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Assignment 2
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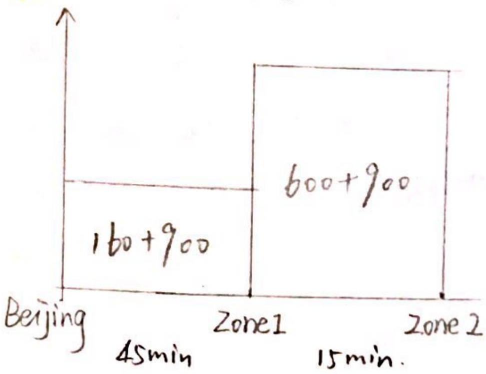
1. (a) The passengers load:



Frequency calculations are based on Max-load method 2.

$F_{train} = \frac{600+900}{500} = 3$ (veh/hour)

$F_{Bus} = \frac{600+900}{300} = 5$ (veh/hour)

$Headway_{(train)} = \frac{60}{F_{train}} = 20$ minutes

$Headway_{(Bus)} = \frac{60}{F_{bus}} = 12$ minutes

$\bar{w} = \frac{\bar{h}}{2}$, $\bar{w}_{train} = \frac{20}{2} = 10$ min $\bar{w}_{bus} = \frac{12}{2} = 6$ min.

The wait-time cost : Train : $\frac{10}{60} \times 10 \times (160+900+600) = \underline{2767}$

Bus : $\frac{6}{60} \times 10 \times (160+900+600) = \underline{1660}$.

(b) The number of empty seats is $600 - 160 = 440$, from Beijing to Zone 1.

Lost-cost of empty seats per hour Train : $440 \times 25 = \underline{11000}$

Bus : $440 \times 20 = \underline{8800}$

(c) Lost-cost of the lost-travel time

Train : $(160 \times \frac{45}{60} + 600 \times \frac{15}{60} + 900 \times \frac{60}{60}) \times 2.5 = \underline{2925}$

Bus : $(160 \times \frac{75}{60} + 600 \times \frac{25}{60} + 900 \times \frac{100}{60}) \times 2.5 = \underline{4875}$

(d) Income

Train : $160 \times 25 + 900 \times 33 + 600 \times 11 = \underline{40300}$

Bus : $160 \times 20 + 900 \times 25 + 600 \times 8 = \underline{30500}$

(e). Profit = Income - cost

Train : $40300 - 2767 - 11000 - 2925 = \underline{23608}$

Bus : $30500 - 1660 - 8800 - 4875 = \underline{15165}$.

(e) As a passenger, the large bus is better because of its lower fares and shorter wait-time which could save money and time. But on the other hand, the time spent on the road is more ($100 > 60$).

(eii). As the operator, train is better than large bus because its profit is more ($23608 > 15165$). But in fact, due to the long wait time, some passengers will choose other public transport. then the profit will cut down.

(f) is on the next page ↓

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(f). ① The cost of buying a train or a large bus.

② The pay of cabin crews.

③ The cost of fuel

④ The cost of pollution ⑤ Cleaning and maintenance costs.

2、(a). SDM(i, j).

j \ i	1	2	3	4	5	6
1	0	9(1-2)	3(1-3)	13(1-3-4)	7(1-3-5)	13(1-3-5-6)
2		0	11(2-3)	13(2-4)	15(2-3-5)	18(2-4-6)
3			0	10(3-4)	4(3-5)	10(3-5-6)
4				0	7(4-5)	5(4-6)
5					0	6(5-6)
6						0

