Appendix of A Two-layer Heterogeneous Ant Colony System with Applications in Tape Carrier Packaging

Appendix A. The experimental results of the 3×1 sucker matrix configuration.

No.	Amount	Methods	e_n	e_{max}	*std*	$\bar{n}$	$\overline{N_c}$	t_w	e_t
		THACS	3.328	3.367	0.033	177.020	51.563	53.193	3.042
		ACS	3.267	3.360	0.068	176.640	58.271	54.067	2.991
		IMMAS	3.280	3.366	0.063	176.960	53.470	53.949	3.002
1	250	GA	3.259	3.363	0.051	174.200	49.440	53.454	2.980
		SA	3.247	3.356	0.071	173.800	51.803	53.531	2.969
		PSO	3.255	3.355	0.059	174.400	50.853	53.581	2.977
		Greedy	2.992	3.315	0.165	206.200	672.043	68.928	2.789
		THACS	3.305	3.383	0.037	194.260	43.340	58.780	3.046
		ACS	3.284	3.392	0.067	195.100	43.860	59.405	3.029
		IMMAS	3.285	3.384	0.080	195.400	43.600	59.484	3.030
2	275	GA	3.265	3.381	0.076	192.420	41.760	58.941	3.009
		SA	3.238	3.383	0.094	191.080	42.760	59.005	2.985
		PSO	3.275	3.385	0.078	191.120	42.320	58.357	3.017
		Greedy	3.033	3.283	0.142	227.200	569.480	74.903	2.843
		THACS	3.303	3.406	0.047	212.100	35.760	64.223	3.064
		ACS	3.238	3.303	0.054	209.460	38.740	64.687	3.006
		IMMAS	3.274	3.359	0.050	210.600	36.740	64.332	3.038
3	300	GA	3.233	3.375	0.088	207.260	33.960	64.117	2.999
		SA	3.218	3.283	0.046	205.180	33.400	63.759	2.984
		PSO	3.234	3.359	0.060	205.680	334.640	63.607	2.998
		Greedy	2.990	3.262	0.121	257.700	520.820	86.183	2.826
		THACS	3.346	3.457	0.045	231.240	29.580	69.110	3.120
		ACS	3.302	3.352	0.040	229.260	31.940	69.438	3.080
		IMMAS	3.317	3.410	0.045	231.300	30.920	69.735	3.095
4	325	GA	3.270	3.345	0.066	227.260	29.620	69.499	3.051
		SA	3.263	3.326	0.037	227.020	29.080	69.571	3.044
		PSO	3.287	3.328	0.032	229.160	29.700	69.710	3.067
		Greedy	2.945	3.135	0.146	265.500	403.820	90.159	2.790
		THACS	3.377	3.459	0.040	246.600	25.900	73.015	3.161
		ACS	3.323	3.403	0.060	246.240	27.080	74.106	3.113
		IMMAS	3.340	3.425	0.043	246.800	26.380	73.897	3.128
5	350	GA	3.292	3.387	0.047	243.160	25.080	73.855	3.084
		SA	3.273	3.371	0.046	242.060	25.740	73.961	3.066
		PSO	3.286	3.389	0.053	245.660	25.280	74.764	3.080
		Greedy	3.105	3.358	0.122	281.180	366.560	90.570	2.942

Appendix B. The experimental results of the 3×2 sucker matrix configuration.

