

BAB 6

KESIMPULAN DAN SARAN

6.1. Kesimpulan

Penelitian ini bertujuan menyelesaikan kasus *Team Orienteering Proble With Time Windows* dengan menggunakan algoritma *Particle Swarm Optimization*. Tiap dimensi partikel PSO diterjemahkan menjadi vertex pada kasus TOPTW. Prioritas vertex dibentuk dari skor vertex. Terdapat 2 alternatif program yang membedakan pengujian prioritas vertex pada rute *path*, yaitu PSO_TOPTW1 dan PSO_TOPTW2.

PSO_TOPTW1 menguji tiap prioritas vertex pada urutan terakhir rute *path*. Vertex akan ditempatkan pada rute yang memenuhi *time window* dan durasi kurang dari T_{max} , sebaliknya, vertex diujikan pada *path* berikutnya.

PSO_TOPTW2 merupakan pengujian yang lebih kompleks untuk menutupi kekurangan pada PSO_TOPTW1. Prioritas vertex diuji pada setiap urutan dalam rute *path*, dimulai dari pengujian pada urutan terakhir sampai pada urutan pertama. Vertex akan ditempatkan pada urutan rute *path* yang memenuhi *time window* dan mempunyai durasi waktu sementara terbaik, sebaliknya, vertex diujikan pada *path* berikutnya.

Program dijalankan dan dibagi ke dalam tiga bagian, TOPTW1_30_1000, TOPTW2_30_1000, TOPTW2_100_1000, yang membedakan alternatif program, jumlah partikel, dan jumlah iterasi yang digunakan. Tabel 6.1. menunjukkan hasil program yang dijalankan. TOPTW1_30_1000 mempunyai rata-rata persentase deviasi yang lebih besar dan waktu komputasi yang kecil,

sebaliknya TOPTW2_100_1000 menghasilkan rata-rata persentase deviasi kecil dan waktu komputasi yang besar. Secara keseluruhan penelitian ini menghasilkan 88 *Best known Solution* dan 1 *Best Known Solution* baru.

Perbandingan penelitian yang dilakukan terhadap penelitian terdahulu ditunjukkan pada tabel 6.2. Beberapa hal yang didapatkan dari perbandingan adalah solusi yang dihasilkan PSO masih belum sama baiknya dengan penelitian terdahulu. Penelitian ini mempunyai rata-rata persentase deviasi yang lebih besar dibanding penelitian terdahulu. Sehingga algoritma PSO basic efektif digunakan pada kasus sederhana. Untuk kasus yang lebih sulit, PSO memerlukan program penerjemahan partikel yang lebih baik. Waktu komputasi penelitian ini masih lebih baik dibandingkan waktu komputasi pada metode optimisasi *Ant Colony System*.

6.2. Saran

Berdasarkan hasil program dan perbandingan, penelitian ini sangat baik untuk dikembangkan agar menghasilkan solusi yang optimum. Salah satu cara yang dilakukan adalah dengan menggabungkan metode optimisasi PSO dengan metode optimisasi lain. Analisis pada pembuatan prioritas vertex dan pengembangan pengujian partikel pada urutan *path* juga sangat disarankan, dengan lebih memperhatikan nilai skor pada vertex.

Tabel 6.1. Rata-rata Deviasi dan Waktu Hasil Program

Path	Set Data	TOPTW1_30_1000		TOPTW2_30_1000		TOPTW2_100_1000	
		Avg %Dev	Avg CPU	Avg %Dev	Avg CPU	Avg %Dev	Avg CPU
1	c100	4.04%	10.81	0.73%	25.01	0.59%	109.40
	c200	15.01%	13.58	2.13%	101.70	1.62%	363.23
	r100	11.64%	11.44	4.04%	23.02	2.46%	116.27
	r200	26.99%	14.28	7.88%	154.24	5.39%	665.94
	rc100	14.32%	12.41	3.92%	19.48	1.91%	155.64
	rc200	31.24%	13.43	9.45%	118.24	7.25%	601.41
	pr01-10	31.72%	91.60	13.99%	91.60	13.09%	437.84
	pr11-20	31.88%	87.99	19.91%	87.99	15.50%	614.59
2	c100	6.91%	13.74	1.50%	33.90	0.90%	263.52
	c200	17.49%	16.78	3.85%	137.30	3.32%	1125.31
	r100	18.20%	13.82	8.01%	28.85	5.19%	130.25
	r200	23.97%	17.59	6.31%	154.66	4.79%	620.07
	rc100	16.35%	16.68	6.88%	26.14	4.18%	272.56
	rc200	31.57%	16.90	11.47%	125.89	8.80%	532.69
	pr01-10	32.81%	23.06	18.09%	119.67	14.56%	460.87
	pr11-20	36.63%	21.70	23.87%	103.41	19.75%	432.63
3	c100	9.13%	10.00	2.86%	75.73	2.20%	334.40
	c200	17.08%	11.13	4.63%	159.09	4.19%	1184.06
	r100	21.73%	9.88	9.86%	36.88	7.70%	168.31
	r200	11.46%	22.89	0.68%	149.51	0.41%	929.30
	rc100	18.17%	9.51	8.50%	33.35	6.37%	304.36
	rc200	22.03%	11.11	4.04%	130.58	2.96%	551.56
	pr01-10	32.85%	27.68	19.44%	142.87	18.93%	676.26
	pr11-20	37.02%	26.71	23.32%	135.62	20.40%	647.08
4	c100	9.98%	13.12	3.86%	52.69	3.07%	431.75
	c200	7.24%	12.84	0.00%	229.38	0.00%	1278.76
	r100	22.67%	22.01	11.38%	221.68	9.42%	243.30
	r200	3.51%	13.02	0.01%	376.64	0.00%	525.16
	rc100	21.68%	11.30	10.85%	70.00	8.33%	336.43
	rc200	11.26%	12.90	0.21%	220.14	0.10%	504.88
	pr01-10	31.24%	41.62	18.74%	169.99	16.28%	1122.58
	pr11-20	34.55%	37.96	21.45%	161.13	19.14%	1709.08
Optimal	c100	7.45%	28.88	3.27%	149.93	2.80%	378.33
	c200	7.24%	12.84	0.00%	229.38	0.00%	1278.76
	r100	13.09%	32.08	5.76%	98.25	4.63%	469.01
	r200	16.21%	25.38	2.11%	278.42	1.73%	344.49
	rc100	16.40%	31.37	7.17%	174.11	6.52%	338.90
	rc200	12.79%	12.25	1.18%	208.55	1.08%	363.56
	pr01-10	17.14%	191.12	7.40%	456.72	6.44%	1818.35

