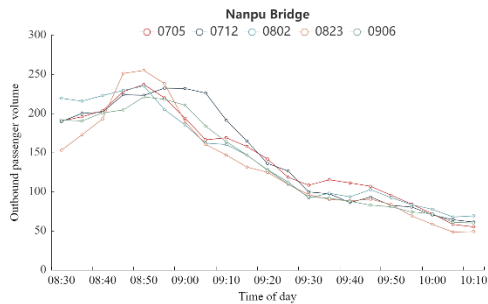
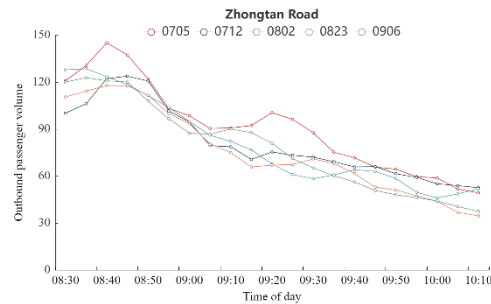


Supplementary Information for Analysing Train Delay

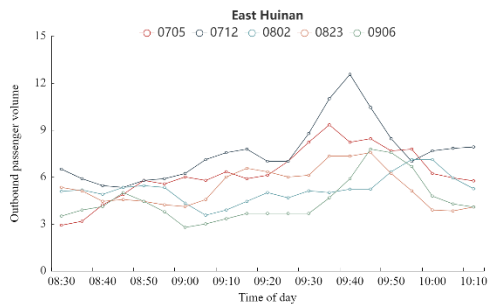
Impacts on Subway Stations via a Three-stage Approach: An Empirical Study on Shanghai Metro



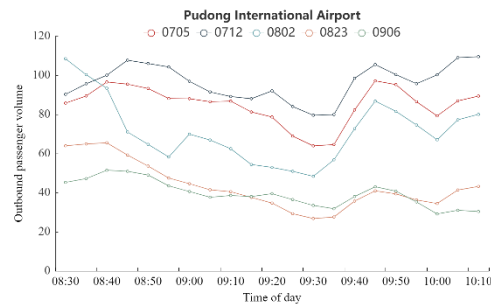
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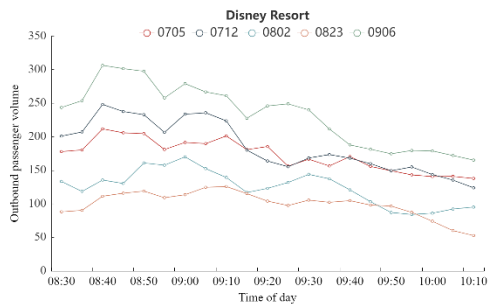
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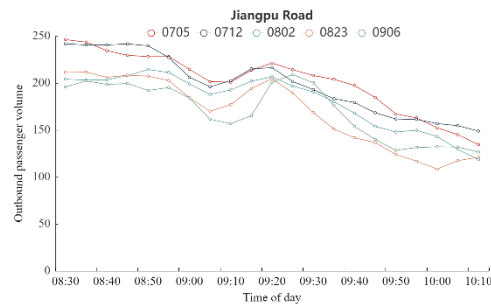
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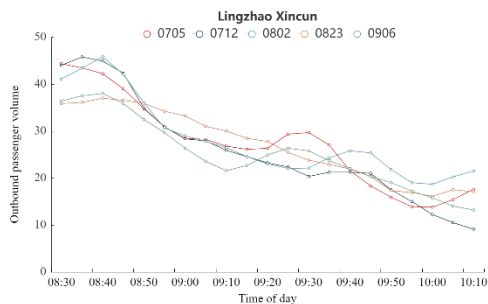
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(e)

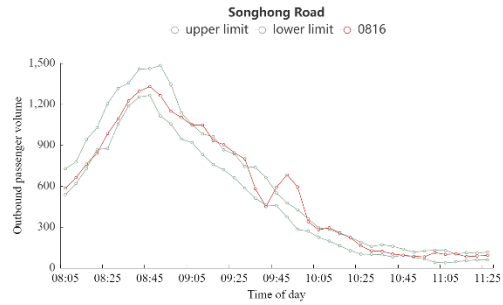


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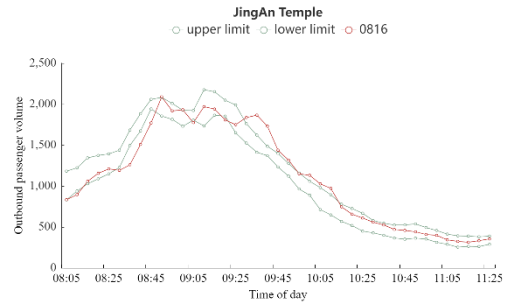


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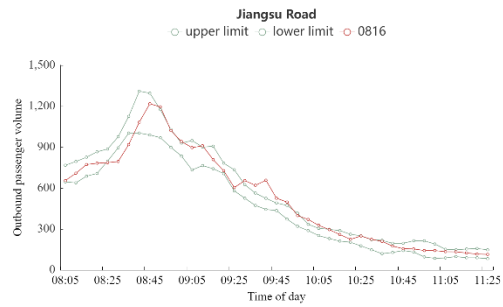
Fig. 1 Display of outbound passenger volume series for stations with unstable passenger flow: (a) Nanpu Bridge; (b) Zhongtan Road; (c) East Huinan; (d) Pudong International Airport; (e) Disney Resort; (f) Jiangpu Road; (g) Lingzhao Xincun.



