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**Supplementary Information**

**Simulation optimization approach for dynamic and stochastic closed loop supply chain network**

A.T. Dosdoğru<sup>a,\*</sup>, A. Boru İpek<sup>a</sup>, M. Göçken<sup>a</sup>, E. Özceylan<sup>b</sup>

*a. Department of Industrial Engineering, Adana Alparslan Türkeş Science and Technology University, 01250, Adana, Turkey.*

*b. Department of Industrial Engineering, Gaziantep University, 27310, Gaziantep, Turkey.*

\* Corresponding author: [adosdogru@atu.edu.tr](mailto:adosdogru@atu.edu.tr) (A.T. Dosdoğru)

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**Appendix A: Transfer Times (hours)**

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
Plants 1	Uniform(2,3)	Uniform(1.33,2)	Uniform(1.8,2)	Uniform(1.25,2)
Plants 2	Uniform(2,2.5)	Uniform(1.66,2)	Uniform(1.5,2)	Uniform(2.25,3)
Plants 3	Uniform(3,3.5)	Uniform(2.5,3)	Uniform(2.3,3)	Uniform(2.5,3)
Plants 4	Uniform(2,2.25)	Uniform(2.8,3.25)	Uniform(1.8,2)	Uniform(2,2.5)

	Collection Center 1	Collection Center 2	Refurbishing Center 1	Refurbishing Center 2
Plants 1	Uniform(3.75,4)	Uniform(4.25,5)	Uniform(2,3)	Uniform(3.15,4)
Plants 2	Uniform(3,3.75)	Uniform(2.5,3)	Uniform(2.5,3)	Uniform(2.8,3)
Plants 3	Uniform(3.15,4)	Uniform(2.8,3)	Uniform(1.8,2)	Uniform(2.25,3)
Plants 4	Uniform(3.8,4)	Uniform(3.5,4)	Uniform(3,4)	Uniform(2.15,2.75)

	Collection Center 1	Collection Center 2
Customer1	Uniform(0.75,1)	Uniform(1.75,2)
Customer2	Uniform(1.25,2)	Uniform(1.5,2)
Customer3	Uniform(1.75,2)	Uniform(1,1.25)
Customer4	Uniform(1.5,2)	Uniform(1.5,2)
Customer5	Uniform(2.25,3)	Uniform(1.75,2)

	Plant 1	Plant 2	Plant 3	Plant 4
Supplier 1	Uniform(1.75,2)	Uniform(2.15,3)	Uniform(1.5,2)	Uniform(2.5,3)
Supplier 2	Uniform(1.75,2)	Uniform(2.5,3)	Uniform(3,3.75)	Uniform(3.15,4)
Supplier 3	Uniform(2.25,3)	Uniform(1.25,2)	Uniform(1.5,2)	Uniform(2.5,3)
Supplier 4	Uniform(3.15,4)	Uniform(3,4)	Uniform(3.5,4)	Uniform(3.5,4)

	Collection Center 1	Collection Center 2	Disposal Center	Refurbishing Center 1	Refurbishing Center 2
Disassembly Center 1	Uniform(1.5,2)	Uniform(1.15,2)	Uniform(0.5,1)	Uniform(2.15,3)	Uniform(2.5,3)
Disassembly Center 2	Uniform(1.75,2)	Uniform(1.5,2)	Uniform(1,1.75)	Uniform(1.75,2.5)	Uniform(2,3)

**Appendix B.1. Reverse Network Analysis.**

Period	Number of incoming orders per period								Quantity of incoming products per period							
	P-T		P-D		C-T		C-D		P-T		P-D		C-T		C-D	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
<b>1</b>	74	71	72	73	72	74	73	72	1149	1102	1116	1128	1110	1131	1138	1109
<b>2</b>	74	76	77	73	74	77	77	74	1157	1183	1192	1134	1144	1187	1187	1141
<b>3</b>	74	76	76	74	75	75	76	74	1154	1158	1185	1146	1163	1156	1187	1141
<b>4</b>	77	74	75	75	76	74	73	77	1186	1139	1154	1165	1170	1139	1137	1187
<b>5</b>	73	77	75	75	74	76	77	74	1135	1196	1158	1165	1139	1186	1187	1140
<b>6</b>	76	74	75	75	74	76	76	74	1178	1147	1163	1168	1141	1184	1171	1152
<b>7</b>	77	73	74	76	75	75	74	76	1183	1148	1146	1190	1165	1166	1151	1185
<b>8</b>	76	75	74	76	75	75	74	76	1171	1156	1153	1168	1167	1157	1147	1179
<b>9</b>	73	77	76	74	77	74	77	73	1129	1195	1181	1152	1194	1134	1196	1129
<b>10</b>	74	76	75	75	74	75	75	75	1147	1177	1162	1154	1153	1167	1167	1156
<b>11</b>	75	75	76	74	75	75	77	73	1176	1152	1184	1146	1173	1161	1184	1131
<b>12</b>	76	74	74	75	75	75	74	76	1182	1148	1158	1170	1157	1167	1151	1171

