

Supplementary Materials: Capacitated Waste Collection Problem Solution Using Open-Source Tool

Adriano Santos Silva ^{1,2,3,4,5,*}, Filipe Alves ^{1,3,6,†}, José Luis Diaz de Tuesta ^{2,3,7}, Ana Maria A. C. Rocha ⁶, Ana I. Pereira ^{1,3}, Adrián M. T. Silva ^{4,5,*} and Helder T. Gomes ^{2,3}

Table S1. Central depot (CD) and dumpsters locations.

Site	Latitude	Longitude	Site	Latitude	Longitude
CD	41.82169681141	-6.76443593490	25	41.81523678070	-6.76620098764
1	41.78720474230	-6.78118419571	26	41.80952920640	-6.76642816497
2	41.81969833440	-6.75789689978	27	41.81339008360	-6.76738957375
3	41.81866836520	-6.75533914580	28	41.81057094540	-6.76262317495
4	41.80391311600	-6.74591398243	29	41.80858583660	-6.77203398202
5	41.81259155270	-6.76252317395	30	41.80379020880	-6.77500850312
6	41.80365371700	-6.76502704655	31	41.80479706560	-6.77945165024
7	41.80543899470	-6.76429700929	32	41.80485933890	-6.78266950155
8	41.81728363000	-6.76014518727	33	41.80041444800	-6.78203834713
9	41.81797409140	-6.77046823459	34	41.80111176820	-6.78497253628
10	41.80888366660	-6.76223516545	35	41.80330480330	-6.76184008495
11	41.79860687320	-6.75750207924	36	41.80787015850	-6.77042735615
12	41.81499862690	-6.77017879526	37	41.80301580010	-6.77329748574
13	41.79141235440	-6.77258300782	38	41.79983337270	-6.77148637944
14	41.81573486260	-6.75953578858	39	41.81954918520	-6.75925726449
15	41.80909347530	-6.77342796251	40	41.81640496770	-6.76043716543
16	41.79577636680	-6.76426887492	41	41.81374158510	-6.76067411678
17	41.81614685130	-6.75683116867	42	41.81542200210	-6.75655890661
18	41.79243087810	-6.76876211244	43	41.81169821390	-6.75974645274
19	41.80489730790	-6.75844621742	44	41.80522300450	-6.76014099295
20	41.80027389500	-6.76562976839	45	41.79977009680	-6.76815932707
21	41.81761075200	-6.76406596806	46	41.80586417060	-6.75822219431
22	41.79068357450	-6.77954329093	47	41.79437674010	-6.76375480015
23	41.78995667530	-6.77221766031	48	41.79508199500	-6.75988738044
24	41.80262259920	-6.77134323359	49	41.80701653110	-6.76360284746
			50	41.81113349430	-6.75566925811

[illegible]

[illegible]

Table S5. Filling velocities of the dumpsters on a daily basis (part I).