$l=9$. $2l=18$. so all of the distance of (i,j) belong to $S_{u,v}$

$u,v \in S_{u,v}$ \ $(i,j) \in A$	(1,2)	(1,3)	(2,3)	(2,4)	(3,4)	(3,5)	(4,5)	(4,6)	(5,6)
1,2	9(1-2)	14(1-3-2)	14(2-3-1)	X	X	X	X	X	X
1,3	X	3(1-3)	X	X	X	X	X	X	X
1,4	X	13(1-3-4)	X	X	13(1-3-4)	14 (1-3-5-4)	14 (4-5-3-1)	18 (4-6-5-3-1)	18 (1-3-5-6-4)
1,5	X	7(1-3-5)	X	X	X	7(1-3-5)	X	X	X
1,6	X	13 (1-3-5-6)	X	X	18 (1-3-4-6)	13 (1-3-5-6)	X	18 (1-3-4-6)	13 (1-3-5-6)
2,3	12 (3-1-2)	12 (2-1-3)	11(2-3)	X	X	X	X	X	X
2,4	X	X	X	13(2-4)	X	X	X	X	X
2,5	16 (5-3-1-2)	16 (2-1-3-5)	15 (2-3-5)	X	X	15(2-3-5)	X	X	X
2,6	X	X	X	18(2-4-6)	X	X	X	18 (2-4-6)	X
3,4	X	X	X	X	10(3-4)	11(3-5-4)	11(4-5-3)	15 (4-6-5-3)	15 (4-6-5-3)
3,5	X	X	X	X	17(3-4-5)	4(3-5)	17(3-4-5)	X	X

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	(1,2)	(1,3)	(2,3)	(2,4)	(3,4)	(3,5)	(4,5)	(4,6)	(5,6)
3,6	X	X	X	X	15(3-4-6)	10(3-5-6)	X	15 (3-4-6)	10 (3-5-6)
4,5	X	X	X	X	14(5-3-4)	14 (4-3-5)	7(4-5)	11 (4-6-5)	11 (5-6-4)
4,6	X	X	X	X	X	X	13 (4-5-6)	5 (4-6)	13 (4-5-6)
5,6	X	X	X	X	X	X	12 (6-4-5)	12 (5-4-6)	6 (5-6)

The table of SCP Analysis results:

	1,2	1,2	1,2	1,3	1,4	1,4	1,4	1,4	1,4	1,4	...,
DL	9	14	14	3	13	13	14	14	18	18	
(i,j)u,v	(1,2)	(1,3)	(2,3)	(1,3)	(1,3)	(3,4)	(3,5)	(4,5)	(4,6)	(5,6)	
d(i,s)	9	2	7	2	2	6	4	7	2	0	
1	1	1	1	1	1	0	1	1	0	1	...
2	1	0	1	0	0	0	0	0	0	0	
3	0	1	1	1	1	1	1	1	0	1	
4	0	0	0	0	0	1	1	1	1	1	...
5	0	0	1	0	0	0	1	1	0	1	
6	0	0	0	0	0	1	1	1	1	1	

The smallest number of centers is Two.

One is at node 5 (center for node 1, 3, 4, 6).

another one is at node 2 (center for node 2).

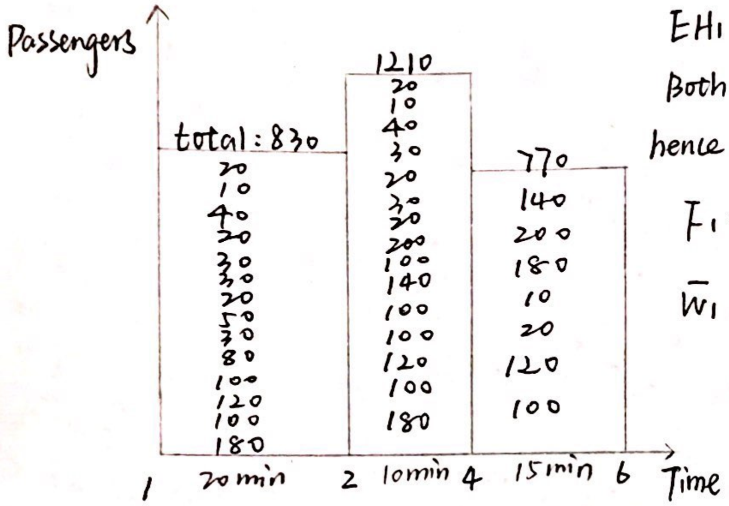
(b). The largest distance from node $i \in N$ to one of the centers is $l = 2.5$. which is decided by the center of (4,6).

The other three: ① on the arc(1,3). $d(1,s) \geq 0.5$ and $d(3,s) \geq 0.5$ ② on the arc(3,4), $d(3,s) > 1.5$ and $d(4,s) > 1.5$. ③ on arc(1,2) (2,3), (3,4). $d(2,s) = 2.5$.