Tabel 6.2. Perbandingan Hasil Penelitian

<i>Path</i>	Avg % dev	Avg CPU	Avg % dev	Avg CPU	Avg % dev	Avg CPU
	TOPTW1_30_1000		ACO		GRASP-ELS	
1	24.50	51.23	3.44	882.10	1.50	9.58
2	26.90	19.15	2.84	1944.00	1.90	25.31
3	25.77	19.81	2.35	1789.70	1.61	30.47
4	22.81	26.99	1.93	1699.90	1.34	37.76
Variasi	13.85	79.57			0.49	46.89
	TOPTW2_30_1000		ILS		FSA	
1	13.69	81.70	4.39	1.40	5.22	1.40
2	13.23	98.00	4.21	3.40	4.10	3.40
3	13.23	118.38	4.01	5.50	3.84	5.50
4	12.29	180.32	3.72	7.80	2.27	7.80
Variasi	4.63	278.76	1.50	11.70	1.16	11.70
	TOPTW2_100_1000		VNS		SSA	
1	8.75	430.76	0.96	649.60	0.99	85.40
2	10.84	468.74	1.82	506.50	1.27	122.40
3	11.82	620.17	1.26	345.50	0.94	136.70
4	10.60	984.61	1.16	254.80	1.14	159.60
Variasi	4.01	958.68	0.88	46.30	0.57	235.00

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Lampiran 1: Hasil Program untuk Path = 1

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
c101	320	310	320	320
c102	360	360	360	360
c103	400	380	400	400
c104	420	390	410	410
c105	340	340	340	340
c106	340	340	340	340
c107	370	370	370	370
c108	370	370	370	370
c109	380	380	380	380
c201	870	730	870	870
c202	930	790	920	920
c203	960	850	940	940
c204	980	880	970	970
c205	910	820	910	910
c206	930	870	920	920
c207	930	860	920	920
c208	950	890	940	940
r101	198	187	198	198
r102	286	274	286	286
r103	293	279	286	286
r104	303	285	303	303
r105	247	227	247	247
r106	293	283	289	289
r107	299	289	297	297
r108	308	277	297	297
r109	277	270	277	277
r110	284	253	282	281
r111	297	281	294	297
r112	298	275	292	298
r201	797	636	776	789
r202	929	736	870	907
r203	1021	813	965	988
r204	1086	781	966	1006
r205	953	736	895	947
r206	1029	798	1007	1003
r207	1072	806	1018	1048
r208	1112	857	1067	1090
r209	950	758	911	921

Lampiran 1 (Lanjutan)

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
r210	987	746	930	955
r211	1046	792	998	1023
rc101	219	213	219	219
rc102	266	235	266	266
rc103	266	243	266	266
rc104	301	272	301	301
rc105	244	225	241	244
rc106	252	250	252	252
rc107	277	277	276	276
rc108	298	277	288	288
rc201	795	583	786	795
rc202	936	725	882	912
rc203	1003	712	941	961
rc204	1140	810	1109	1126
rc205	859	653	834	814
rc206	895	744	831	864
rc207	983	725	854	860
rc208	1053	762	976	1010
pr01	308	290	305	305
pr02	404	377	395	400
pr03	394	311	391	385
pr04	489	364	448	404
pr05	595	407	481	386
pr06	590	394	520	540
pr07	298	256	293	298
pr08	463	349	452	463
pr09	493	339	406	462
pr10	594	348	446	508
pr11	351	309	339	353
pr12	442	370	420	432
pr13	461	344	414	440
pr14	567	416	451	494
pr15	685	444	558	569
pr16	674	402	472	520
pr17	362	334	358	354
pr18	535	449	467	511
pr19	562	369	453	494
pr20	667	420	509	521

Lampiran 2: Hasil Program untuk Path = 2

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
c101	590	570	590	590
c102	660	620	660	660
c103	720	680	710	720
c104	760	700	750	750
c105	640	620	640	640
c106	620	600	620	620
c107	670	660	670	670
c108	680	670	680	680
c109	720	710	720	720
c201	1460	1180	1450	1430
c202	1470	1200	1420	1430
c203	1480	1250	1420	1420
c204	1480	1280	1430	1460
c205	1470	1240	1440	1440
c206	1480	1330	1450	1450
c207	1490	1330	1450	1460
c208	1490	1360	1450	1450
r101	349	326	349	349
r102	508	424	497	501
r103	522	438	497	501
r104	549	482	529	532
r105	453	429	446	445
r106	529	458	515	509
r107	535	453	512	514
r108	557	477	525	530
r109	506	461	498	506
r110	525	450	495	490
r111	544	478	536	532
r112	544	472	525	534
r201	1250	1061	1214	1223
r202	1347	1074	1293	1305
r203	1414	1083	1360	1376
r204	1458	1107	1356	1361
r205	1379	1135	1297	1335
r206	1440	1158	1391	1398
r207	1458	1157	1408	1419
r208	1458	1177	1445	1450
r209	1405	1084	1326	1350

