

Appendix 1: Parameter Values

Table 1: Fixed establishing cost of facilities

	1	2	3	4	5	6	7	8
f_i	35222	35359	34190	35370	-	-	-	-
f_j	1690	1529	1584	1664	1787	1790	1547	1791
f_l	27393	26213	27001	25355	26054	27289	-	-
f_m	1738	1788	1697	1511	-	-	-	-
f_p	1285	1293	1268	-	-	-	-	-

Table 2: Maximum capacity of facilities

	1	2	3	4	5	6	7	8
p_i	6606	6595	6314	6524	-	-	-	-
p_j	2313	2666	2221	2383	2231	2264	2744	2659
p_l	2977	3369	2801	3052	3017	3255	-	-
p_m	1459	1337	1398	1389	-	-	-	-
p_p	1059	1084	1102	-	-	-	-	-

Table 3: Unit transportation cost from plant to distribution center tc_{ij}

(i, j)	1	2	3	4	5	6	7	8
1	7.1041	6.4760	8.3411	8.0238	8.1889	9.3629	9.7171	8.4642
2	8.7188	7.9935	6.8952	8.7963	6.5545	7.0171	7.3999	7.8932
3	8.6204	9.8390	9.0051	9.5636	6.5972	9.2571	6.7864	7.4066
4	6.6504	7.3615	7.0204	9.8372	7.0300	6.9741	7.0043	9.3233

The related proportional parameters $\omega = 0.6639$, $\theta_1 = 0.0765$, $\theta_2 = 0.2327$; the related parameters of income $s_1 = 458.2791$, $s_2 = 290.7699$, $s_3 = 29.3951$.

Table 4: Unit transportation cost from distribution center to primary customer tc_{jk} & Customer demand $d_{k,n}$

(j, k)	1	2	3	4	5	6	7	8	9	10	11	12
1	10.3411	8.3034	8.0476	9.0519	8.6095	8.0185	9.7257	10.1994	8.9597	9.9635	8.9668	8.9391
2	10.1989	8.2158	9.3485	10.6163	11.3033	11.0996	11.6426	8.5798	8.4933	9.9570	9.6156	9.4126
3	11.6688	10.1232	8.6487	10.7569	10.1534	11.2692	8.7274	11.4121	8.7356	9.3509	8.3858	11.2848
4	9.1434	11.1167	11.1771	10.9926	11.9845	11.4748	9.0552	10.4882	8.9598	11.6002	8.5279	8.0616
5	11.0288	11.7360	9.2449	9.8022	8.3127	8.3377	8.5822	9.4038	9.6691	9.4770	11.7682	8.1721
6	11.0149	8.5196	10.1141	8.3353	9.7707	9.5991	8.5443	10.0530	8.1986	8.4448	11.8245	8.6760
7	9.5218	10.2753	8.6626	8.9159	8.4266	9.0395	11.4772	9.6072	11.6109	11.1210	10.3008	10.5965
8	10.2713	9.8776	10.4079	11.6533	11.8476	11.2003	10.3188	8.3039	11.7791	9.5590	8.2391	10.9269
d_k	1013	1006	939	979	910	959	945	927	929	958	918	979
d_n	431	452	452	446	390	393	-	-	-	-	-	-

Table 5: Unit transportation cost from disassembly center to plant tc_{li}

(l, i)	1	2	3	4
1	7.2955	7.3736	7.8588	7.0170
2	6.9018	6.3670	7.5514	7.0215
3	7.0940	6.7370	6.9736	7.6353
4	6.5926	7.2512	6.8717	7.5897
5	7.4894	7.5605	6.8936	7.2886
6	6.3779	6.1623	6.6127	6.7572

Table 6: Unit transportation cost from disassembly center to redistribution center tc_{lm}

(l, m)	1	2	3	4
1	9.2463	8.4899	9.3772	7.2444
2	8.1313	8.3482	6.7791	9.6935
3	7.4029	6.8310	6.9037	7.7208
4	9.7560	7.2050	6.6828	6.7393
5	9.5038	7.8837	6.9107	9.6195
6	8.2006	6.9220	7.7428	9.9190

Table 7: Unit transportation cost from disassembly center to disposal center tc_{lp}

(l, p)	1	2	3
1	4.8777	5.2057	4.8483
2	4.2222	5.4224	5.0157
3	4.5161	4.4435	4.1710
4	4.8174	4.2348	4.5250
5	5.1898	4.5934	5.6020
6	4.5244	4.6376	4.0584

Table 8: Unit transportation cost from plant to redistribution center tc_{im}

(i, m)	1	2	3	4
1	9.7154	6.9491	8.0845	8.7165
2	8.9213	7.8354	6.9264	7.5821
3	7.9544	9.8524	7.9556	7.4697
4	8.3141	8.1872	8.4962	9.9519

Table 9: Unit transportation cost from redistribution center to secondary market tc_{mn}

(m, n)	1	2	3	4	5	6
1	8.0755	8.1974	8.2731	8.9883	9.7818	8.0611
2	9.7703	8.5237	9.4425	9.5581	8.6683	9.4881
3	9.8266	8.6707	8.2135	9.4301	9.3975	9.0000
4	9.5924	9.3595	9.3075	9.8074	8.3956	8.9598

Table 10: Unit manufacturing, remanufacturing and repairing cost mc_i , vc_i and rc_i

