

Appendix A. Schedules of the rail services in the multimodal service network

Service No.	1	2	3	4	5	6	7	8	9	10
Origin	2	3	4	5	5	6	7	11	11	11
Operation start time	9	2.6	5.8	81	81	20.7	47.5	46	47	45
Operation cutoff time	11	4.1	6.8	83.6	83.6	22.2	48.8	48	48	47.3
Departure time	12	4.6	7.3	84.1	84.1	22.7	49.8	48.8	48.8	48.8
Destination	8	8	8	9	10	8	8	9	10	12
Arrival time	42.9	42.9	42.9	129.2	129.9	46.5	84.5	73.9	74.5	78.3
Operation start time	43.6	43.6	43.6	130.4	130.6	47.7	95.7	75.1	75.2	79
Distance (unit: km)	1272	1358	1415	1281	1326	847	686	767	812	576
	30	40	20	42	36	54	32	12	27	51
Capacity (unit: TEU)	45	55	36	50	45	61	44	20	35	60
	60	65	43	56	60	70	52	32	45	74
Operation period (unit: day/train)	2	2	2	3.5	3.5	2	2	2	2	2
Operation times	3	3	3	2	2	3	3	4	4	4

## Appendix B. Travel distances and times of the road services in the multimodal service network

Service No.	Arc	Distance (unit: km)	Time-dependent travel time [unit: h, travel time (time of the day)]
11	(1, 2)	525	9.5 (0); 9.5 (8); 16 (9); 12 (11); 12 (14); 14 (15.5); 16 (19); 12 (21); 9.5 (22); 9.5 (24)
12	(1, 3)	419	7 (0); 7 (8.5); 13 (10); 9.5 (11); 9.5 (13); 10 (14); 12 (17); 13 (19.5); 8 (21); 7 (23); 7 (24)
13	(1, 4)	362	5 (0); 5 (8); 6 (9); 9 (10); 7.5 (11.5); 7.5 (13.5); 8 (15); 6 (16.5); 9 (19); 6.5 (21); 5 (22); 5 (24)
14	(1, 5)	618	11.5 (0); 11.5 (7.5); 18 (9.5); 15 (12); 13 (13); 15.5 (15); 18 (18.5); 16.5 (20); 13 (21.5); 11.5 (24)
15	(1, 9)	1790	19.2 (0); 19.2 (8); 26 (10); 21 (13.5); 22 (16); 26 (17.5); 26 (19); 19.2 (21.5); 19.2 (24)
16	(1, 10)	1757	19 (0); 19 (7); 25 (9); 27 (10); 22 (13); 23 (15.5); 27 (18); 21 (20.5); 19 (21.5); 19 (24)
17	(1, 11)	1083	18 (0); 18 (7); 19 (8.5); 27 (10); 20 (11.3); 23 (17.5); 27 (20); 20 (21.5); 18 (22); 18 (24)
18	(1, 12)	1613	29 (0); 29 (8); 33 (9.5); 38 (10.5); 36 (12); 32 (14); 35 (16); 38 (19); 32 (21); 29 (22); 29 (24)
19	(7, 6)	147	4.5 (0); 4.5 (8); 12 (11); 10 (11.5); 8 (13.5); 9 (15); 10.5 (16.5); 12 (18); 8 (20); 7.5 (21); 4.5 (24)
20	(7, 9)	1158	12.6 (0); 12.6 (9); 20 (13.5); 15 (15.5); 17 (15.5); 20 (19); 16 (20); 13 (21.5); 12.6 (24)
21	(7, 10)	1801	24.5 (0); 24.5 (8.5); 34 (11); 29 (14); 30 (15.5); 32 (17.5); 34 (19); 31 (20.5); 27 (22); 24.5 (24)
22	(7, 12)	1222	13.3 (0); 13.3 (6); 15 (7.5); 23 (13); 20 (15); 21 (16.5); 23 (19); 20 (21); 17 (22.5); 13.3 (24)
23	(8, 9)	449	10.9 (0); 10.9 (7.5); 12 (8); 19 (10); 17 (11.5); 15 (14); 16 (16.5); 19 (18); 19 (19.5); 17 (21.5); 10.9 (24)
24	(8, 10)	489	12 (0); 12 (5.5); 14 (7.5); 21 (10); 16 (14); 17.5 (16); 21 (18.5); 18 (20); 14 (23); 12 (24)
25	(8, 12)	558	14.5 (0); 14.5 (6); 16 (8); 23 (11); 18 (13.5); 19 (15); 21 (17); 23 (18.5); 19 (19.5); 17.5 (21); 14.5 (24)