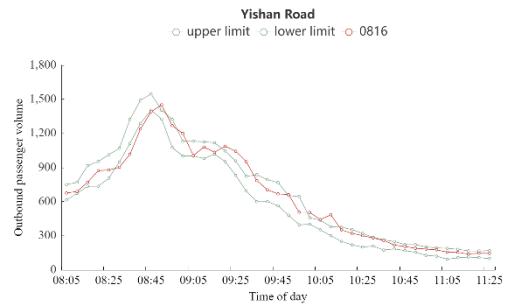
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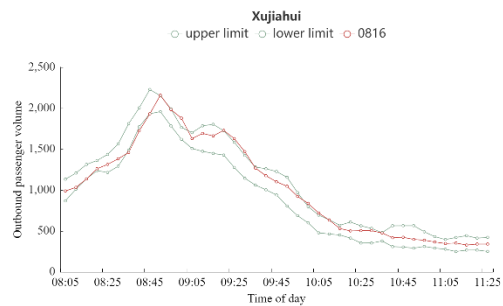
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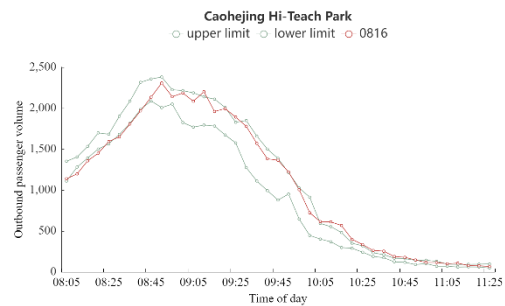
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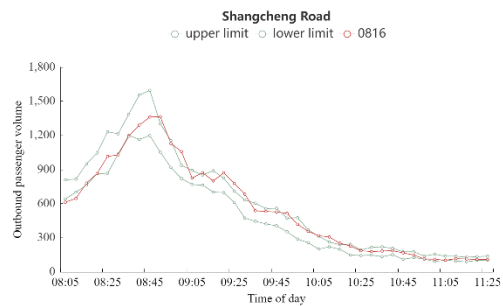
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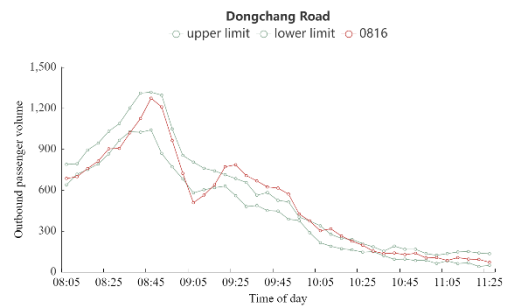
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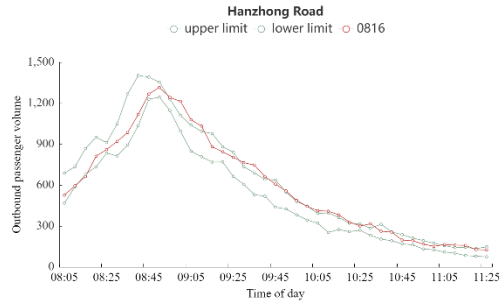
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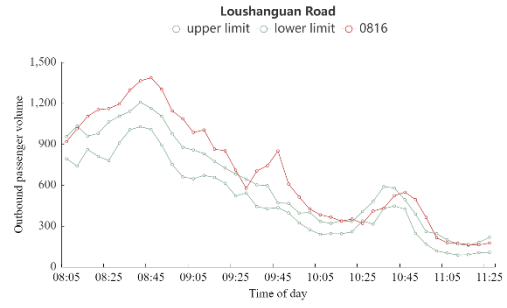
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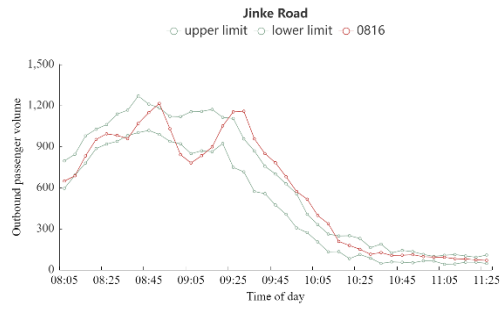
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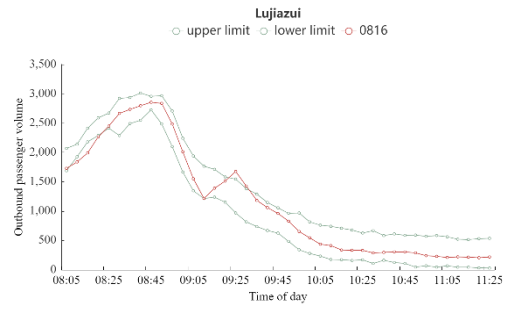
(i)