	1	2	3	4	5	6
mc_i	128.0944	122.1973	122.3533	127.1888	-	-
vc_i	76.1098	71.5344	63.6584	64.7986	-	-
rc_i	62.7302	45.5735	54.7980	48.3585	64.5736	59.2539

Table 11: Unit treatment cost in the related facilities $hc_{j,l,m}$ & Unit disposal cost dc_p

	1	2	3	4	5	6	7	8
hc_j	8.7279	6.1697	6.2858	8.0866	6.3869	9.2726	9.2702	8.8898
hc_l	10.7493	13.2980	12.5930	14.8649	13.2450	14.0017	-	-
hc_m	7.8152	7.7296	9.3013	6.3339	-	-	-	-
dc_p	7.5024	7.3554	5.2981	-	-	-	-	-

Table 12: Unit recovery cost of used product from customer to disassembly center cc_{kl}

(k, l)	1	2	3	4	5	6
1	15.6659	17.1583	18.6893	18.3326	19.9082	17.9149
2	15.8669	15.0774	16.3456	15.8907	15.7820	16.2590
3	16.9547	19.9203	17.1142	15.6401	19.2776	16.4522
4	19.1569	15.8358	17.7394	19.9954	18.2238	18.0855
5	19.0168	15.5311	19.7137	15.8556	16.8814	16.3264
6	15.3024	16.8620	17.0887	15.1630	15.9546	19.1219
7	16.9963	15.9906	19.9153	17.8060	17.1413	19.9133
8	17.6344	17.4484	16.5073	19.4093	17.4101	18.6512
9	17.0840	16.6975	18.5055	18.3459	15.6031	16.7194
10	18.2843	19.7582	18.3317	15.9522	17.9475	17.9203
11	18.1399	19.6017	17.6956	16.8446	16.1309	15.5388
12	16.4599	15.2634	18.4905	17.3036	16.9231	19.5315

Table 13: Delivery time from distribution center to customer dt_{jk} & Expected delivery time of customer et_k

	1	2	3	4	5	6	7	8	9	10	11	12
(j, k)	dt_{jk}											
1	6.1742	6.0002	5.6570	6.0662	6.7252	5.8722	5.9151	5.6846	5.3802	6.1861	5.5766	5.7932
2	6.2785	5.8883	6.6062	5.4126	6.1205	6.2664	5.6638	5.1132	6.9848	6.4626	5.3727	6.5219
3	5.2503	5.6512	5.2869	5.3139	6.0883	5.2936	6.7147	5.8407	6.3599	6.3062	6.8947	5.3256
4	6.7305	6.1318	5.1572	5.8045	6.6846	6.1307	6.2143	5.9217	6.8698	5.1239	5.7961	5.9362
5	5.9756	5.0304	5.8908	5.8752	6.5759	5.8062	5.3942	6.071	6.2728	5.3061	5.2783	6.1873
6	5.5520	6.1057	5.9310	6.9501	6.0727	5.1080	5.2870	6.6568	6.2974	6.5113	6.0827	5.1707
7	5.6229	6.8716	6.4734	6.8535	5.0037	5.2720	6.5348	6.9967	5.7652	5.9917	5.0610	5.9943
8	6.3331	5.9635	6.3981	5.6161	5.7403	5.7810	6.3054	5.7648	5.0557	5.7687	6.0969	6.5538
et_k	4.2676	5.5495	4.5102	4.1946	5.3821	5.8943	5.4582	4.6328	4.2818	5.5743	4.4152	5.7112

Appendix 2: Partial Experiment Results

In the paper, we conducted multi-group experiments, which corresponds to multiple sets of location and flow distribution solutions. However, due to space constraints, only some results of the single objective optimization for maximizing the enterprise profit are presented here. The flow distribution $X_l = (0, 2327, 0, 533, 0, 0)$.

Table 1: Flow distribution from plant to distribution center X_{ij}

(i, j)	1	2	3	4	5	6	7	8
1	0	0	0	0	0	0	0	0
2	0	2666	2221	0	0	1708	0	0
3	0	0	0	0	2231	0	2636	0
4	0	0	0	0	0	0	0	0

Table 2: Distribution schemes for primary markets X_{jk}

(j, k)	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	1006	0	0	0	0	0	927	734	0	0	0
3	0	0	455	0	0	0	652	0	195	0	918	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	959	293	0	0	0	0	979
6	0	0	0	749	0	0	0	0	0	958	0	0
7	1013	0	483	230	910	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: The number of used products collected from primary markets X_{kl}

(l, k)	1	2	3	4	5	6	7	8	9	10	11	12
2	0	668	0	650	604	0	627	0	170	0	0	650
4	0	0	623	0	0	636	0	0	0	636	610	0

Table 4: Flow distributions of used products in three directions: remanufacturing, repairing and disposal

	1	2	3	4
(l, i)	X_{li}			
2	0	0	0	0
4	0	0	1198	0
(l, m)	X_{lm}			
2	784	0	0	0
4	0	0	0	583
(l, p)	X_{lp}			
2	0	0	258	-
4	0	0	192	-

Table 5: Flow distributions from plant to redistribution center X_{im}

(i, m)	1	2	3	4
1	0	0	0	0
2	0	0	0	0
3	391	0	0	806
4	0	0	0	0

Table 6: Distribution schemes for secondary markets X_{mn}

(m, n)	1	2	3	4	5	6
1	431	452	293	0	0	0
4	0	0	159	446	390	393