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Trip generation

Given:

Avg. rate	Range of Rate	Std. deviation
8.11	1.78 – 24.95	5.85

Trip generation per 1000 sq. feet floor area

T = Avg. vehicle trip ends

$\ln(T) = 0.82 \ln x + 3.14$

x = 1000 sq.ft gross floor area

Question: For a four storied building determine avg. trips generated if the dimension of every storey is 200ft x 100ft. use avg. rate and fitted curve

Answer:

Using average rate:

Total area = $4 \times (200 \times 100)$
= 80000 sq. feet

Per 1000 sq. feet of floor area produces 8.11 trips

∴ " 1 " " " " $\frac{8.11}{1000}$ trips

∴ " 80000 " " " " $\frac{8.11 \times 80000}{1000}$ "

= 648.8

≃ 649 "

By using fitted curve:

$\ln(T) = 0.82 \ln x + 3.14$ where, x = in 1000 sq-ft gross floor area.

Here, total area = 80000 sq-feet

$\therefore x = \frac{80000}{1000} = 80$

$\therefore \ln(T) = 0.82 \ln(80) + 3.14$

$\Rightarrow T = 839.8$

≈ 840 trips.

(*) Question: 10 A zone has 275 households with car and 275 households without car and let the average trip generation rates for each group is 5.0 and 2.5 trips per day respectively. Assuming that in future all household will have a car find the growth factor and future trips from that zone assuming that the population and income remain contant.

Answer:

Current trips:

With car = 275 × 5 = 1375 trips per day

without car = 275 × 2.5 = 687.5 trip per day

≈ 688 trips per day

∴ Total current trips = 1375 + 688 = 2063 trips/day

Future trips: All households have car. Total household = 550

With car = 550 × 5 = 2750 trips/day

∴ Growth Factor = $\frac{\text{Future total trips}}{\text{Current total trips}}$

$= \frac{2750}{2063} = 1.33$

So, Growth Factor = 1.33

and Future total trips = 2750 trips/day.

(*) Given:

Workers	Rate
1	1.383 25222
2	2.39110122
3+	3.886 67372

TAZ 123 has:

50 HHs with 0 workers

100 HHs with 1 worker

200 HHs with 2 workers

50 HHs with 3+ workers

Question: How many HBW trip productions are generated by TAZ 123?

⇒ Trips for 0 workers = 0 ⊗

Trips for 1 worker = 100 × 1.38
= 138

Trips for 2 workers = 200 × 2.39
= 478

Trips for 3+ workers = 50 × 3.88
= 194

∴ Total = 0 + 138 + 478 + 194
= 810 HBW trip productions.

(*) Given

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(*) Given TAZ (123) has
400 households
600 Jobs → 400 office jobs
→ 200 government jobs

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ITE -

Trip attraction rate:
HBW : 1.25 trips / Jobs
HB Social : 0.9 trips / office jobs + 0.25 trips / government job + 0.3 trips / household

Question: How many HBW and HBSocial trip attractions are generated by TAZ.

⇒ HBW: Trips = 1.25 × 600
= 750 (Home based work वाले या Job वाले)

HBSocial: Trips = 0.9 × 400 + 0.25 × 200 + 0.3 × 400
= 530

Gravity model calibration

Base year ও impedance matrix দেয়া থাকবে।
1st ও একটা FF matrix ধরে নিয়ে এটা use করে base year (1) matrix বের করব।
পরে friction factor বের করব ও 1st FF matrix 2 বের করে base year 2 matrix বের করব। এভাবে চলবে।

$$T_{ij} = \frac{P_i \times A_j \times F_{ij}}{\Sigma (A_j \times F_{ij})}$$

এটা Question এর Aij

Given:

Base year

P/A	Z_1	Z_2	Z_3	Total
Z_1	5	50	95	150
Z_2	45	5	100	150
Z_3	50	95	5	150
Total	100	150	200	450

Impedance

TT	Z_1	Z_2	Z_3
Z_1	5	16	13
Z_2	16	7	20
Z_3	13	20	2

CamScanner

Answer:

$$T_{ij} = \frac{P_i \times A_j \times F_{ij}}{\Sigma (A_j \times F_{ij})}$$

Base year (1)

P/A	Z_1	Z_2	Z_3	Total	$\Sigma A_j \times F_{ij}$
Z_1	33.3	50	66.7	150	450
Z_2	33.3	50	66.7	150	450
Z_3	33.3	50	66.7	150	450
Total	100	150	200		

FF matrix (1)

P/A	Z_1	Z_2	Z_3
Z_1	1	1	1
Z_2	1	1	1
Z_3	1	1	1

$\left(\frac{\text{obs.}}{\text{Est}}\right) \times$ Previous FF

Friction Factor

Base year (2)