Days	Dumpsters																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7.3	30.7	8.2	26.2	7.8	47.2	61.0	10.2	37.4	29.7	37.0	18.1	16.6	40.0	14.7	17.1	29.6	11.8	29.7	6.0
3	18.1	11.1	4.5	10.5	25.8	25.7	45.3	30.6	12.9	44.0	36.2	8.7	15.7	15.2	6.3	36.7	8.6	38.4	40.7	15.0
4	19.2	26.7	6.4	39.8	33.8	25.9	40.4	8.0	54.5	27.9	47.2	26.2	49.2	44.2	3.4	45.6	26.7	28.5	25.3	8.8
5	23.7	41.7	4.0	18.7	15.8	29.9	35.9	8.0	56.0	20.3	11.0	5.2	24.0	52.0	6.8	28.5	12.1	14.8	23.3	15.6
6	49.9	38.2	9.5	35.7	40.2	47.4	32.3	9.2	16.2	21.7	11.9	5.6	24.5	50.9	11.1	40.4	12.0	12.6	29.6	6.9
7	33.3	18.3	5.9	7.1	35.0	11.3	19.2	24.2	24.2	12.4	29.5	20.3	21.4	11.6	14.2	12.6	13.9	28.4	45.0	12.0
8	27.0	23.7	15.9	30.7	40.7	15.5	61.9	37.8	27.2	37.9	45.6	4.0	26.3	16.8	15.6	40.2	14.5	41.5	16.4	3.2
9	30.7	21.1	16.7	22.9	27.0	24.9	25.9	25.3	33.3	30.3	28.0	25.8	12.7	23.3	7.8	36.8	12.4	37.2	25.3	6.2
10	25.9	30.3	17.0	41.5	15.3	54.1	50.8	28.7	64.2	41.9	15.3	18.2	11.9	34.9	12.9	46.9	12.1	42.2	47.5	10.6
11	35.8	24.1	10.5	11.1	37.0	17.3	48.2	38.6	56.5	20.2	21.1	26.4	19.0	30.5	16.6	32.3	25.9	17.1	49.5	12.0
12	17.7	35.3	15.3	12.3	35.7	20.0	32.5	26.4	28.4	38.9	38.3	8.5	50.4	53.3	14.5	49.5	15.6	9.4	25.3	3.2
13	37.3	27.2	12.0	21.5	47.0	11.0	31.4	31.8	20.8	37.4	26.7	25.2	11.5	35.6	9.7	42.5	43.4	7.1	32.7	9.6
14	16.8	37.2	10.8	14.8	24.5	57.7	40.3	22.1	56.8	26.3	13.9	7.7	23.0	62.9	5.5	13.6	44.7	31.1	12.2	2.9
15	24.7	38.2	4.6	21.8	33.6	15.3	18.0	30.1	57.1	29.4	24.7	25.0	23.7	64.4	12.3	11.5	42.0	8.1	9.9	8.9
16	22.3	26.2	4.3	22.1	18.4	28.4	17.7	20.4	44.4	25.3	34.4	23.8	29.2	58.6	4.0	34.4	17.8	13.9	18.6	13.7
17	23.3	13.5	10.9	27.0	30.0	55.6	67.8	8.7	54.5	40.8	21.4	12.6	17.8	26.0	13.5	48.3	33.2	46.1	21.9	12.9
18	16.2	18.9	10.7	33.8	30.3	60.6	56.7	29.0	37.1	20.9	47.2	23.9	22.0	54.8	13.3	45.6	7.0	30.9	19.9	16.3
19	30.6	11.7	11.5	13.1	35.5	49.0	43.4	33.6	62.4	35.6	33.8	5.0	37.0	57.2	12.6	42.0	26.4	23.3	38.7	14.7
20	39.8	43.4	13.3	10.1	14.6	13.1	48.7	35.9	12.8	42.3	44.9	10.6	14.6	59.7	13.9	42.7	24.4	30.1	12.8	3.3
21	44.6	13.9	15.7	17.8	46.3	31.9	37.7	27.4	33.5	44.2	22.8	26.2	13.3	40.3	11.5	42.7	20.7	12.4	34.4	3.9
22	12.4	36.5	13.6	18.0	40.9	43.2	17.6	36.4	57.6	25.3	17.1	26.0	30.3	35.1	8.6	33.6	12.0	23.1	9.6	3.8
23	16.1	37.0	11.6	7.4	27.1	23.4	39.6	18.7	68.1	21.9	45.6	13.6	13.7	13.1	13.4	28.3	34.8	34.6	42.7	11.5
24	23.7	19.5	10.3	8.4	32.6	51.9	48.8	13.2	45.9	22.6	8.5	4.2	42.0	26.8	8.9	25.2	10.8	31.3	11.9	9.2
25	26.5	8.2	7.4	33.2	37.3	12.7	39.0	16.0	57.6	34.8	42.8	5.1	34.5	38.3	5.6	11.7	20.7	28.7	26.1	12.6
26	34.9	19.5	16.2	38.6	35.9	43.2	17.4	22.5	36.6	14.6	37.7	4.5	18.7	51.2	11.3	24.1	33.4	7.4	7.7	7.3
27	37.0	39.9	10.7	15.2	9.1	49.8	28.0	23.7	50.5	6.5	36.1	28.0	47.2	26.5	2.9	12.5	8.0	45.2	29.1	4.5
28	49.0	10.0	5.6	21.7	17.1	60.0	17.3	38.4	36.9	40.7	13.4	14.7	17.5	31.6	3.3	18.6	33.7	9.6	43.9	9.9
29	20.8	18.5	16.7	29.9	46.9	36.3	26.1	23.6	30.7	43.3	15.5	13.0	31.0	16.6	16.6	17.6	30.2	11.1	40.0	6.7
30	44.9	19.0	16.2	23.5	11.3	22.8	39.9	31.1	36.1	24.7	55.8	9.9	9.3	39.8	6.4	18.0	37.1	23.2	21.8	15.1