(c). The center is on the arc(2,3), $d(2,s) = 10.5$, $d(3,s) = 0.5$.

From node 2, 4, 6, there is the largest distance which is 10.5.

3. ① 1-2-4-6



$PH_1 = 830 \times \frac{20}{60} + 1210 \times \frac{10}{60} + 770 \times \frac{15}{60} = 670.83$

$EH_1 = (1210-830) \times \frac{20}{60} + (1210-770) \times \frac{15}{60} = 236.7$

Both 1-2-4 and 1-2-4-6 are not the shortest paths.

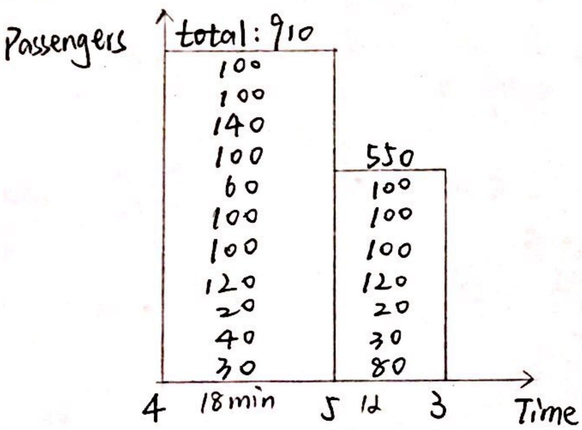
hence, $DPH_1 = 120 \times \frac{30-15}{60} + 180 \times \frac{45-30}{60} = 75.$

$F_1 = \frac{1210}{75} = 16.1$ (veh/hr)

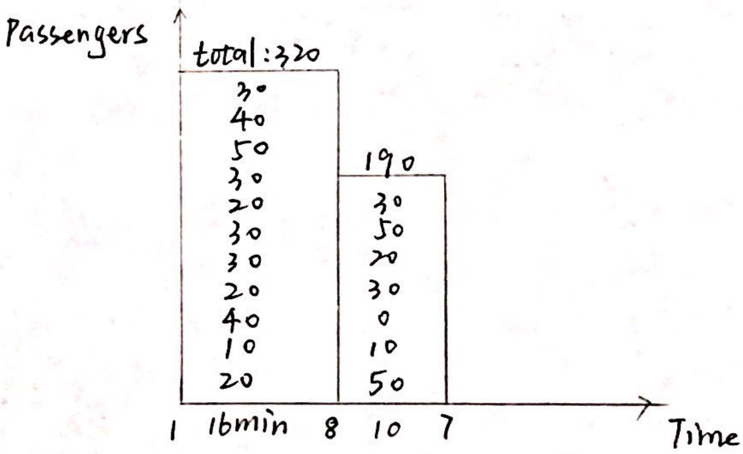
$\bar{W}_1 = \frac{1}{2F_1} \times Passengers_1 = \frac{1}{2 \times 16.1} \times (830+540+140+120+100$

$= 53.6.$

② 4-5-3



③ 1-8-7



$PH_2 = 910 \times \frac{18}{60} + 550 \times \frac{12}{60} = 383$

$EH_2 = (910-550) \times \frac{12}{60} = 72$

The shortest Path is 4-1-3, 15+14=29min

$DPH_2 = \frac{(30-29)}{60} \times 100 = 1.7$

$F_2 = \frac{910}{50} = 18.2$ (veh/hr)

$\bar{W}_2 = \frac{1}{2F_2} \times Passengers_2$

$= \frac{1}{2 \times 18.2} \times (910+80) = 27.2$

$PH_3 = 320 \times \frac{16}{60} + 190 \times \frac{10}{60} = 117$

$EH_3 = (320-190) \times \frac{10}{60} = 21.7$

The shortest path is 1-7. 12 min

$DPH_3 = \frac{26-12}{60} \times 30 = 7.$

$F_3 = \frac{320}{25} = 12.8$ (veh/hr)

$\bar{W}_3 = \frac{1}{2F_3} \times Passengers_3$

$= \frac{1}{2 \times 12.8} \times (320+50) = 14.4$