No.	Amount	Methods	e_n	e_{max}	*std*	$\bar{n}$	$\overline{N_c}$	t_w	e_t
		THACS	4.898	4.961	0.053	168.820	86.460	34.464	4.278
		ACS	4.808	4.937	0.075	166.740	86.520	34.678	4.202
		IMMAS	4.818	4.939	0.056	167.520	83.820	34.773	4.212
1	250	GA	4.792	4.901	0.053	163.500	74.260	34.121	4.179
		SA	4.729	4.787	0.055	162.320	84.560	34.323	4.128
		PSO	4.787	4.850	0.058	164.560	76.260	34.375	4.179
		Greedy	3.354	3.613	0.147	186.300	1196.720	55.546	3.077
		THACS	4.843	4.935	0.060	185.900	73.280	38.385	4.285
		ACS	4.753	4.913	0.066	186.520	74.520	39.243	4.216
		IMMAS	4.778	4.854	0.050	184.560	75.120	38.629	4.230
2	275	GA	4.749	4.895	0.066	182.260	69.200	38.378	4.202
		SA	4.660	4.883	0.096	184.320	71.020	39.554	4.137
		PSO	4.738	4.836	0.062	184.200	68.980	38.880	4.198
		Greedy	3.383	3.783	0.221	212.700	936.340	62.875	3.134
		THACS	4.760	4.852	0.076	203.120	54.980	42.616	4.266
		ACS	4.678	4.809	0.086	199.860	57.840	42.708	4.189
		IMMAS	4.683	4.827	0.092	204.220	56.140	43.600	4.202
3	300	GA	4.659	4.785	0.083	196.540	47.920	42.175	4.166
		SA	4.621	4.731	0.084	193.200	58.740	41.809	4.127
		PSO	4.645	4.751	0.091	195.660	48.120	42.112	4.153
		Greedy	3.741	4.125	0.157	235.520	605.320	62.956	3.466
		THACS	4.870	4.997	0.079	214.620	51.900	44.074	4.373
		ACS	4.779	4.913	0.087	218.820	52.200	45.791	4.308
		IMMAS	4.787	4.912	0.065	214.700	53.540	44.855	4.307
4	325	GA	4.720	4.775	0.033	214.800	50.760	45.513	4.252
		SA	4.708	4.902	0.110	212.060	51.540	45.047	4.237
		PSO	4.767	4.842	0.054	213.460	50.860	44.783	4.288
		Greedy	3.292	3.772	0.217	257.380	573.400	78.180	3.094
		THACS	4.886	4.968	0.066	233.740	44.460	47.834	4.424
		ACS	4.804	4.933	0.065	236.220	45.460	48.931	4.380
		IMMAS	4.828	4.944	0.078	235.000	46.320	48.923	4.358
5	350	GA	4.798	4.918	0.097	234.660	41.760	48.607	4.377
		SA	4.738	4.936	0.104	234.200	42.780	48.809	4.352
		PSO	4.754	4.938	0.095	233.720	44.200	49.332	4.302
		Greedy	3.437	3.775	0.169	279.620	502.000	81.353	3.238

Appendix C. The experimental results of the 3×3 sucker matrix configuration.

No.	Amount	Methods	e_n	e_{max}	*std*	$\bar{n}$	$\overline{N_c}$	t_w	e_t
		THACS	5.407	5.549	0.074	160.420	87.399	29.670	4.627
		ACS	5.325	5.448	0.070	159.800	101.704	30.010	4.564
		IMMAS	5.333	5.466	0.120	161.320	95.007	30.251	4.576
1	250	GA	5.287	5.405	0.045	160.260	84.967	30.313	4.538
		SA	5.307	5.395	0.057	158.260	86.947	29.822	4.545
		PSO	5.309	5.426	0.107	158.600	84.881	29.875	4.548
		Greedy	3.423	4.047	0.326	181.620	1506.024	53.055	3.128
		THACS	5.450	5.607	0.111	176.400	77.217	32.366	4.721
		ACS	5.369	5.531	0.106	175.340	85.036	32.657	4.656
		IMMAS	5.379	5.461	0.059	179.400	80.690	33.351	4.678
2	275	GA	5.346	5.518	0.110	173.260	73.271	32.408	4.632
		SA	5.169	5.394	0.130	172.060	75.163	33.288	4.494
		PSO	5.257	5.427	0.137	174.000	73.712	33.098	4.567
		Greedy	3.295	3.549	0.204	201.200	1225.490	61.062	3.046
		THACS	5.448	5.570	0.071	191.400	67.327	35.134	4.769
		ACS	5.324	5.501	0.112	189.920	81.923	35.669	4.670
		IMMAS	5.337	5.532	0.114	190.800	69.501	35.750	4.682
3	300	GA	5.316	5.492	0.086	187.620	63.749	35.295	4.656
		SA	5.233	5.486	0.152	186.200	66.116	35.582	4.588
		PSO	5.263	5.329	0.039	188.260	65.600	35.770	4.618
		Greedy	3.370	3.900	0.324	225.260	1157.407	66.850	3.135
		THACS	5.476	5.685	0.125	208.860	60.222	38.144	4.841
		ACS	5.373	5.513	0.101	210.000	67.496	39.084	4.764
		IMMAS	5.402	5.569	0.131	208.200	65.183	38.543	4.781
4	325	GA	5.347	5.483	0.072	207.260	56.918	38.765	4.736
		SA	5.223	5.397	0.093	206.220	59.291	39.483	4.636
		PSO	5.252	5.472	0.119	207.680	58.053	39.545	4.662
		Greedy	3.371	3.879	0.304	245.620	1131.222	72.860	3.155
		THACS	5.510	5.674	0.077	222.800	53.813	40.436	4.904
		ACS	5.424	5.622	0.129	224.880	62.521	41.459	4.840
		IMMAS	5.464	5.651	0.128	223.620	58.591	40.930	4.869
5	350	GA	5.390	5.540	0.121	220.240	50.893	40.861	4.802
		SA	5.209	5.440	0.124	219.180	52.843	42.076	4.656
		PSO	5.359	5.499	0.134	222.120	51.302	41.452	4.782
		Greedy	3.443	3.773	0.174	268.700	1008.065	78.054	3.235

Appendix D. The experimental results of the 3×4 sucker matrix configuration.