P/A	Z_1	Z_2	Z_3	Total	$\Sigma A_j \times F_{ij}$
Z_1	2.9	63	84.1	150	517.5
Z_2	48.3	5	96.7	150	450
Z_3	56.9	85.3	7.8	150	382.5
Total	108.1	153.3	188.6	450	

TT	Est	obs.	FF
1-10	150	15	0.1
11-15	100	145	1.45
16-20	200	290	1.45

P/A	Z_1	Z_2	Z_3
Z_1	0.1	1.45	1.45
Z_2	1.45	0.1	1.45
Z_3	1.45	1.45	0.1

Base year 3

P/A	Z_1	Z_2	Z_3	Total	$\Sigma(A_j \times F_{ij})$
Z_1	2.73	61.64	85.63	150	.522
Z_2	48.4	~~72.6~~ 4.8	96.8	150	443.25
Z_3	58.4	84.2	7.45	150	382.5
Total	109.53	150.64	189.88	450	

Friction factor

TT	Est	obs.	FF
1-10	15.7	15	0.095
11-15	141	145	1.49
16-20	293.3	290	1.43

$\frac{290}{293.3} \times 1.45$

$\left(\frac{obs.}{Est}\right) \times$ Previous FF

P/A	Z_1	Z_2	Z_3
Z_1	0.095	1.43	1.49
Z_2	1.43	0.095	1.43
Z_3	1.49	1.43	0.095

Base year 4

P/A	Z_1	Z_2	Z_3	Total	$\Sigma A_j \times F_{ij}$
Z_1	2.72	61.4	85.9	150	524
Z_2	48.4	4.82	96.8	150	443.25
Z_3	58.7	83.9	7.43	150	383.5
Total	109.82	150.12	190.13	450	

Friction factor

TT	Est	obs	FF
1-10	14.98	15	0.095
11-15	144.03	145	1.5
16-20	291.04	290	1.43

FF matrix

P/A	Z_1	Z_2	Z_3
Z_1	0.095	1.43	1.5
Z_2	1.43	0.095	1.43
Z_3	1.5	1.43	0.095

যতক্ষণ পর্যন্ত $|FF_{new} - FF_{old}| < 0.01$

or 0.001 না হয়

Gravity application

Forecast year

P/A	Z_1	Z_2	Z_3	Goal
Z_1				180
Z_2				165
Z_3				255
Goal	195	165	240	600

Impedance

TT	Z_1	Z_2	Z_3
Z_1	7	18	16
Z_2	18	11	20
Z_3	16	20	5

TT	Ext.	obs.	FF
1–10	15	15	0.1
11–15	145	145	1.51
16–20	290	290	1.43

⇒ Friction factor matrix:

P/A	Z_1	Z_2	Z_3
Z_1	0.1	1.43	1.43
Z_2	1.43	1.51	1.43
Z_3	1.43	1.43	0.1

$$T_{ij} = \frac{P_i \times A_j \times F_{ij}}{\Sigma (A_j \times F_{ij})}$$

P/A	Z_1	Z_2	Z_3	Total	$\Sigma(A_j \times F_{ij})$
Z_1	5.86	70.94	103.2	180	598.65
Z_2	52.8	47.2	65	165	871.2
Z_3	131.97	111.6	11.4	255	538.8
Total	190.63	229.74	179.6	600	

Mode choice

Utility maximization

Question:

Alternative	Time (min)	Cost ($)
Car	5	5.0
Bus	15	2.0

Utility function: $U_k = (-0.2) \times \text{time} + (-1)\,\text{cost}$

Which mode should be choosed?

$\Rightarrow U_{car} = -0.2 \times 5 + (-1) \times 5 = -6$

$U_{bus} = -0.2 \times 15 + (-1) \times 2 = -5$

$U_{bus} > U_{car} \rightarrow$ So use bus.

Question:	Alternative	Time (min)	Cost ($)	Benefit
	Car to shop	5	5.00	yes
	Bus to shop	15	2.00	yes
	Stay at home	0	0.00	no

Utility function: $U_k = (-0.5)\,\text{time} + (-1)\,\text{cost} + 20 \times \text{benefit}$

Which alternate will be choosen.

$\Rightarrow U_{car} = (-0.5) \times 5 + (-1) \times 5 + 20 = 12.5$

$U_{bus} = (-0.5) \times 15 + (-1) \times 2 + 20 = 10.5$

$U_{home} = 0$

$U_{car} > U_{bus} > U_{home} \Rightarrow$ Choose car

Multinomial logit model:

Question	Alternative	Time	Cost
	Car	5	5
	bus	15	2

$V_k = (-0.2)\text{time} + (-1)\text{cost}$

which mode will be choosen ?