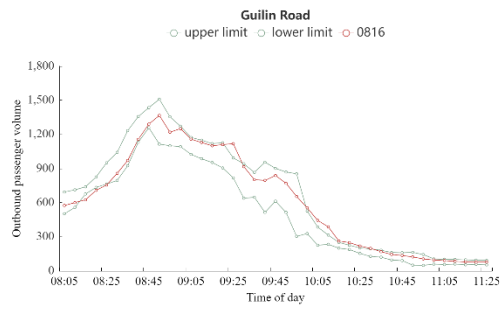
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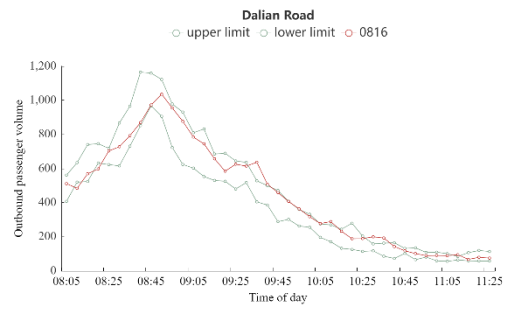
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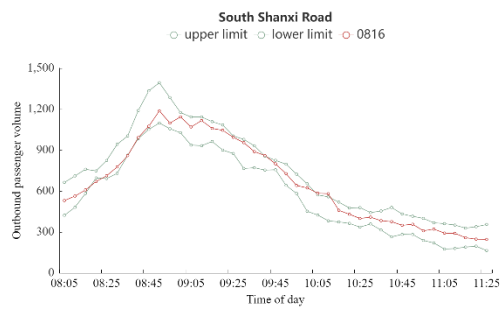
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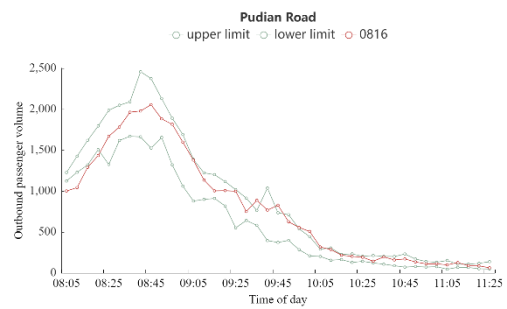
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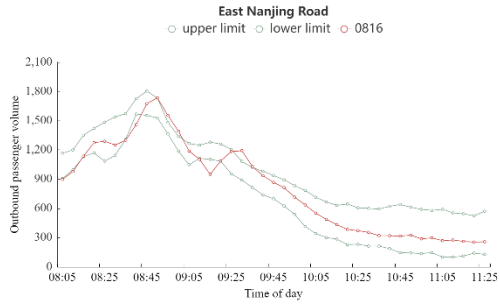
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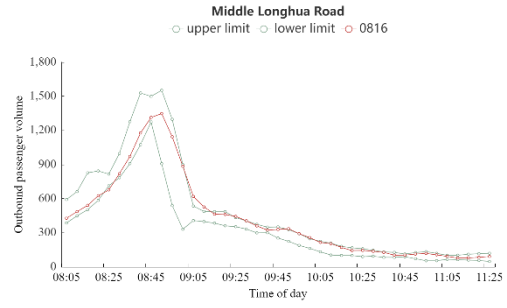
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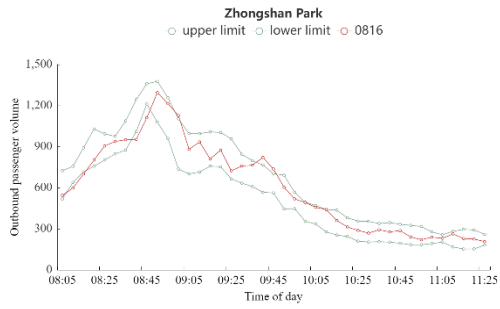
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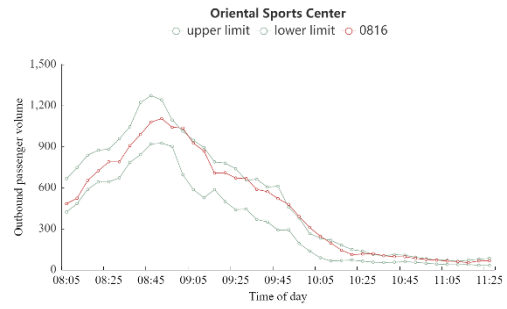
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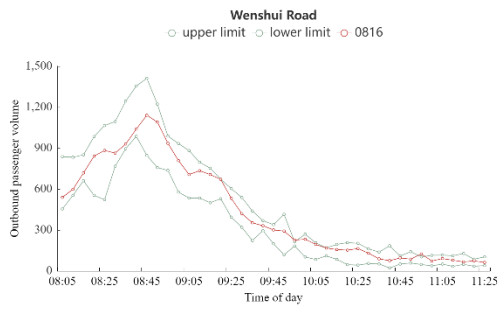
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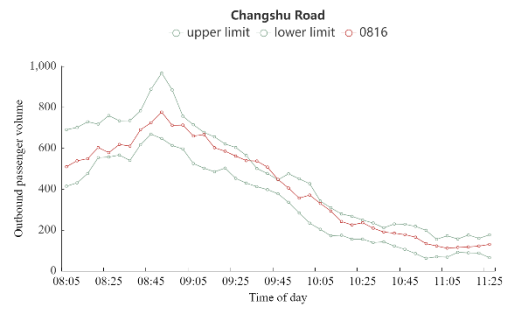
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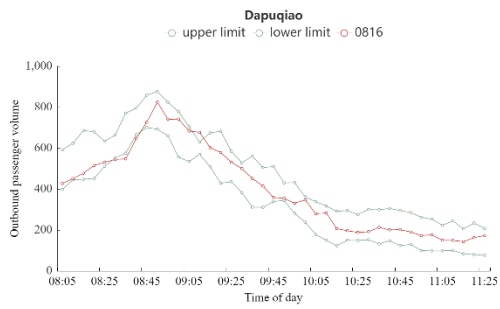
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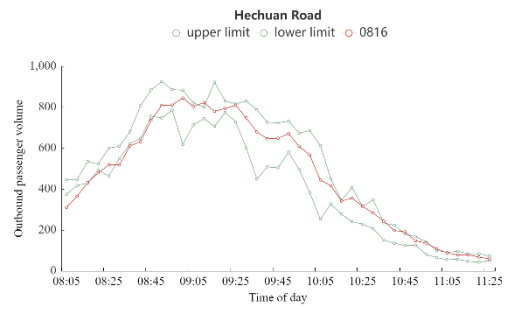
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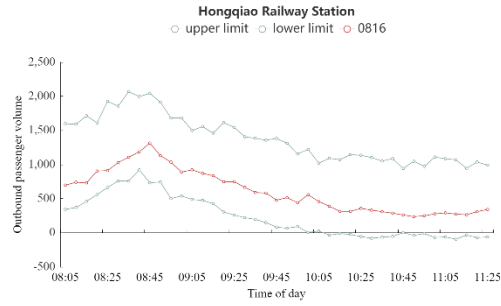
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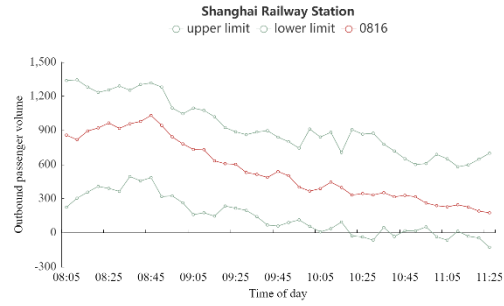
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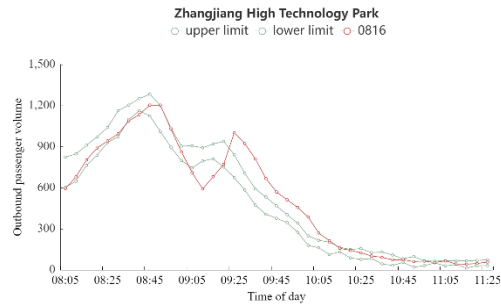
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(y)