Lampiran 2 (Lanjutan)

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
r210	1423	1141	1343	1361
r211	1458	1177	1410	1419
rc101	427	421	427	427
rc102	505	448	504	505
rc103	524	459	497	501
rc104	575	460	532	549
rc105	480	451	474	480
rc106	483	450	464	481
rc107	534	477	511	518
rc108	556	478	531	540
rc201	1377	1042	1311	1356
rc202	1509	1103	1377	1414
rc203	1632	1109	1471	1465
rc204	1716	1166	1591	1605
rc205	1458	1037	1337	1381
rc206	1546	1127	1414	1451
rc207	1587	1174	1397	1432
rc208	1691	1228	1566	1609
pr01	502	436	502	502
pr02	714	601	664	688
pr03	742	583	684	683
pr04	924	633	770	835
pr05	1090	711	888	924
pr06	1076	656	800	867
pr07	566	493	551	564
pr08	834	614	750	774
pr09	905	592	731	770
pr10	1124	629	929	955
pr11	566	497	533	548
pr12	774	614	690	727
pr13	831	597	716	726
pr14	1017	632	776	795
pr15	1219	697	908	968
pr16	1231	651	948	921
pr17	652	533	613	633
pr18	938	657	781	831
pr19	1034	670	775	806
pr20	1232	627	846	916

Lampiran 3: Hasil Program untuk Path = 3

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
c101	810	790	810	810
c102	920	880	910	920
c103	980	880	960	960
c104	1030	920	990	990
c105	870	830	860	860
c106	870	820	870	860
c107	910	860	910	910
c108	920	870	910	910
c109	970	940	940	960
c201	1810	1400	1760	1750
c202	1810	1500	1760	1750
c203	1810	1520	1720	1730
c204	1810	1570	1760	1770
c205	1810	1560	1760	1750
c206	1810	1620	1740	1740
c207	1810	1610	1760	1770
c208	1810	1650	1740	1760
r101	484	455	481	481
r102	694	561	663	680
r103	747	571	679	681
r104	777	621	729	717
r105	620	558	609	610
r106	729	604	685	714
r107	760	631	705	721
r108	797	599	708	737
r109	710	641	677	686
r110	737	604	677	679
r111	773	625	687	729
r112	776	682	727	719
r201	1441	1222	1392	1409
r202	1458	1286	1442	1452
r203	1458	1310	1458	1458
r204	1458	1346	1458	1458
r205	1458	1365	1455	1458
r206	1458	1388	1458	1458
r207	1458	1391	1458	1458
r208	1458	1361	1458	1458
r209	1458	1282	1458	1458

Lampiran 3 (Lanjutan)

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
r210	1458	1317	1458	1458
r211	1458	1386	1458	1458
rc101	621	587	621	621
rc102	714	623	695	710
rc103	764	644	705	710
rc104	833	672	749	776
rc105	682	621	676	676
rc106	706	646	687	695
rc107	773	686	713	721
rc108	795	715	756	760
rc201	1698	1312	1632	1635
rc202	1724	1390	1666	1681
rc203	1724	1410	1698	1721
rc204	1724	1440	1724	1724
rc205	1709	1308	1645	1648
rc206	1724	1433	1669	1692
rc207	1724	1454	1663	1704
rc208	1724	1491	1724	1724
pr01	622	545	599	614
pr02	942	777	843	896
pr03	1010	767	890	913
pr04	1294	926	1023	1102
pr05	1482	927	1218	1210
pr06	1514	969	1110	1164
pr07	744	624	726	724
pr08	1138	835	989	1002
pr09	1275	819	1016	1084
pr10	1573	881	1204	1281
pr11	654	583	640	644
pr12	1002	778	875	915
pr13	1132	792	961	980
pr14	1372	825	1049	1097
pr15	1650	970	1262	1279
pr16	1668	877	1257	1245
pr17	838	679	767	780
pr18	1276	837	1012	1066
pr19	1385	827	1052	1104
pr20	1682	874	1166	1270

Lampiran 4: Hasil Program untuk Path = 4

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
c101	1020	950	1020	1020
c102	1150	1060	1120	1140
c103	1200	1080	1170	1190
c104	1260	1110	1210	1210
c105	1060	1000	1040	1050
c106	1080	1010	1050	1050
c107	1120	1060	1090	1110
c108	1130	1110	1110	1120
c109	1190	1110	1140	1150
c201	1810	1590	1810	1810
c202	1810	1640	1810	1810
c203	1810	1720	1810	1810
c204	1810	1780	1810	1810
c205	1810	1710	1810	1810
c206	1810	1790	1810	1810
c207	1810	1770	1810	1810
c208	1810	1810	1810	1810
r101	611	561	608	608
r102	843	707	813	817
r103	926	690	793	828
r104	972	746	896	889
r105	778	716	756	758
r106	905	726	855	858
r107	945	731	868	863
r108	994	775	852	877
r109	884	768	814	827
r110	914	770	837	845
r111	949	786	865	886
r112	971	771	883	913
r201	1458	1356	1458	1458
r202	1458	1411	1458	1458
r203	1458	1420	1458	1458
r204	1458	1421	1458	1458
r205	1458	1443	1458	1458
r206	1458	1458	1458	1458
r207	1458	1458	1458	1458
r208	1458	1446	1458	1458
r209	1458	1420	1458	1458