Days		Dumpsters																											
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40								
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
2	16.3	17.4	10.2	63.5	18.7	28.7	41.9	46.7	57.0	33.1	33.8	78.3	34.7	34.7	20.6	65.4	27.3	27.9	58.7	41.1	10.1								
3	28.9	58.2	17.5	48.1	14.0	15.8	48.3	24.9	38.0	19.2	60.1	74.5	58.1	58.1	26.8	61.7	10.6	36.9	54.5	50.7	5.3								
4	18.9	21.6	17.3	52.0	13.2	48.6	47.5	60.0	69.3	25.9	24.8	80.8	17.7	17.7	16.6	58.2	8.4	43.5	53.5	50.7	9.4								
5	25.0	35.1	15.5	48.0	30.6	33.6	29.3	26.4	71.1	12.0	79.8	78.9	25.5	25.5	53.2	48.3	25.5	28.3	30.0	43.2	6.8								
6	16.5	16.3	4.2	22.5	26.2	49.2	33.0	41.7	32.5	29.9	21.0	64.3	15.8	19.7	55.8	45.0	34.7	45.0	21.7	7.9	7.9								
7	16.0	10.2	13.6	63.2	6.0	43.1	20.0	59.8	57.4	27.5	40.7	18.2	57.7	17.8	12.8	9.5	16.9	56.6	50.5	5.1	5.1								
8	6.4	46.6	14.5	25.4	8.5	39.8	46.0	77.7	31.2	25.4	38.9	71.9	55.4	40.0	24.5	16.6	55.6	36.8	43.1	2.4	2.4								
9	30.6	54.3	10.5	10.5	37.8	37.7	44.5	66.4	52.3	39.1	49.3	17.4	20.5	20.1	42.4	11.3	48.4	27.9	47.8	2.4	2.4								
10	30.1	13.0	18.3	41.3	10.9	53.9	29.1	43.7	14.5	35.2	71.3	54.8	16.5	55.7	11.4	14.7	23.4	46.7	29.6	11.6	11.6								
11	11.3	46.9	4.8	69.1	13.8	9.2	48.3	37.7	48.2	28.3	32.7	37.6	9.1	10.0	39.8	29.8	42.2	55.0	24.3	11.0	11.0								
12	7.9	52.3	17.4	60.3	11.6	59.2	50.5	74.3	12.7	45.4	33.5	33.1	10.3	17.0	11.6	41.2	46.4	45.8	27.9	3.1	3.1								
13	15.4	20.8	18.3	47.0	24.2	42.3	36.6	51.0	17.2	27.7	52.8	26.0	20.1	35.5	36.2	41.1	43.5	38.4	43.6	10.6	10.6								
14	13.3	23.2	10.5	38.6	25.5	20.7	21.4	37.3	33.1	8.4	22.2	33.8	12.2	44.7	21.7	21.6	50.6	13.8	13.7	11.1	11.1								
15	16.2	36.7	10.5	39.2	17.5	27.6	58.2	70.0	43.0	6.8	35.1	78.0	11.5	53.6	62.9	41.5	50.6	25.1	24.9	2.7	2.7								
16	18.2	23.9	10.5	44.2	28.1	14.7	15.5	81.8	45.2	16.8	28.9	63.0	36.7	15.0	25.8	15.8	17.0	13.8	9.9	4.6	4.6								
17	25.4	17.0	16.6	35.8	11.3	59.7	57.2	14.5	42.4	30.9	58.9	69.9	26.1	42.7	30.1	14.6	17.0	13.8	9.9	4.6	4.6								
18	21.9	48.4	13.0	23.3	17.5	58.8	29.8	42.1	14.9	42.5	75.3	56.2	44.4	36.6	45.5	15.6	35.6	36.5	27.5	9.1	9.1								
19	33.7	29.8	10.5	36.5	21.7	46.1	38.4	22.7	25.4	8.0	38.1	43.9	9.4	11.1	39.5	13.9	16.6	26.1	11.4	9.6	9.6								
20	33.7	24.7	17.5	67.3	18.1	43.6	38.8	77.3	54.0	23.9	80.3	51.7	47.4	46.8	31.3	7.8	36.6	18.5	10.5	2.2	2.								