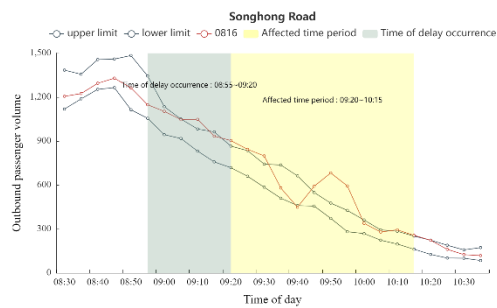


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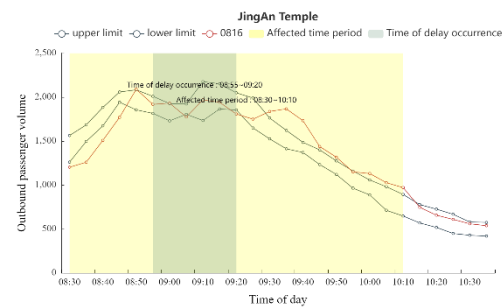


(aa)

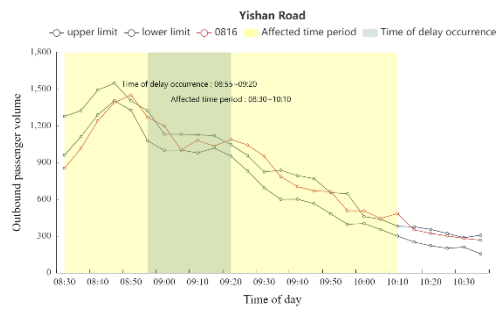
Fig.2 Normal passenger volume ranges for key stations: (a) Songhong Road; (b) JingAn Temple; (c) Jiangsu Road; (d) Yishan Road; (e) Xujiahui; (f) Caohejing Hi-Teach Park; (g) Shangcheng Road; (h) Dongchang Road; (i) Hanzhong Road; (j) Loushuguan Road; (k) Jinke Road; (l) Lujiiazui; (m) Guilin Road; (n) Dalian Road; (o) South Shanxi Road; (p) Pudian Road; (q) East Nanjing Road; (r) Middle Longhua Road; (s) Zhongshan Park; (t) Oriental Sports Center; (u) Wenshui Road; (v) Changshu Road; (w) Dapugqiao; (x) Hechuan Road; (y) Hongqiao Railway Station; (z) Shanghai Railway Station; (aa) Zhangjiang High Technology Park.