Lampiran 4 (Lanjutan)

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
r210	1458	1437	1458	1458
r211	1458	1458	1458	1458
rc101	811	746	791	808
rc102	908	765	862	884
rc103	970	806	875	888
rc104	1059	763	938	976
rc105	875	762	859	865
rc106	909	801	852	861
rc107	980	831	876	916
rc108	1025	826	908	938
rc201	1724	1491	1724	1724
rc202	1724	1587	1724	1724
rc203	1724	1560	1724	1724
rc204	1724	1558	1724	1724
rc205	1724	1516	1724	1724
rc206	1724	1621	1724	1724
rc207	1724	1615	1724	1724
rc208	1724	1634	1724	1724
pr01	657	627	657	654
pr02	1079	904	999	1014
pr03	1222	965	1047	1085
pr04	1557	1059	1317	1317
pr05	1833	1168	1422	1458
pr06	1854	1177	1498	1535
pr07	872	765	821	846
pr08	1382	1007	1177	1195
pr09	1592	1029	1271	1284
pr10	1933	1130	1392	1559
pr11	657	640	657	657
pr12	1132	865	1016	1041
pr13	1355	961	1175	1207
pr14	1660	995	1282	1310
pr15	1958	1175	1538	1525
pr16	2021	1179	1504	1513
pr17	933	786	858	890
pr18	1521	1028	1291	1232
pr19	1695	1035	1304	1293
pr20	2037	1152	1423	1478

Lampiran 5: Hasil Program untuk Path = Optimal

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
c101	1810	1620	1710	1730
c102	1810	1750	1810	1810
c103	1810	1720	1810	1810
c104	1810	1720	1810	1810
c105	1810	1660	1740	1720
c106	1810	1660	1730	1740
c107	1810	1700	1740	1750
c108	1810	1710	1760	1770
c109	1810	1770	1810	1810
c201	1810	1590	1810	1810
c202	1810	1640	1810	1810
c203	1810	1720	1810	1810
c204	1810	1780	1810	1810
c205	1810	1710	1810	1810
c206	1810	1790	1810	1810
c207	1810	1770	1810	1810
c208	1810	1810	1810	1810
r101	1458	1436	1455	1458
r102	1458	1453	1458	1458
r103	1458	1332	1406	1415
r104	1458	1135	1356	1356
r105	1458	1389	1434	1448
r106	1458	1382	1432	1444
r107	1458	1252	1371	1392
r108	1458	1187	1319	1352
r109	1458	1334	1388	1414
r110	1458	1273	1374	1378
r111	1458	1250	1387	1401
r112	1458	1228	1349	1351
r201	1458	1356	1458	1458
r202	1458	1286	1442	1442
r203	1458	1310	1458	1458
r204	1458	1107	1356	1361
r205	1458	1365	1455	1455
r206	1458	1388	1458	1458
r207	1458	1157	1408	1419
r208	1458	1177	1445	1450
r209	1458	1282	1458	1458

Lampiran 5 (Lanjutan)

Kasus	BKS	TOPTW1_30_1000	TOPTW2_30_1000	TOPTW2_100_1000
r210	1458	1317	1458	1458
r211	1458	1177	1410	1419
rc101	1724	1600	1689	1695
rc102	1724	1535	1672	1694
rc103	1724	1452	1637	1645
rc104	1724	1385	1583	1568
rc105	1724	1562	1699	1706
rc106	1724	1519	1581	1597
rc107	1724	1494	1631	1638
rc108	1724	1422	1590	1592
rc201	1724	1491	1724	1724
rc202	1719	1390	1666	1666
rc203	1724	1410	1698	1698
rc204	1724	1440	1724	1724
rc205	1724	1516	1724	1724
rc206	1458	1458	1458	1458
rc207	1458	1458	1458	1458
rc208	1458	1446	1458	1458
pr01	657	564	599	611
pr02	1220	1079	1152	1174
pr03	1788	1470	1670	1690
pr04	2477	2106	2306	2330
pr05	3351	2755	3180	3220
pr06	3671	3129	3434	3479
pr07	948	825	901	910
pr08	2006	1711	1896	1920
pr09	2736	2358	2655	2669
pr10	3850	3301	3709	3731

Lampiran 6: Hasil Penelitian Terdahulu Set Data Solomon (Path = 1)

Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)	Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)
c101	320	320.0	0.5	320	0.4	320.0	72.2	320	0.4	320	20.4	c201	870	870.0	507.8	840	1.1	870.0	507.8	870	1.1	870	28.3
c102	360	360.0	0.7	360	0.3	360.0	102.2	360	0.3	360	20.7	c202	930	928.0	454.8	910	2.8	928.0	454.8	930	2.8	930	33.5
c103	400	400.0	16.9	390	0.5	398.0	106.2	390	0.5	400	24.2	c203	960	960.0	614.3	940	1.7	960.0	614.3	940	1.7	960	59.6
c104	420	420.0	33.5	400	0.3	418.0	124.3	410	0.3	420	21.9	c204	980	972.0	484.0	950	1.6	972.0	484.0	950	1.6	970	42.3
c105	340	340.0	0.9	340	0.3	340.0	87.1	330	0.3	340	20.6	c205	910	908.0	645.4	900	1.2	908.0	645.4	900	1.2	910	46.9
c106	340	340.0	1.0	340	0.3	340.0	86.7	340	0.3	340	20.3	c206	930	927.0	616.5	910	1.6	927.0	616.5	920	1.6	930	29.0
c107	370	370.0	2.1	360	0.3	370.0	88.7	370	0.3	370	20.5	c207	930	930.0	599.5	910	2.1	930.0	599.5	930	2.1	930	29.1
c108	370	370.0	0.8	370	0.3	370.0	99.3	370	0.3	370	20.5	c208	950	949.0	558.9	930	1.6	949.0	558.9	940	1.6	950	31.2
c109	380	380.0	0.8	380	0.3	380.0	118.7	380	0.3	380	20.5	r201	797	796.7	1021.7	788	1.2	796.7	1021.7	772	1.2	794	51.1
r101	198	198.0	0.1	182	0.1	198.0	49.9	198	0.1	198	19.7	r202	915	905.6	1057.5	880	1.4	905.6	1057.5	878	1.4	914	46.4
r102	286	286.0	11.1	286	0.2	285.2	77.9	282	0.2	286	21.0	r203	1016	1007.9	1139.9	980	1.6	1007.9	1139.9	988	1.6	997	44.2
r103	293	292.6	640.6	286	0.2	293.0	90.2	293	0.2	293	20.3	r204	1081	1076.3	1253.5	1073	1.7	1076.3	1253.5	1059	1.7	1058	39.7
r104	303	303.0	164.0	297	0.2	303.0	95.9	294	0.2	303	23.2	r205	953	952.6	745.1	931	1.4	952.6	745.1	936	1.4	946	37.8
r105	247	247.0	3.0	247	0.1	247.0	85.4	247	0.1	247	20.3	r206	1022	1014.0	1168.1	996	1.5	1014.0	1168.1	950	1.5	1020	40.9
r106	293	293.0	86.3	293	0.2	292.2	89.6	270	0.2	293	22.1	r207	1072	1061.5	1065.3	1038	2.0	1061.5	1065.3	1033	2.0	1069	52.5
r107	299	294.6	922.6	288	0.2	299.0	105.5	277	0.2	297	21.5	r208	1112	1101.5	1160.8	1069	1.6	1101.5	1160.8	1066	1.6	1079	35.8
r108	308	306.0	696.1	297	0.2	308.0	119.1	294	0.2	306	40.6	r209	950	947.8	925.9	926	2.4	947.8	925.9	914	2.4	945	61.6
r109	277	277.0	28.0	276	0.2	277.0	77.4	264	0.2	277	20.4	r210	978	975.9	1065.6	958	1.9	975.9	1065.6	975	1.9	973	53.6
r110	284	283.2	617.6	281	0.3	284.0	86.0	282	0.3	284	20.8	r211	1042	1024.2	1120.7	1023	1.6	1024.2	1120.7	1023	1.6	1041	40.5
r111	297	296.6	484.4	295	0.2	297.0	95.4	286	0.2	297	27.9	rc201	795	795.0	640.8	780	1.0	795.0	640.8	781	1.0	795	44.4
r112	298	297.4	947.1	295	0.2	297.9	97.0	284	0.2	298	22.3	rc202	936	925.6	951.5	882	1.3	925.6	951.5	866	1.3	930	46.3
rc101	219	219.0	0.2	219	0.2	219.0	61.3	216	0.2	219	19.8	rc203	1003	988.2	938.4	960	2.7	988.2	938.4	956	2.7	967	32.4
rc102	266	266.0	30.9	259	0.2	266.0	53.3	249	0.2	266	20.2	rc204	1136	1120.8	970.3	1117	2.3	1120.8	970.3	1061	2.3	1140	46.5
rc103	266	266.0	57.2	265	0.3	266.0	62.9	265	0.3	266	20.7	rc205	857	845.9	726.6	840	1.0	845.9	726.6	800	1.0	854	52.6
rc104	301	301.0	29.4	297	0.3	301.0	58.0	263	0.3	301	27.5	rc206	895	878.4	838.7	860	1.1	878.4	838.7	866	1.1	885	60.2
rc105	244	244.0	9.7	221	0.2	244.0	78.6	219	0.2	244	20.3	rc207	983	960.8	893.5	926	1.3	960.8	893.5	899	1.3	977	68.4
rc106	252	252.0	308.6	239	0.2	252.0	71.9	240	0.2	252	21.0	rc208	1053	1043.5	995.5	1037	2.3	1043.5	995.5	1015	2.3	1041	51.2
rc107	277	277.0	502.1	274	0.2	277.0	69.6	244	0.2	277	22.0												
rc108	298	298.0	207.5	288	0.2	297.0	66.1	263	0.2	298	26.0												
Ave time			200.1		0.2		85.4		0.2		22.3				1193.4		1.7		857.8		1.7		44.7
Ave RDP			0.01		1.94		0.07		3.63		0.05				1.88		2.69		0.71		3.16		0.66

Lampiran 7: Hasil Penelitian Terdahulu Set Data Solomon (Path = 2)

Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)	Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)
c101	590	588.0	110.8	590	1.4	587.0	83.8	590	1.4	590	26.2	c201	1460	1452.0	508.6	1400	2.7	1447.0	634.5	1440	2.7	1450	64.3
c102	660	660.0	1427.4	650	0.9	653.0	100.0	660	0.9	660	26.5	c202	1460	1446.0	1568.2	1430	5.1	1457.0	658.7	1460	5.1	1460	50.2
c103	720	710.0	938.9	700	1.2	717.0	93.8	720	1.2	720	26.8	c203	1480	1446.0	2334.8	1430	3.8	1471.0	568.9	1440	3.8	1450	39.4
c104	760	754.0	1355.0	750	1.5	759.0	96.7	740	1.5	760	28.0	c204	1480	1436.0	1373.2	1460	4.2	1480.0	420.3	1440	4.2	1450	38.9
c105	640	640.0	1436.6	640	0.8	640.0	68.9	640	0.8	640	26.1	c205	1460	1452.0	925.4	1450	3.1	1457.0	593.4	1450	3.1	1470	68.0
c106	620	620.0	104.6	620	0.8	620.0	95.8	620	0.8	620	25.6	c206	1470	1460.0	1876.4	1440	2.8	1464.0	509.4	1460	2.8	1460	42.4
c107	670	670.0	76.0	670	1.4	669.0	92.5	670	1.4	670	26.3	c207	1480	1452.0	1434.0	1450	3.2	1469.0	496.6	1450	3.2	1480	87.7
c108	680	680.0	95.3	670	0.8	680.0	89.7	660	0.8	680	26.2	c208	1480	1462.0	1164.2	1460	2.8	1473.0	483.3	1460	2.8	1460	38.4
c109	720	720.0	1817.3	710	0.9	719.0	70.6	720	0.9	720	26.1	r201	1250	1236.0	2693.6	1231	2.1	1232.1	1401.6	1229	2.1	1242	73.7
r101	349	349.0	36.5	330	0.4	349.0	35.3	344	0.4	349	25.0	r202	1338	1298.6	2482.2	1270	2.3	1333.5	1421.5	1319	2.3	1334	50.4
r102	508	506.6	2006.6	508	0.9	498.5	64.1	497	0.9	508	43.9	r203	1407	1349.4	3057.4	1377	1.9	1402.7	1148.4	1382	1.9	1414	196.2
r103	522	518.8	1095.1	513	0.9	515.4	51.0	505	0.9	519	32.3	r204	1458	1399.0	2713.5	1440	3.4	1455.3	785.2	1428	3.4	1447	70.9
r104	549	540.0	2291.8	539	1.5	542.5	66.9	523	1.5	548	29.1	r205	1378	1342.0	2593.7	1338	2.8	1366.8	1276.0	1350	2.8	1363	51.5
r105	453	453.0	1037.3	430	0.8	451.5	66.8	439	0.8	453	25.4	r206	1427	1373.8	2954.4	1401	2.8	1422.4	1015.9	1428	2.8	1430	113.7
r106	529	523.8	2034.7	529	0.9	518.1	66.4	504	0.9	529	27.2	r207	1458	1385.0	2624.1	1428	1.7	1453.6	723.2	1413	1.7	1452	158.8
r107	535	527.4	2357.6	529	1.0	529.0	73.9	508	1.0	532	37.0	r208	1458	1425.4	2828.9	1458	1.6	1458.0	448.7	1455	1.6	1457	56.0
r108	556	553.6	1906.2	549	1.4	547.3	63.7	553	1.4	558	67.5	r209	1405	1350.6	2988.9	1345	2.6	1393.0	1076.0	1372	2.6	1404	89.5
r109	506	505.4	1386.6	498	0.5	505.0	66.3	492	0.5	506	45.5	r210	1423	1355.4	2423.9	1365	1.9	1408.6	912.0	1379	1.9	1414	77.8
r110	525	523.4	1180.2	515	1.0	509.4	62.5	523	1.0	525	27.5	r211	1457	1403.0	2726.1	1422	1.9	1457.0	957.5	1416	1.9	1451	66.9
r111	544	535.6	1726.2	535	0.6	537.4	71.4	533	0.6	544	54.0	rc201	1376	1365.4	1654.3	1305	1.9	1359.7	897.1	1335	1.9	1377	73.3
r112	544	541.6	1653.6	515	0.5	535.2	73.2	533	0.5	542	25.1	rc202	1500	1464.8	2619.6	1461	2.1	1487.6	909.1	1461	2.1	1499	51.8
rc101	427	427.0	27.9	427	0.6	419.0	54.9	427	0.6	427	25.3	rc203	1621	1542.2	2176.2	1573	2.0	1593.4	821.0	1507	2.0	1576	94.9
rc102	505	497.2	1496.9	494	0.8	504.1	61.1	480	0.8	505	42.4	rc204	1716	1614.8	2561.8	1656	2.1	1710.2	740.8	1633	2.1	1674	115.6
rc103	524	510.2	1965.9	519	1.1	519.0	53.1	510	1.1	523	26.5	rc205	1455	1417.4	2115.2	1381	3.2	1436.3	766.8	1413	3.2	1458	50.5
rc104	575	568.8	2381.3	565	0.7	568.2	53.0	558	0.7	575	63.1	rc206	1546	1495.6	2105.1	1495	1.9	1523.4	769.6	1491	1.9	1528	50.8
rc105	480	478.4	1676.7	459	0.8	479.8	45.3	463	0.8	480	56.3	rc207	1566	1523.0	2937.5	1531	2.7	1552.2	835.9	1532	2.7	1574	73.5
rc106	483	480.2	1865.1	458	0.6	477.9	57.5	467	0.6	483	47.3	rc208	1691	1608.4	2572.3	1606	1.7	1676.1	698.2	1630	1.7	1675	130.4
rc107	534	530.2	771.5	515	0.5	519.3	63.2	489	0.5	529	26.8												
rc108	556	541.6	821.0	546	0.6	535.8	53.2	509	0.6	554	36.1												
Ave time			1278.6		0.9		68.8		0.9		34.5				222.7		2.6		813.7		2.6		79.6
Ave RDP			0.68		1.90		1.02		2.49		0.10				2.84		2.75		0.65		2.28		0.61