MNL use ~~use~~ always

$\Rightarrow V_{car} = (-0.2)\times 5 + (-1)\times 5 = -6$

$V_{bus} = (-0.2)\times 15 + (-1)\times 2 = -5$

$\exp(V_{car}) = e^{-6} = 0.00248$

$\exp(V_{bus}) = e^{-5} = 0.00674$

$\therefore \text{Prob(car)} = \frac{0.00248}{0.00248+0.00674} = 0.269$

$\therefore \text{Prob(bus)} = \frac{0.00674}{0.00248+0.00674} = 0.731$

Bus

Question:	Alternative	Time	cost
	car	5	5
	Bus1 (blue)	15	2
	Bus 2 (Red)	15	2

$V_k = (-0.2)\text{time} + (-1)\text{cost}$

$\Rightarrow V_{car} = (-0.2)\times 5 + (-1)\times 5 = -6$

$V_{bus_1} = (-0.2)\times 15 + (-1)\times 2 = -5$

$V_{bus\ 2} = (-0.2)\times 15 + (-1)\times 2 = -5$

$\exp(\text{car}) = e^{-6} = 0.00248$

$\exp(\text{bus_1}) = e^{-5} = 0.00674$

$\exp(\text{bus_2}) = e^{-5} = 0.00674$

$\text{Prob}(\text{car}) = \frac{0.00248}{0.00248 + 0.00674 + 0.00674} = 0.155$

$\text{Prob}(\text{bus_1}) = \frac{0.00674}{0.00248 + 0.00674 + 0.00674} = 0.422$

$= \text{Prob}(\text{bus 2})$

Red bus / blue bus paradox

15.5% car and 84.4% bus (total)

Question -3:

Alternative	Time	Cost
Car 1 (Uber)	5	5
Car 2 (Lyft)	5	5
Bus	15	2

$V_k = (-0.2)\text{time} + (-1)\text{cost}$

What are the probabilities of choosing each alternative?

$\Rightarrow V_{car1} = (-0.2) \times 5 + (-1) \times 5 = -6$

$V_{car2} = (-0.2) \times 5 + (-1) \times 5 = -6$

$V_{bus} = (-0.2) \times 15 + (-1) \times 2 = -5$

$\exp(V_{car1}) = e^{-6} = 0.00248 = \exp(V_{car2})$

$\exp(V_{bus}) = e^{-5} = 0.00674$

$\therefore \text{Prob}(V_{car1}) = \frac{0.00248}{0.00248 \times 2 + 0.00674} = 0.212 = \text{Prob}(V_{car2})$

$\text{Prob}(\text{bus}) = (0.00674) / (0.00248 \times 2 + 0.00674) = 0.576$

Uber and Lyft paradox

42.4% car (total) and 57.6% bus

যেইসব math এ IIA paradox পাওয়া যায় তারাই IIA দ্বারা affect হবে সেক্ষেত্রে Nested logit model use- Correlation যেয়া থাকবে।

Nested logit model:

m + correlation = 1

Alternative	Time	cost
Car	5	5
Bus 1 (Blue)	15	2
Bus 2 (Red)	15	2

Correlation = 0.85

$m = 0.15$

$V_k = (-0.2)\,time + (-1)\,cost$

$\Rightarrow$ ∴ $V_{car} = (-0.2) \times 5 + (-1) \times 5 = -6$

$V_{bus\,1} = (-0.2) \times 15 + (-1) \times 2 = -5 = V_{bus\,2}$

$\exp(car) = e^{-6} = 0.00248$

$$IV_{bus} = m_{bus} \times \ln\left[\exp\left(V_{bus\,1} \div m_{bus}\right) + \exp\left(V_{bus\,2} \div m_{bus}\right)\right]$$

$$= 0.15 \ln\left[\exp(-5 \div 0.15) + \exp(-5 \div 0.15)\right]$$

$$= -4.896$$

$$\exp(IV_{bus}) = e^{-4.896} = 0.007476$$

$$\text{Prob}(\text{car}) = \frac{\exp(\text{car})}{\exp(\text{car}) + \exp(TV_{bus})}$$

$$= \frac{0.00248}{0.00248 + 0.007476} = 0.249$$

$$\text{Prob}(\text{bus}) = \frac{\exp(TV_{bus})}{\exp(\text{car}) + \exp(TV_{bus})}$$

$$= \frac{0.007476}{0.00248 + 0.007476}$$

$$= 0.7509$$