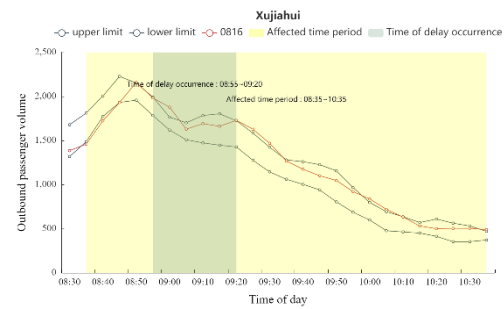
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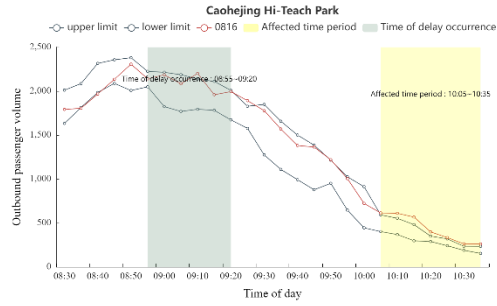
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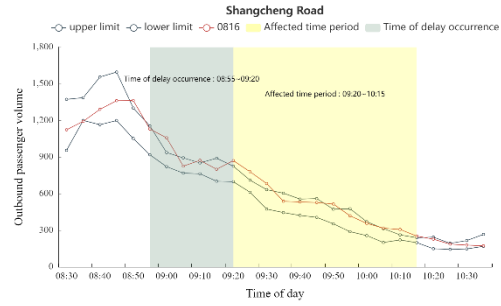
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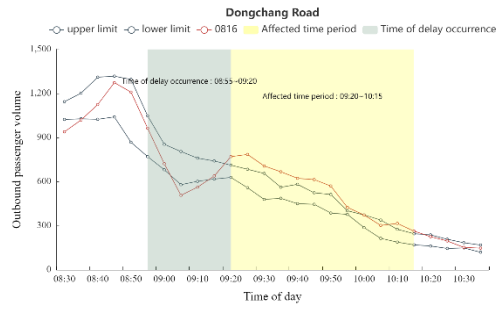
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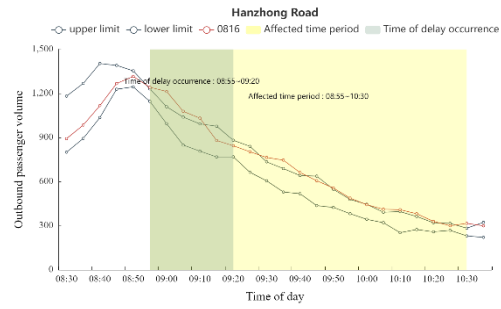
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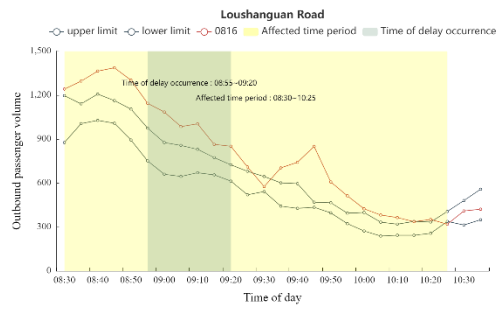
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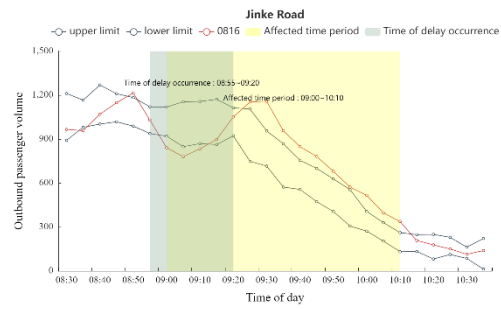
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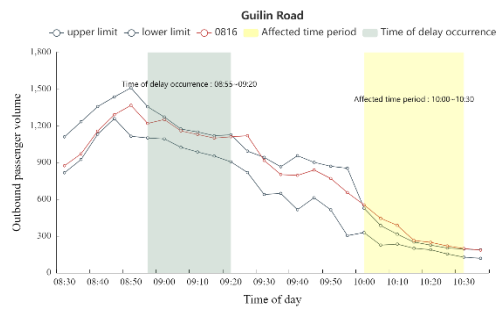
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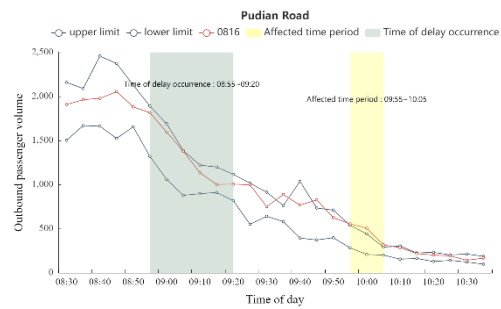
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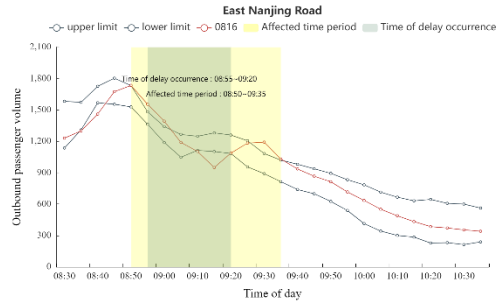
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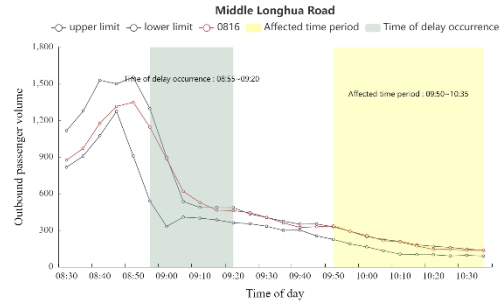
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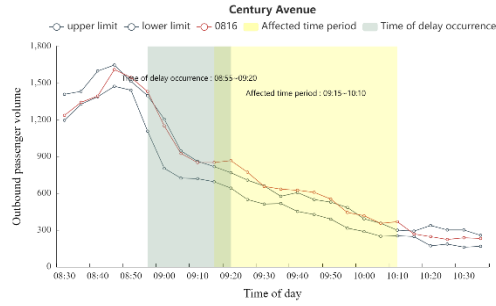
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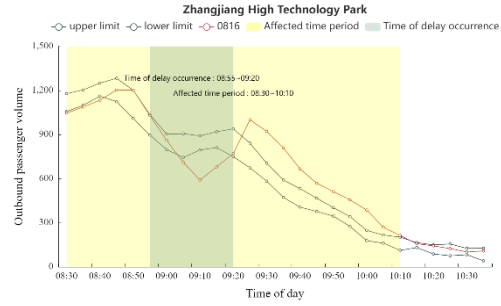
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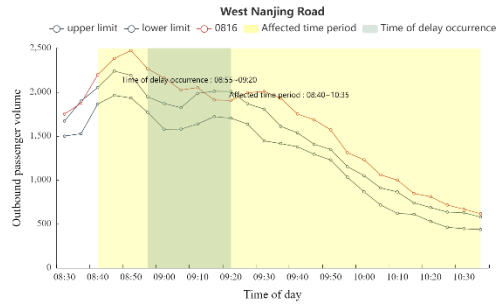
(n)