No.	Amount	Methods	e_n	e_{max}	*std*	$\bar{n}$	$\overline{N_c}$	t_w	e_t
		THACS	6.225	6.306	0.108	154.300	59.800	24.788	5.180
		ACS	6.090	6.265	0.111	152.420	71.780	25.029	5.076
		IMMAS	6.110	6.256	0.116	154.900	64.900	25.353	5.103
1	250	GA	6.010	6.164	0.112	154.120	57.660	25.645	5.029
		SA	5.950	6.091	0.126	150.560	59.060	25.306	4.968
		PSO	6.008	6.165	0.114	152.200	57.940	25.332	5.018
		Greedy	4.029	5.564	0.594	170.120	766.880	42.224	3.602
		THACS	6.076	6.228	0.085	169.500	52.780	27.897	5.152
		ACS	5.931	6.049	0.107	167.700	60.060	28.275	5.040
		IMMAS	5.936	6.082	0.117	168.800	56.000	28.435	5.049
2	275	GA	5.893	6.098	0.125	167.260	50.780	28.383	5.010
		SA	5.823	5.965	0.107	165.100	52.800	28.354	4.950
		PSO	5.866	6.010	0.119	165.220	51.820	28.164	4.982
		Greedy	4.075	5.316	0.591	195.200	619.360	47.896	3.690
		THACS	6.065	6.250	0.101	185.100	45.500	30.521	5.211
		ACS	5.919	6.102	0.078	184.200	56.460	31.119	5.100
		IMMAS	5.904	6.115	0.093	183.300	51.700	31.047	5.085
3	300	GA	5.863	6.012	0.098	185.660	46.000	31.666	5.063
		SA	5.778	6.002	0.129	185.140	47.660	32.043	4.998
		PSO	5.804	5.942	0.111	185.160	46.860	31.903	5.017
		Greedy	3.529	4.558	0.410	219.000	578.700	62.051	3.266
		THACS	6.073	6.243	0.105	198.700	41.560	32.718	5.268
		ACS	5.933	6.114	0.105	199.000	45.540	33.543	5.163
		IMMAS	5.963	6.153	0.078	201.480	43.700	33.788	5.194
4	325	GA	5.869	5.945	0.069	196.360	39.340	33.455	5.106
		SA	5.769	5.942	0.084	195.160	38.360	33.829	5.026
		PSO	5.840	5.953	0.082	197.220	39.980	33.771	5.087
		Greedy	3.704	3.893	0.161	235.120	517.600	63.470	3.434
		THACS	6.131	6.252	0.127	215.100	38.700	35.085	5.366
		ACS	5.967	6.224	0.129	216.220	43.740	36.234	5.244
		IMMAS	5.995	6.243	0.121	215.400	40.760	35.927	5.263
5	350	GA	5.883	6.124	0.143	213.160	37.180	36.233	5.170
		SA	5.796	5.945	0.078	212.000	38.200	36.578	5.099
		PSO	5.854	6.042	0.133	214.880	37.640	36.707	5.152
		Greedy	3.591	4.142	0.255	257.200	482.620	71.632	3.356

Appendix E. The experimental results of the 3×5 sucker matrix configuration.

