a) = 0.0					
P(LCR) = 0.0					
P(RT) = 0.0					
P(RB) = 0.0					
P(RR) = 0.0					
Qij (Auto) =	0	ndividuals/day			
Qij (LCR) =	0	ndividuals/day			
Qij (RT) =	0	ndividuals/day			

When 30%subsidu given bu govt					
Attributes	C	A	W	R	ak
Automobile	210	60	4	25	3.2
LCR	49	7	10	30	1
LBUs	35	10	15	40	1.7
Rdidng Bikes	31.5	1	0	20	1.3
Rapid railk	63	5	20	15	1.5

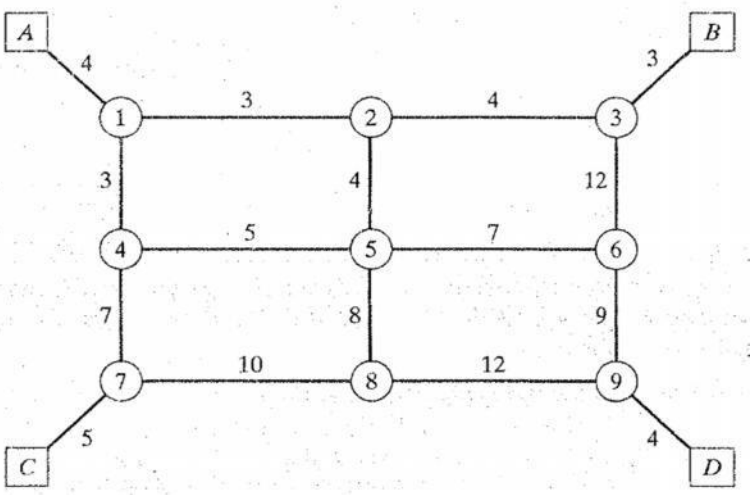
U(a)= -179.075
U(LCR)= -46.805
U(RT)= -37.1
U(RB)= -26.19
U(RR)= -62.65

P(a) = 0.0
P(LCR) = 0.0
P(RT) = 0.0
P(RB) = 0.0
P(RR) = 0.0

Etc……

Note:Abbrevation are used for all modes of tranport

Q3: Find link array and minimum impedance tree originating from Zone-A for the network



described below. (10)

Assign the following interzonal vehicular-trips originating from Zone-A per hour to the above network.

If the travel time at practical capacity of link (5-6) 36.24-miles long is as shown in the etwork diagram above with assigned traffic of 75000 veh/day. What is the link operating speed with $\alpha = 0.25$ and $\beta = 6$.

Interzonal vehicular-trips originating from Zone-A			
J	*B*	*C*	*D*
Q_{Aj}	*900*	*1200*	*1750*

Link Array

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

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
	2	1	7	3	10	10> 4	Rejected
III	2	3	7	4	11	11 < Infinity	Accepted
	2	5	7	4	11	11 < Infinity	Accepted
	3	B	11	3	14	14 < Infinity	Accepted
	3	6	11	12	23	23> 18	Rejected
	3	2	11	4	15	15> 7	Rejected
	4	1	7	3	10	10> 4	Rejected
	4	5	7	5	12	12> 11	Rejected
	4	7	7	7	14	14 < Infinity	Accepted
	5	2	11	4	15	15> 7	Rejected
	5	4	11	5	16	16> 7	Rejected
	5	6	11	7	18	18 < Infinity	Accepted
	5	8	11	8	19	19 < Infinity	Accepted
	6	3	23	12	35	35 > 11	Rejected
	6	5	23	7	30	30 > 11	Rejected
	6	9	23	9	32	32> 31	Rejected
	7	4	14	7	21	21 > 7	Accepted
	7	8	14	10	24	24 > 19	Rejected
	7	C	14	5	19	19< Infinity	Accepted
iv	8	5	19	8	27	27> 11	Rejected
	8	9	19	12	31	31< Infinity	Accepted
	8	7	19	10	29	29> 14	Rejected
	9	D	32	4	36	36< Infinity	Accepted
	9	8	32	12	44	44> 19	Rejected
	9	6	32	9	41	41> 18	Rejected

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

	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
	3	B	11	3	14	14 < Infinity	Accepted
	4	7	7	7	14	14 < Infinity	Accepted
	5	6	11	7	18	18 < Infinity	Accepted
	5	8	11	8	19	19 < Infinity	Accepted
	7	4	14	7	21	21 > 7	Accepted
	7	C	14	5	19	19< Infinity	Accepted
Iv	8	9	19	12	31	31< Infinity	Accepted
	9	D	32	4	36	36< Infinity	Accepted

Q4:The City government wants to start a transit service between three cities A, B & C. The alternatives are having the following attributes.(10)

S.No	Alternative (X)	Initial Cost (million)	Annual Operating Cost (million)	Annual Maintenance (million)	Annual Salvage value (million)	Annual revenue generation (million)	Useful life (Years)	Interest rate, i%
1	CNG Bus	60	16.048	7.99	7.04	25	11	7
2	Bus Rapid Transit	50	19.589	12.116	11	27	12	7
3	Light Rail	66	19.554	16	14	29	12	5
4	Fast Train	95	31.132	19.345	17	45	14	8
5	Metro	70	25	19.535	16	35	18	6

Using Net Present Value which alternative will you recommend and why?

Ans: #4

PV = PW (BENEFITS) – PW (COSTS)
USPWF = (1+i)^n -1/i(1+i)^n
SPPWF = 1/(1+i)^n
All values are calculated for all modes on the base of standard formulas for NPV

(1) NPV for CNG Bus

= 25 * USPWF (7%,11)- 60 - (24.038)*USPWF(7%,11)+7.04 (SPPWF)(7%,11)
= -49.27 MILL

(2) NPVFor BUS RAPD TRASIT:

= 27 * USPWF (7%,12)- 50 - (31.704)*USPWF(7%,12) +11 (SPPWF)(7%,12)
= - 82.61 MILL

(3) NPV for LIGHT RAIL:

= 29 * USPWF (5%,12)- 66 - (35.55)*USPWF(5%,12) +14 (SPPWF)(5%,12)
= - 116.26 MILL

(4) NPV of FAST TRAIN):

= 45 * USPWF (8%,14)- 95 - (50.47)*USPWF(8%,14) +17 (SPPWF)(8%,14)
= - 134.31 MILL

(5) NPV of METRO:

= 35 * USPWF (6%,18)- 70 - (44.53)*USPWF(6%,18) +16 (SPPWF)(6%,18)

= - 167.3 MIL

Reference Material:

1. Class Lectures/Presentations/Video demonstrations
2. Engineering Transportation Engineering & Planning by Papacostas
3. Transportation Engineering by C JotinKhisty& B. Kent Lall
4. Highway Traffic Analysis and Design 2nd Edition By R. J. Salter
5. Transport Planning and traffic engineering Edited by C A O Flaherty
6. Principles of Engineering Economics with Applications ByZahid A. Khan, Arshad N. Siddiquee, Brajesh Kumar, Mustufa H. Abidi