(o)



(p)



(q)

Fig. 3 Impact duration at key stations: (a) Songhong Road; (b) JingAn Temple; (c) Yishan Road; (d) Xujiahui; (e) Caohejing Hi-Teach Park; (f) Shangcheng Road; (g) Dongchang Road; (h) Hanzhong Road; (i) Loushanguan Road; (j) Jinke Road; (k) Guilin Road; (l) Pudian Road; (m) East Nanjing Road; (n) Middle Longhua Road; (o) Century Avenue; (p) Zhangjiang High Technology Park; (q) West Nanjing Road.

Table 1 Anomalies exceeding normal passenger volume upper limits

Rank	Station	time	Over upper limit	Over upper limit (%)
1	Loushanguan Road	09:45	381	81.22%
2	Zhangjiang High Technology Park	10:00	138	55.82%
3	Guanglan Road	10:05	103	49.77%
4	Songhong Road	09:50	206	43.23%
5	Songhong Road	09:55	167	39.17%
6	Zhangjiang High Technology Park	09:35	219	37.12%
7	Guanglan Road	09:30	220	33.97%
8	Zhangjiang High Technology Park	09:55	114	33.55%

9	Zhangjiang High Technology Park	09:30	217	30.82%
10	Loushanguan Road	09:50	142	30.43%
11	Loushanguan Road	09:55	118	30.01%
12	Jinke Road	10:10	75	28.94%
13	Yishan Road	10:10	104	27.41%
14	Jinke Road	10:00	110	27.17%
15	Zhangjiang High Technology Park	09:50	109	27.08%
16	Guanglan Road	10:00	70	25.56%
17	Zhangjiang High Technology Park	09:40	135	25.34%
18	Loushanguan Road	09:40	146	24.45%
19	Zhangjiang High Technology Park	10:05	52	24.33%
20	Loushanguan Road	09:00	209	23.87%
21	Century Avenue	10:10	70	23.33%
22	Guilin Road	10:10	73	23.13%
23	Guanglan Road	09:55	84	23.12%
24	Zhangjiang High Technology Park	09:45	102	21.77%
25	Jinke Road	09:30	202	21.17%
26	Loushanguan Road	09:10	174	20.94%
27	Jinke Road	10:05	67	20.37%
28	West Nanjing Road	09:35	320	19.88%
29	West Nanjing Road	09:45	277	19.71%
30	Loushanguan Road	08:45	224	19.23%
31	Zhangjiang High Technology Park	09:25	159	18.96%
32	Dongchang Road	09:35	105	18.75%
33	Guanglan Road	09:25	135	18.34%
34	West Nanjing Road	10:20	124	18.06%
35	Caohejing Hi-Teach Park	10:15	86	17.98%
36	Loushanguan Road	08:50	198	17.90%
37	Loushanguan Road	09:20	127	17.50%
38	Guanglan Road	09:50	73	17.46%
39	Loushanguan Road	08:55	169	17.36%
40	West Nanjing Road	10:00	181	17.27%
41	Dongchang Road	09:45	90	17.15%
42	Loushanguan Road	09:35	102	17.02%
43	Shangcheng Road	10:10	44	16.94%
44	West Nanjing Road	09:50	224	16.59%
45	JingAn Temple	09:40	246	16.59%
46	Oriental Sports Center	10:00	43	16.43%
47	West Nanjing Road	10:05	149	16.43%
48	West Nanjing Road	08:55	319	16.41%
49	Pudian Road	09:35	125	16.36%
50	Middle Longhua Road	09:05	84	15.64%
51	Yishan Road	09:30	129	15.64%
52	West Nanjing Road	09:00	291	15.57%