**Appendix B.2: Average results of D1 and D2 per period**

Period	Number of incoming orders per period								Quantity of incoming products per period								Quantity of disposed products per period							
	P-T		P-D		C-T		C-D		P-T		P-D		C-T		C-D		P-T		P-D		C-T		C-D	
	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2
<b>1</b>	70	66	68	67	68	68	67	68	672	629	652	644	648	645	638	659	196	182	190	187	188	188	186	191
<b>2</b>	73	76	75	75	76	74	74	77	707	729	719	715	722	715	708	735	206	213	208	207	209	207	204	214
<b>3</b>	75	75	76	75	74	76	75	75	717	713	723	711	704	729	717	715	210	206	209	206	205	212	208	209
<b>4</b>	73	77	75	75	73	77	74	77	696	740	720	714	698	729	705	735	202	215	209	206	203	212	205	214
<b>5</b>	74	77	76	74	74	76	75	74	708	736	726	711	712	724	725	709	204	212	211	207	207	211	210	204
<b>6</b>	74	75	76	75	75	76	73	76	709	717	725	715	716	725	702	731	207	209	210	208	208	210	204	213
<b>7</b>	75	75	76	74	74	76	72	79	722	719	723	709	710	725	690	761	210	210	210	206	207	211	201	220
<b>8</b>	74	76	76	74	76	74	75	75	705	729	732	710	727	709	715	715	204	212	214	205	212	206	208	207
<b>9</b>	76	73	75	74	77	73	77	73	728	705	723	711	738	694	740	695	211	204	209	206	214	201	215	203
<b>10</b>	75	75	74	77	74	76	74	76	717	716	697	732	711	728	711	728	209	207	204	211	205	210	205	212
<b>11</b>	75	76	72	78	74	76	74	76	718	727	695	745	714	725	709	716	208	212	200	217	207	210	206	209
<b>12</b>	78	72	76	75	77	73	76	74	743	689	724	717	732	702	726	711	218	201	209	207	213	205	211	205

**Appendix B.3: Average results of R1 and R2 per period**

Period	Number of incoming orders per period								Quantity of incoming products per period							
	P-T		P-D		C-T		C-D		P-T		P-D		C-T		C-D	
	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
<b>1</b>	63	59	61	61	61	61	61	62	3654	3384	3516	3504	3498	3486	3468	3576
<b>2</b>	75	76	76	75	76	74	74	77	4314	4332	4356	4254	4356	4284	4230	4422
<b>3</b>	73	76	75	75	74	76	76	74	4230	4350	4320	4278	4212	4368	4332	4260
<b>4</b>	73	77	75	75	74	76	73	77	4176	4428	4308	4296	4224	4368	4212	4416
<b>5</b>	74	77	75	75	74	77	75	75	4248	4404	4332	4314	4230	4404	4314	4266
<b>6</b>	75	75	76	74	75	75	75	75	4296	4284	4380	4266	4308	4302	4272	4338
<b>7</b>	75	75	76	74	74	76	71	79	4284	4338	4344	4266	4278	4350	4122	4560
<b>8</b>	73	77	76	73	75	75	74	76	4218	4398	4416	4206	4314	4308	4278	4380
<b>9</b>	77	73	75	75	77	72	77	73	4410	4206	4302	4314	4446	4140	4428	4146
<b>10</b>	75	75	74	76	75	75	74	76	4278	4326	4248	4344	4320	4326	4248	4368
<b>11</b>	76	75	71	79	74	76	76	75	4356	4296	4128	4488	4278	4380	4332	4260
<b>12</b>	77	72	75	75	76	74	75	75	4416	4128	4326	4338	4320	4236	4314	4302

**Appendix C Analysis of lead time over period**

**Appendix C.1: Average lead time lengths for plants**

Period	Plant 1				Plant 2			Plant 3		Plant 4	
	P-T	P-D	C-T	C-D	P-D	C-T	C-D	P-T	C-D	P-T	P-D
<b>1</b>	-	86.75	179.28	139.38	-	205.56	38.19	-	-	-	-
<b>2</b>	68.060	91.64	168.44	109.85	70.34	171.58	45.73	109.14	-	53.80	69.97
<b>3</b>	107.42	91.75	163.97	125.91	33.39	188.74	48.71	2.8800	56.46	55.83	79.79
<b>4</b>	101.09	97.89	159.89	122.42	44.96	169.56	47.51	104.02	64.78	52.33	43.53
<b>5</b>	102.23	89.60	151.89	126.13	41.43	187.80	48.05	-	63.56	34.99	76.82
<b>6</b>	101.96	91.77	156.37	120.81	46.87	161.95	46.74	99.410	65.75	44.66	80.00
<b>7</b>	101.63	87.15	158.05	124.50	41.43	184.51	49.70	3.1200	68.25	53.42	72.65
<b>8</b>	102.59	89.26	151.99	122.92	45.15	183.71	45.11	79.340	66.34	44.49	64.57
<b>9</b>	101.67	92.71	156.47	121.66	34.94	190.28	47.94	-	64.39	35.00	70.61
<b>10</b>	104.55	96.27	155.41	120.13	37.90	166.77	49.48	105.80	69.24	47.37	62.02
<b>11</b>	102.08	83.09	152.26	125.49	46.38	176.44	49.29	0.4300	69.43	40.22	67.54
<b>12</b>	99.790	93.54	148.42	116.39	31.49	180.23	46.54	86.760	66.08	52.49	72.91