Table S7. Amount of waste inside dumpsters in a daily basis (part III).

Days	Dumpsters														
	41	42	43	44	45	46	47	48	49	50					
1	0	0	0	0	0	0	0	0	0	0					
2	66.0	24.2	17.8	17.5	9.1	11.2	10.0	14.2	42.7	44.0					
3	66.8	10.5	18.8	41.0	28.8	6.5	31.9	12.5	21.0	64.9					
4	85.2	10.8	33.9	41.8	34.0	11.5	22.3	8.4	54.4	28.9					
5	28.0	24.5	21.6	46.0	9.6	6.4	27.7	5.2	16.7	64.5					
6	18.4	14.3	43.1	39.2	31.8	23.2	20.9	5.9	33.2	33.4					
7	74.0	9.1	16.2	32.5	42.1	10.3	28.8	5.8	45.9	50.9					
8	35.9	25.7	47.5	46.6	24.3	21.3	32.8	7.4	49.7	50.7					
9	73.5	9.5	26.9	18.2	12.3	29.0	14.5	7.1	20.5	11.2					
10	40.3	23.9	46.9	21.8	37.2	20.8	6.8	10.1	31.5	41.9					
11	42.9	26.8	27.7	37.3	38.1	26.6	14.4	3.5	69.6	17.2					
12	72.9	36.5	36.6	28.8	9.8	27.4	30.4	7.1	61.0	20.2					
13	42.0	21.5	47.4	25.7	19.6	16.3	20.1	18.9	20.0	33.5					
14	40.8	16.8	23.9	14.9	31.5	15.4	6.2	16.0	22.2	50.4					
15	42.8	18.5	14.2	31.8	30.0	11.1	20.4	5.9	30.1	62.9					
16	78.1	22.2	44.3	35.3	11.7	26.1	8.2	5.6	68.0	38.8					
17	23.7	5.7	10.9	19.6	42.7	27.6	12.8	10.7	65.5	30.0					
18	19.8	14.3	25.4	10.7	41.7	20.3	24.5	12.7	43.9	13.0					
19	32.2	27.0	37.7	43.3	18.8	5.8	22.6	4.3	39.0	60.4					
20	43.4	27.9	48.2	28.9	43.3	23.4	29.4	6.3	29.9	31.7					
21	44.5	30.5	25.3	7.4	9.5	8.4	28.5	20.0	63.6	20.8					
22	28.7	32.1	31.3	39.4	39.8	20.9	32.1	13.8	16.0	11.5					
23	62.5	28.7	19.4	33.6	7.2	29.9	27.3	20.8	56.4	42.6					
24	26.7	36.3	26.9	9.6	36.4	34.2	28.9	6.9	67.3	38.5					
25	50.8	21.6	18.0	7.4	16.6	10.1	15.4	12.5	53.8	20.6					
26	43.3	14.5	23.9	8.5	21.6	25.2	5.2	17.7	55.9	31.0					
27	41.6	24.6	17.4	14.6	7.8	10.7	23.0	12.5	30.5	56.5					
28	33.3	7.6	48.1	16.7	32.0	20.4	27.7	14.8	43.0	40.2					
29	14.2	7.3	49.5	41.2	19.1	13.2	20.2	6.1	46.0	58.4					
30	80.3	29.8	52.6	19.1	30.6	9.7	13.4	10.3	26.9	12.4					