53	West Nanjing Road	10:10	135	15.57%
54	Guilin Road	10:05	59	15.27%
55	JingAn Temple	09:35	245	15.11%
56	Loushanguan Road	09:05	129	15.04%
57	Dongchang Road	09:25	101	14.76%
58	Loushanguan Road	10:05	49	14.66%
59	Pudian Road	10:00	64	14.51%
60	West Nanjing Road	10:15	107	14.43%
61	Dongchang Road	10:10	40	14.42%
62	Loushanguan Road	10:10	45	14.15%
63	West Nanjing Road	09:40	213	13.86%
64	West Nanjing Road	09:55	159	13.81%
65	Caohejing Hi-Teach Park	10:20	48	13.80%
66	Loushanguan Road	08:35	155	13.60%
67	Loushanguan Road	08:40	157	13.00%
68	Shangcheng Road	09:00	121	12.91%
69	Century Avenue	09:20	99	12.91%
70	West Nanjing Road	08:50	282	12.89%
71	West Nanjing Road	10:25	81	12.72%
72	Guilin Road	09:25	125	12.63%
73	Pudian Road	09:45	92	12.52%
74	Jinke Road	09:40	93	12.26%
75	Jinke Road	09:45	82	11.71%
76	Loushanguan Road	09:15	90	11.66%
77	Caohejing Hi-Teach Park	10:30	27	11.62%
78	Caohejing Hi-Teach Park	10:35	27	11.55%
79	Hanzhong Road	10:30	32	11.46%
80	Guanglan Road	10:15	16	11.25%
81	Dongchang Road	09:50	57	11.16%
82	West Nanjing Road	09:30	201	11.15%
83	West Nanjing Road	09:05	201	11.04%
84	Century Avenue	09:45	59	10.75%
85	Caohejing Hi-Teach Park	10:10	57	10.40%
86	Jinke Road	09:35	89	10.20%
87	Guilin Road	10:20	23	10.19%
88	Yishan Road	10:00	47	10.19%
89	East Nanjing Road	09:30	110	10.12%
90	Century Avenue	09:35	58	10.08%
91	Shangcheng Road	09:25	69	9.72%
92	Hanzhong Road	09:00	104	9.38%
93	Century Avenue	09:25	64	9.12%
94	Shangcheng Road	09:50	43	9.05%
95	Pudian Road	10:05	26	9.01%
96	Yishan Road	09:25	86	8.96%

97	JingAn Temple	10:10	79	8.81%
98	Oriental Sports Center	10:35	8	8.62%
99	Hanzhong Road	09:35	57	8.33%
100	Jinke Road	09:50	52	8.30%
101	Guanglan Road	09:45	44	8.28%
102	Middle Longhua Road	09:10	40	8.24%
103	Dongchang Road	09:20	58	8.20%
104	Guilin Road	10:25	16	8.15%
105	Shangcheng Road	09:30	50	7.90%
106	Dongchang Road	09:30	51	7.73%
107	Songhong Road	09:45	42	7.67%
108	Songhong Road	09:30	56	7.53%
109	Changshu Road	09:35	36	7.28%
110	Dongchang Road	10:15	18	7.24%
111	West Nanjing Road	08:40	146	7.12%
112	Dongchang Road	09:40	41	7.02%
113	JingAn Temple	10:00	73	6.94%
114	West Nanjing Road	09:25	125	6.70%
115	Songhong Road	09:10	66	6.70%
116	Changshu Road	09:40	31	6.58%
117	West Nanjing Road	10:35	38	6.51%
118	Oriental Sports Center	10:05	15	6.50%
119	Century Avenue	10:00	25	6.49%
120	West Nanjing Road	08:45	145	6.46%
121	Loushanguan Road	10:00	25	6.40%
122	Xujiahui	09:00	113	6.39%
123	West Nanjing Road	10:30	40	6.38%
124	Guanglan Road	10:10	11	6.09%
125	Yishan Road	09:00	69	6.08%
126	Dongchang Road	09:55	23	5.77%
127	Zhangjiang High Technology Park	10:10	12	5.71%
128	Oriental Sports Center	10:30	6	5.68%
129	Shangcheng Road	09:20	46	5.56%
130	Shangcheng Road	10:15	13	5.47%
131	Loushanguan Road	10:20	18	5.31%
132	Guilin Road	10:00	28	5.28%
133	Hanzhong Road	10:15	19	5.23%
134	Guilin Road	10:15	13	5.15%
135	Hanzhong Road	10:05	20	5.10%
136	Xujiahui	10:00	40	5.03%
137	East Nanjing Road	08:55	72	4.86%
138	Century Avenue	09:50	26	4.86%
139	Shangcheng Road	08:50	62	4.78%
140	Caohejing Hi-Teach Park	10:25	15	4.77%