**Appendix C.2: Average lead time lengths for retailers**

Period	Retailer 1		Retailer 2				Retailer 3			Retailer 4	
	P-T	P-D	P-T	P-D	C-T	C-D	P-D	C-T	C-D	P-T	C-D
<b>1</b>	63.43	55.01	68.72	43.50	46.98	40.67	45.42	49.07	-	57.39	41.74
<b>2</b>	62.71	54.25	69.53	42.79	46.15	40.75	47.47	49.08	66.50	57.03	43.45
<b>3</b>	64.36	55.22	68.85	44.52	47.26	41.46	43.98	49.46	67.85	57.46	42.53
<b>4</b>	64.19	54.77	68.70	43.36	47.90	40.15	45.81	49.21	67.42	58.42	43.18
<b>5</b>	62.31	54.94	69.45	42.65	48.07	41.55	44.83	48.88	66.10	57.78	42.99
<b>6</b>	60.86	54.96	68.58	42.59	48.03	40.33	46.11	49.23	66.77	59.60	42.04
<b>7</b>	63.07	54.26	71.50	42.89	47.60	40.28	45.63	48.79	66.82	57.90	42.99
<b>8</b>	63.65	54.50	71.62	42.39	47.87	37.69	42.68	48.64	67.11	60.42	40.95
<b>9</b>	64.07	53.89	69.36	42.54	47.42	41.63	44.92	49.10	68.45	58.32	42.11
<b>10</b>	63.15	54.69	69.56	43.07	47.35	39.40	46.78	49.24	67.41	58.10	40.67
<b>11</b>	63.59	55.43	68.44	42.59	46.91	40.67	47.29	49.21	67.12	57.43	42.62
<b>12</b>	64.27	55.59	69.67	43.61	47.75	39.68	45.78	49.05	66.57	56.89	42.17

## Appendix D Analysis of order met probability

### Appendix D.1: Average order met probabilities per lead time period for all plants

Period	Plant 1				Plant 2			Plant 3		Plant 4	
	P-T	P-D	C-T	C-D	P-D	C-T	C-D	P-T	C-D	P-T	P-D
<b>1</b>	-	0.889	1.000	1.000	-	1.000	1.000	-	-	-	-
<b>2</b>	0.840	0.858	1.000	1.000	1.000	1.000	0.964	1.000	-	1.000	0.960
<b>3</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.974	1.000	1.000	1.000	0.950
<b>4</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.993	1.000	1.000	1.000	1.000
<b>5</b>	0.685	0.858	1.000	1.000	1.000	1.000	1.000	-	1.000	1.000	0.953
<b>6</b>	0.685	0.858	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.953
<b>7</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.990	0.842	1.000	0.885	0.953
<b>8</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.988	0.953	1.000	0.947	0.950
<b>9</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.985	-	1.000	1.000	1.000
<b>10</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.973	0.908	1.000	0.673	0.953
<b>11</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.982	1.000	1.000	1.000	0.953
<b>12</b>	0.685	0.858	1.000	1.000	1.000	1.000	0.999	0.908	1.000	1.000	0.953

**Appendix D.2: Average order met probabilities per lead time period for all retailers**

Period	Retailer 1		Retailer 2				Retailer 3			Retailer 4	
	P-T	P-D	P-T	P-D	C-T	C-D	P-D	C-T	C-D	P-T	C-D
1	0.051	1.000	0.900	0.032	0.905	0.999	1.000	0.941	-	0.065	1.000
2	0.145	0.455	0.954	0.207	0.931	0.992	0.328	0.938	1.000	0.259	0.998
3	0.163	0.802	0.987	0.165	0.885	1.000	0.898	0.915	1.000	0.227	1.000
4	0.114	0.802	0.995	0.147	0.964	0.996	0.851	0.932	1.000	0.229	1.000
5	0.106	0.838	0.957	0.128	0.910	1.000	0.909	0.915	1.000	0.209	1.000
6	0.123	0.795	0.980	0.123	0.929	1.000	0.805	0.940	1.000	0.087	1.000
7	0.093	0.877	0.970	0.192	0.938	0.992	0.917	0.905	1.000	0.079	1.000
8	0.124	0.856	0.983	0.143	0.956	1.000	0.917	0.915	1.000	0.079	1.000
9	0.141	0.869	0.911	0.146	0.925	0.996	0.861	0.929	1.000	0.054	1.000
10	0.098	0.741	0.981	0.142	0.927	1.000	0.818	0.911	1.000	0.107	1.000
11	0.128	0.774	0.948	0.200	0.966	0.992	0.826	0.931	1.000	0.179	1.000
12	0.154	0.806	0.947	0.142	0.934	1.000	0.941	0.927	1.000	0.138	0.999