## Appendix C. Information on the transportation orders in the empirical case

Order No.	O-D	Penalty costs (Unit: ¥/ h)	Destination inventory costs (Unit: ¥/TEU-h)	Volume (Unit: TEU)	Earliest release time	Due date time window
1	1-9	200	5	16	28	[130, 140]
2	1-9	150	0	25	37	[115, 127]
3	1-10	240	7	10	111	[210, 225]
4	1-12	300	6	14	15	[70, 78]
5	1-12	250	6	27	90	[160, 170]
6	7-9	100	5	16	8	[90, 100]
7	7-9	230	5	14	22	[105, 115]
8	7-10	145	7	32	36	[160, 172]
9	7-12	280	0	28	39	[190, 198]
10	7-12	170	6	39	72	[186; 195]

## Appendix D. Optimization results of the fuzzy simulations

Train No.	1	2	3	4	5	6	7	8	9	10	Optimization result
Simulation No.	Carrying capacities										Optimization result
1	52	54	23	44	47	55	46	12	36	57	1,517,055
2	46	50	21	44	41	64	33	16	30	53	1,575,559
3	38	41	24	44	48	54	34	13	28	65	1,575,559
4	31	41	20	48	43	55	34	14	28	58	1,575,559
5	36	44	34	46	44	59	33	15	28	54	1,575,559
6	31	40	26	48	39	60	39	28	27	53	1,555,432
7	44	44	22	47	37	55	45	13	38	55	1,533,003
8	32	48	21	45	46	61	41	14	27	54	1,555,432
9	54	45	38	44	39	55	37	20	27	57	1,575,559
10	48	45	21	44	42	54	32	16	31	51	1,575,559
11	43	45	21	45	42	59	35	21	28	58	1,575,559
12	31	41	29	49	37	54	34	17	35	51	1,575,559
13	34	52	22	46	42	54	38	13	35	60	1,575,559
14	31	56	30	42	46	56	32	12	27	51	1,575,559
15	30	49	35	42	56	55	32	14	32	62	1,575,559

## Supplemental File

Train No.	1	2	3	4	5	6	7	8	9	10	Optimization result
Simulation No.	Carrying capacities										
16	32	44	24	47	49	55	32	12	27	51	1,575,559
17	33	40	27	49	45	54	41	13	40	51	1,555,432
18	34	51	20	43	39	56	33	12	29	64	1,575,559
19	30	42	20	49	37	54	33	13	38	52	1,575,559
20	33	45	30	43	40	59	32	16	34	64	1,575,559
21	48	44	24	42	50	65	34	12	36	55	1,575,559
22	30	47	29	45	38	56	37	16	40	58	1,575,559
23	44	42	20	50	45	64	36	15	31	58	1,575,559
24	51	46	21	46	39	56	32	14	35	52	1,575,559
25	39	52	27	44	40	58	38	17	28	55	1,575,559
26	37	44	20	47	41	54	35	13	28	53	1,575,559
27	52	53	28	44	44	55	44	12	32	56	1,533,003
28	34	40	37	46	56	56	48	14	29	66	1,517,055
29	49	47	22	43	43	57	46	14	27	51	1,517,055
30	45	44	32	49	38	63	37	14	32	57	1,575,559

Supplemental File

Train No.	1	2	3	4	5	6	7	8	9	10	Optimization result
Simulation No.	Carrying capacities										
31	40	42	21	42	48	55	33	12	41	54	1,575,559
32	34	41	22	44	37	56	33	15	27	51	1,575,559
33	51	52	23	43	44	62	36	19	33	52	1,575,559
34	40	44	30	43	37	56	35	15	33	64	1,575,559
35	41	41	21	42	40	55	35	28	31	65	1,575,559
36	42	46	22	44	41	66	32	22	30	53	1,575,559
37	35	47	22	44	54	56	39	19	28	53	1,555,432
38	52	53	20	48	41	54	34	14	28	60	1,575,559
39	45	40	21	50	36	54	37	12	28	67	1,575,559
40	37	43	20	46	38	56	33	17	38	55	1,575,559
41	45	41	20	42	38	56	33	17	36	57	1,575,559
42	45	49	22	42	45	61	38	16	29	51	1,575,559
43	30	42	34	42	40	64	37	16	29	65	1,575,559
44	46	44	22	43	45	55	39	15	41	55	1,555,432
45	57	40	33	47	48	60	38	13	28	56	1,575,559

Supplemental File

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<b>Train No.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>Optimization result</b>
<b>Simulation No.</b>	<b>Carrying capacities</b>										
<b>46</b>	31	50	21	48	39	60	33	19	36	61	1,575,559
<b>47</b>	31	52	27	43	52	55	36	17	33	64	1,575,559
<b>48</b>	39	44	20	44	39	61	40	12	32	63	1,555,432
<b>49</b>	40	42	20	42	41	56	44	17	32	52	1,533,003
<b>50</b>	36	43	25	43	37	54	42	14	40	55	1,535,517