141	West Nanjing Road	08:30	79	4.73%
142	JingAn Temple	10:05	46	4.70%
143	Guanglan Road	09:35	29	4.68%
144	Guanglan Road	09:20	44	4.64%
145	Oriental Sports Center	09:50	21	4.59%
146	Songhong Road	09:20	38	4.40%
147	Jinke Road	09:25	48	4.38%
148	Loushanguan Road	09:25	30	4.38%
149	JingAn Temple	09:30	75	4.24%
150	Century Avenue	09:15	34	4.21%
151	Middle Longhua Road	10:00	10	4.12%
152	Hanzhong Road	09:30	30	4.10%
153	Yishan Road	09:20	42	4.03%
154	Xujiahui	10:35	19	3.95%
155	Hanzhong Road	09:10	39	3.91%
156	East Nanjing Road	09:00	51	3.83%
157	Xujiahui	10:05	26	3.82%
158	Hanzhong Road	09:05	39	3.77%
159	Loushanguan Road	08:30	45	3.75%
160	Caohejing Hi-Teach Park	10:05	22	3.72%
161	Caohejing Hi-Teach Park	09:25	64	3.52%
162	Songhong Road	10:10	10	3.47%
163	JingAn Temple	09:50	43	3.36%
164	Yishan Road	08:50	47	3.32%
165	West Nanjing Road	09:10	66	3.30%
166	Hanzhong Road	10:10	13	3.26%
167	Pudian Road	09:55	17	3.21%
168	Hanzhong Road	09:40	21	3.21%
169	Xujiahui	09:30	46	3.21%
170	Century Avenue	09:40	19	3.20%
171	Jinke Road	09:55	17	3.09%
172	Oriental Sports Center	09:55	11	2.95%
173	Caohejing Hi-Teach Park	09:10	63	2.94%
174	Hanzhong Road	10:20	9	2.93%
175	Xujiahui	09:25	44	2.77%
176	JingAn Temple	09:45	39	2.75%
177	Jinke Road	08:50	32	2.66%
178	Hechuan Road	09:10	21	2.62%
179	Middle Longhua Road	09:25	11	2.50%
180	Shangcheng Road	09:10	21	2.47%
181	Century Avenue	08:55	34	2.41%
182	Oriental Sports Center	09:00	23	2.23%
183	Middle Longhua Road	10:35	3	2.22%
184	Guilin Road	10:30	4	2.13%

185	Middle Longhua Road	09:50	7	2.12%
186	Century Avenue	08:50	32	2.08%
187	Songhong Road	10:15	5	2.07%
188	Hanzhong Road	09:55	9	1.86%
189	Oriental Sports Center	09:30	12	1.81%
190	Hanzhong Road	09:50	9	1.61%
191	Yishan Road	10:05	6	1.41%
192	Yishan Road	09:50	8	1.29%
193	Shangcheng Road	10:05	4	1.24%
194	Songhong Road	09:25	9	1.08%
195	East Nanjing Road	09:35	10	0.99%
196	Hanzhong Road	08:55	11	0.88%
197	Hechuan Road	10:25	2	0.66%
198	Caohejing Hi-Teach Park	09:50	5	0.43%
199	Changshu Road	09:45	2	0.37%
200	JingAn Temple	08:50	7	0.33%
201	JingAn Temple	09:00	6	0.29%
202	Xujiahui	09:20	5	0.27%
203	Xujiahui	08:50	6	0.26%
204	Middle Longhua Road	09:30	1	0.23%
205	Zhangjiang High Technology Park	08:50	1	0.09%
206	East Nanjing Road	08:50	1	0.08%
207	Middle Longhua Road	09:55	0	0.07%

Table 2 Anomalies falling below normal passenger volume lower limits

Rank	Station	time	Over lower limit	Over lower limit (%)
1	Zhangjiang High Technology Park	09:10	204	25.72%
2	Zhangjiang High Technology Park	09:15	131	16.14%
3	JingAn Temple	08:35	237	15.83%
4	East Nanjing Road	09:15	153	13.91%
5	Guanglan Road	09:05	105	12.67%
6	Dongchang Road	09:05	72	12.47%
7	Yishan Road	08:30	106	11.07%
8	JingAn Temple	08:40	165	9.85%
9	JingAn Temple	08:45	171	8.83%
10	Yishan Road	08:35	96	8.61%
11	Jinke Road	09:00	79	8.59%
12	Dongchang Road	08:30	84	8.24%
13	Jinke Road	09:05	68	8.01%
14	East Nanjing Road	08:40	108	6.86%
15	Dongchang Road	09:10	39	6.56%
16	Loushanguan Road	10:25	19	5.64%

17	JingAn Temple	08:30	58	4.61%
18	Zhangjiang High Technology Park	09:05	33	4.48%
19	Jinke Road	09:10	35	4.08%
20	Yishan Road	08:40	49	3.80%
21	Guanglan Road	08:35	32	3.15%
22	Xujiahui	08:40	50	2.81%
23	Hechuan Road	08:45	20	2.63%
24	JingAn Temple	09:20	46	2.51%
25	Zhangjiang High Technology Park	08:40	29	2.47%
26	Jinke Road	08:35	24	2.40%
27	Songhong Road	09:40	11	2.37%
28	Hechuan Road	08:40	15	2.35%
29	Guanglan Road	09:10	18	2.13%
30	Xujiahui	08:35	27	1.83%
31	Hechuan Road	08:35	11	1.81%
32	JingAn Temple	09:05	31	1.70%
33	Zhangjiang High Technology Park	08:35	12	1.06%
34	East Nanjing Road	09:10	11	1.02%
35	Zhangjiang High Technology Park	08:30	11	1.01%
36	Yishan Road	08:45	14	1.00%
37	Hechuan Road	08:30	5	0.90%
38	Caohejing Hi-Teach Park	08:40	18	0.88%
39	Dongchang Road	08:35	8	0.79%
40	East Nanjing Road	08:35	10	0.75%
41	Shangcheng Road	08:35	7	0.62%
42	Guanglan Road	09:00	5	0.55%
43	Caohejing Hi-Teach Park	08:35	8	0.45%
44	Xujiahui	08:45	1	0.06%