Lampiran 8: Hasil Penelitian Terdahulu Set Data Solomon (Path = 3)

Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)	Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)
c101	810	810.0	1515.6	790	1.1	810.0	67.0	810	1.1	810	31.7	c201	1810	1810.0	259.2	1750	2.2	1810.0	256.5	1800	2.2	1800	48.1
c102	920	918.0	442.8	890	2.1	916.0	89.3	920	2.1	920	32.7	c202	1810	1784.0	1603.2	1750	2.0	1810.0	321.5	1750	2.0	1790	68.3
c103	980	972.0	1415.3	960	2.2	972.0	91.4	970	2.2	980	37.3	c203	1810	1738.0	1039.9	1760	2.0	1810.0	185.4	1740	2.0	1770	111.9
c104	1030	1004.0	681.7	1010	1.3	1020.0	78.9	1010	1.3	1010	33.1	c204	1810	1758.0	1025.8	1780	1.5	1810.0	201.6	1730	1.5	1750	54.5
c105	870	870.0	1010.0	840	1.0	858.0	93.8	860	1.0	870	32.9	c205	1810	1796.0	2007.3	1770	2.5	1809.0	236.6	1780	2.5	1810	42.5
c106	870	870.0	1132.3	840	1.1	867.0	89.5	860	1.1	870	39.6	c206	1810	1788.0	1862.0	1770	1.5	1810.0	265.9	1770	1.5	1780	40.8
c107	910	910.0	892.7	900	1.5	905.0	91.8	890	1.5	910	33.4	c207	1810	1784.0	1223.0	1810	3.4	1810.0	233.3	1770	3.4	1800	59.5
c108	920	912.0	971.2	900	1.2	913.0	85.3	900	1.2	920	33.1	c208	1810	1786.0	1542.7	1810	2.4	1810.0	231.8	1790	2.4	1800	52.2
c109	970	954.0	1327.5	950	2.0	967.0	82.3	950	2.0	970	43.5	r201	1436	1428.4	1400.0	1408	2.4	1428.2	814.4	1421	2.4	1429	50.3
r101	484	481.0	240.6	481	0.8	482.3	42.9	475	0.8	484	48.6	r202	1458	1445.6	1966.2	1443	2.7	1453.7	519.7	1455	2.7	1458	59.0
r102	691	682.0	2435.4	685	1.0	681.7	66.9	678	1.0	694	43.5	r203	1458	1452.4	2564.3	1458	1.6	1458.0	257.3	1458	1.6	1458	39.9
r103	747	729.8	2694.9	720	2.0	726.6	61.2	714	2.0	736	46.1	r204	1458	1458.0	174.7	1458	1.0	1458.0	211.7	1458	1.0	1458	38.4
r104	777	760.6	2531.4	765	1.5	759.7	60.2	754	1.5	777	71.2	r205	1458	1454.8	1830.7	1458	1.1	1458.0	296.3	1458	1.1	1458	39.3
r105	620	619.2	796.0	609	2.3	619.2	52.7	611	2.3	619	36.5	r206	1458	1456.8	1328.8	1458	1.1	1458.0	240.3	1458	1.1	1458	38.9
r106	726	715.0	755.5	719	2.1	717.4	65.7	719	2.1	729	38.6	r207	1458	1458.0	598.6	1458	1.0	1458.0	220.1	1458	1.0	1458	38.5
r107	760	751.6	1998.9	747	1.1	755.8	60.7	747	1.1	759	90.8	r208	1458	1458.0	425.6	1458	0.8	1458.0	216.6	1458	0.8	1458	38.4
r108	797	781.8	2388.5	790	3.1	781.2	70.9	751	3.1	789	81.8	r209	1458	1456.8	1163.7	1458	1.1	1458.0	272.0	1458	1.1	1458	40.1
r109	710	701.8	1098.8	699	1.8	703.9	64.0	695	1.8	702	40.2	r210	1458	1456.2	1428.1	1458	1.2	1458.0	289.9	1458	1.2	1458	40.0
r110	737	732.6	1708.5	711	1.4	721.9	63.5	705	1.4	734	36.8	r211	1458	1457.8	7.3	1458	1.0	1458.0	200.1	1458	1.0	1458	38.6
r111	773	755.4	1286.7	764	1.8	763.4	65.0	757	1.8	771	46.9	rc201	1698	1672.0	1084.9	1625	1.9	1689.4	786.6	1655	1.9	1681	98.3
r112	771	758.8	2091.2	758	1.1	760.0	69.2	732	1.1	776	91.8	rc202	1719	1701.4	2230.7	1686	1.7	1711.6	491.2	1690	1.7	1714	48.3
rc101	621	620.4	195.7	604	1.4	619.8	58.7	581	1.4	621	34.2	rc203	1724	1719.6	1213.2	1724	2.9	1724.0	313.9	1724	2.9	1724	39.1
rc102	711	698.8	1145.5	698	1.3	710.3	60.4	689	1.3	710	41.3	rc204	1724	1722.2	1261.3	1724	1.0	1724.0	222.8	1724	1.0	1724	38.3
rc103	747	741.4	2754.0	747	1.1	746.5	67.3	721	1.1	764	44.6	rc205	1709	1672.2	1439.8	1659	2.4	1696.7	573.2	1682	2.4	1709	122.3
rc104	833	813.2	2277.0	822	1.3	824.5	59.8	795	1.3	814	33.0	rc206	1724	1712.6	2185.2	1708	1.3	1724.0	339.9	1719	1.3	1724	46.0
rc105	682	677.8	1092.0	654	0.8	677.2	63.8	676	0.8	682	32.0	rc207	1724	1714.8	2553.9	1713	1.5	1724.0	295.1	1722	1.5	1724	40.4
rc106	705	692.4	1748.3	678	1.0	686.2	49.7	682	1.0	706	61.5	rc208	1724	1722.2	893.9	1724	1.1	1724.0	209.5	1724	1.1	1724	39.1
rc107	773	748.0	1158.5	745	0.9	761.6	58.2	751	0.9	773	43.8												
rc108	795	768.2	1443.7	757	1.1	778.0	66.9	757	1.1	778	52.0												
Ave time			1421.7		1.5		68.9		1.5		45.9				1345.0		1.7		322.3		1.7		52.2
Ave RDP			1.26		2.21		1.03		2.61		0.25				0.80		1.08		0.09		0.99		0.43