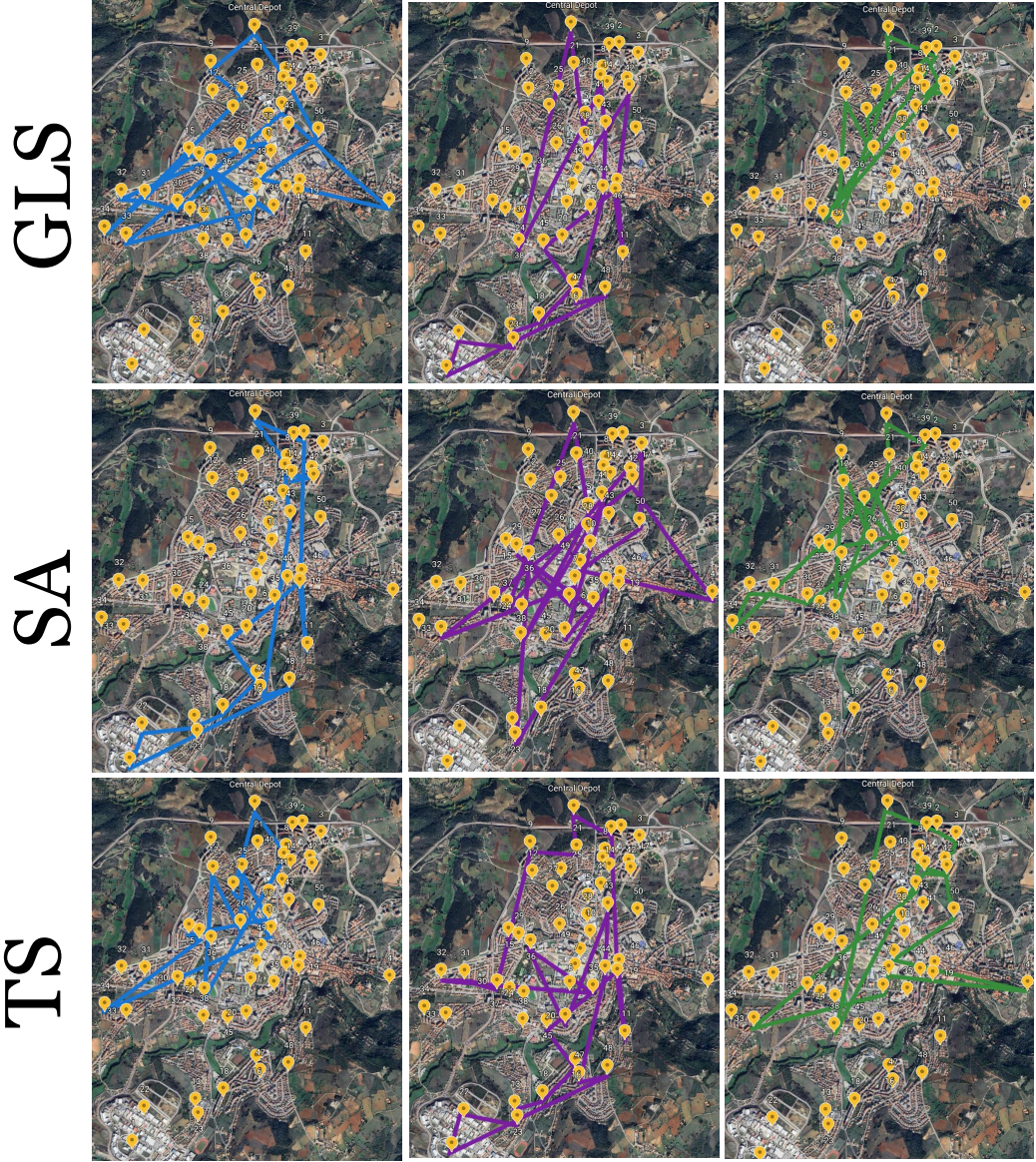


Figure S1. Routes for the trucks according to GLS, SA, and TS.