No.	Amount	Methods	e_n	e_{max}	*std*	$\bar{n}$	$\overline{N_c}$	t_w	e_t
		THACS	6.318	6.424	0.110	150.100	41.085	23.759	5.219
		ACS	6.214	6.401	0.108	143.800	43.275	23.143	5.110
		IMMAS	6.246	6.410	0.115	145.500	42.446	23.294	5.142
1	250	GA	6.122	6.325	0.099	144.160	40.414	23.546	5.050
		SA	5.912	6.125	0.123	143.260	41.017	24.233	4.901
		PSO	6.016	6.245	0.130	143.880	40.750	23.916	4.976
		Greedy	3.486	4.829	0.718	162.800	418.060	46.702	3.149
		THACS	6.372	6.513	0.090	160.320	36.017	25.160	5.316
		ACS	6.253	6.455	0.138	159.400	37.966	25.493	5.228
		IMMAS	6.284	6.435	0.139	163.240	36.773	25.977	5.270
2	275	GA	6.191	6.351	0.099	159.260	35.653	25.725	5.183
		SA	5.979	6.165	0.138	160.000	35.940	26.759	5.038
		PSO	6.062	6.264	0.168	159.480	35.858	26.307	5.094
		Greedy	3.484	4.936	0.682	187.900	382.263	53.932	3.188
		THACS	6.299	6.410	0.099	177.300	32.936	28.149	5.349
		ACS	6.179	6.371	0.117	175.880	35.011	28.466	5.255
		IMMAS	6.211	6.357	0.117	176.400	34.249	28.402	5.281
3	300	GA	6.087	6.294	0.086	175.260	32.514	28.793	5.186
		SA	5.877	6.105	0.123	174.200	33.060	29.640	5.029
		PSO	5.960	6.156	0.144	175.000	32.795	29.362	5.093
		Greedy	3.691	5.092	0.692	210.320	333.778	56.982	3.393
		THACS	6.325	6.457	0.115	192.100	31.483	30.372	5.431
		ACS	6.226	6.439	0.129	189.400	33.485	30.421	5.347
		IMMAS	6.253	6.435	0.124	191.100	32.631	30.560	5.374
4	325	GA	6.108	6.245	0.072	188.440	30.883	30.854	5.256
		SA	5.900	6.045	0.105	187.240	31.309	31.734	5.097
		PSO	6.002	6.125	0.108	189.600	31.230	31.589	5.182
		Greedy	3.626	4.325	0.392	227.300	319.285	62.679	3.359
		THACS	6.217	6.431	0.102	211.400	25.403	34.001	5.420
		ACS	6.121	6.345	0.115	206.300	26.428	33.702	5.330
		IMMAS	6.159	6.342	0.126	209.400	26.385	33.997	5.370
5	350	GA	5.993	6.164	0.112	208.160	25.143	34.731	5.239
		SA	5.841	6.095	0.114	209.820	25.549	35.920	5.128
		PSO	5.928	6.137	0.152	210.120	25.469	35.446	5.195
		Greedy	3.512	4.576	0.528	249.600	267.953	71.065	3.281

Appendix F. The experimental results of the 3×6 sucker matrix configuration.

No.	Amount	Methods	e_n	e_{max}	*std*	$\bar{n}$	$\overline{N_c}$	t_w	e_t
		THACS	6.418	6.530	0.111	132.000	15.920	20.567	5.163
		ACS	6.315	6.517	0.111	131.960	16.560	20.896	5.096
		IMMAS	6.347	6.523	0.117	131.800	16.140	20.764	5.116
1	250	GA	6.314	6.523	0.106	131.920	15.800	20.892	5.095
		SA	6.016	6.212	0.115	130.200	15.920	21.644	4.887
		PSO	6.122	6.375	0.141	130.980	15.820	21.393	4.963
		Greedy	4.181	4.671	0.467	146.280	190.020	34.985	3.658
		THACS	6.288	6.393	0.089	145.800	13.940	23.186	5.173
		ACS	6.169	6.273	0.093	145.220	14.560	23.541	5.088
		IMMAS	6.198	6.342	0.104	147.100	14.460	23.733	5.120
2	275	GA	6.076	6.290	0.086	146.760	13.020	24.152	5.034
		SA	5.898	6.113	0.135	146.460	13.720	24.832	4.909
		PSO	5.940	6.151	0.152	147.020	13.040	24.752	4.941
		Greedy	4.194	4.874	0.697	158.120	164.880	37.703	3.703
		THACS	6.210	6.331	0.080	159.260	13.180	25.647	5.197
		ACS	6.111	6.247	0.096	159.660	13.760	26.125	5.130
		IMMAS	6.149	6.325	0.113	161.120	13.420	26.205	5.163
3	300	GA	5.962	6.059	0.099	160.220	11.820	26.874	5.027
		SA	5.817	6.051	0.125	159.420	12.980	27.406	4.919
		PSO	5.913	6.059	0.132	160.100	12.080	27.074	4.992
		Greedy	3.512	4.576	0.528	184.700	141.540	52.587	3.207
		THACS	6.428	6.530	0.095	171.400	12.080	26.666	5.413
		ACS	6.347	6.531	0.119	171.380	14.480	27.004	5.355
		IMMAS	6.366	6.510	0.111	172.440	12.400	27.087	5.374
4	325	GA	6.316	6.538	0.109	172.360	11.280	27.291	5.338
		SA	6.027	6.331	0.141	170.060	12.220	28.214	5.120
		PSO	6.146	6.413	0.133	171.620	11.800	27.922	5.213
		Greedy	4.181	4.671	0.467	204.260	127.460	48.852	3.793
		THACS	6.383	6.527	0.099	187.800	11.000	29.420	5.456
		ACS	6.277	6.493	0.140	185.440	11.440	29.545	5.368
		IMMAS	6.290	6.495	0.148	186.620	11.240	29.669	5.383
5	350	GA	6.204	6.425	0.122	184.260	9.800	29.701	5.310
		SA	6.001	6.347	0.177	182.200	10.840	30.361	5.153
		PSO	6.073	6.275	0.163	184.400	10.020	30.362	5.215
		Greedy	4.078	5.541	0.760	222.060	115.940	54.447	3.735