Lampiran 9: Hasil Penelitian Terdahulu Set Data Solomon (Path = 4)

Name	BKS	ACO	T(s)	ILS	T(s)	VNS	T(s)	FSA	T(s)	SSA	T(s)	Name	BKS	ACO	T(s)	ILS	T(s)	VNS	T(s)	FSA	T(s)	SSA	T(s)
c101	1020	1018.0	1049.1	1000	3.8	1013.0	78.5	1020	3.8	1020	37.1	c201	1810	1810.0	1.2	1810	1.1	1810.0	92.5	1810	1.1	1810	44.9
c102	1150	1142.0	1211.3	1090	1.8	1139.0	90.1	1140	1.8	1150	40.0	c202	1810	1810.0	8.9	1810	1.1	1810.0	114.8	1810	1.1	1810	44.2
c103	1190	1186.0	2329.6	1150	2.5	1180.0	93.8	1180	2.5	1190	38.1	c203	1810	1810.0	43.9	1810	1.0	1810.0	84.7	1810	1.0	1810	42.0
c104	1260	1226.0	1493.9	1220	3.0	1248.0	79.7	1230	3.0	1230	41.0	c204	1810	1810.0	1.3	1810	1.0	1810.0	107.0	1810	1.0	1810	39.6
c105	1060	1052.0	716.5	1030	1.8	1055.0	85.0	1050	1.8	1060	36.8	c205	1810	1810.0	0.3	1810	1.0	1810.0	106.6	1810	1.0	1810	42.0
c106	1080	1058.0	556.8	1040	2.1	1062.0	82.2	1070	2.1	1080	69.0	c206	1810	1810.0	0.1	1810	1.0	1810.0	109.3	1810	1.0	1810	40.6
c107	1120	1114.0	411.3	1100	2.0	1108.0	83.3	1110	2.0	1120	45.5	c207	1810	1800.0	5.8	1810	1.0	1810.0	115.0	1810	1.0	1810	40.8
c108	1130	1112.0	820.1	1100	3.6	1123.0	70.4	1120	3.6	1130	69.1	c208	1810	1810.0	0.2	1810	0.8	1810.0	108.4	1810	0.8	1810	40.0
c109	1190	1172.0	916.0	1180	2.5	1174.0	73.8	1170	2.5	1190	69.0	r201	1458	1458.0	376.4	1458	1.3	1458.0	294.6	1458	1.3	1458	42.0
r101	611	608.0	55.1	601	1.4	610.2	40.4	605	1.4	611	33.8	r202	1458	1458.0	936.2	1458	1.1	1458.0	171.5	1458	1.1	1458	41.6
r102	840	825.6	1924.5	807	1.7	828.4	59.4	841	1.7	843	45.2	r203	1458	1458.0	73.9	1458	0.9	1458.0	137.3	1458	0.9	1458	40.2
r103	921	902.2	2622.2	878	2.2	909.9	68.8	898	2.2	926	97.1	r204	1458	1458.0	0.0	1458	0.6	1458.0	135.9	1458	0.6	1458	38.9
r104	972	944.2	2343.9	941	3.8	954.8	62.9	928	3.8	964	84.7	r205	1458	1458.0	1.3	1458	0.9	1458.0	153.6	1458	0.9	1458	39.6
r105	778	766.0	838.5	735	2.9	768.0	62.5	758	2.9	771	47.3	r206	1458	1458.0	0.0	1458	0.9	1458.0	131.9	1458	0.9	1458	39.4
r106	905	889.8	929.5	870	3.5	890.9	63.7	900	3.5	905	78.7	r207	1458	1458.0	0.0	1458	0.8	1458.0	111.9	1458	0.8	1458	38.7
r107	938	932.4	2660.9	927	3.3	930.4	62.6	926	3.3	942	42.0	r208	1458	1458.0	0.0	1458	0.5	1458.0	127.0	1458	0.5	1458	38.1
r108	994	976.2	2596.2	982	3.2	973.2	60.4	953	3.2	977	70.6	r209	1458	1458.0	0.0	1458	1.0	1458.0	139.0	1458	1.0	1458	39.6
r109	884	876.6	1374.5	866	2.1	870.5	55.3	846	2.1	885	68.0	r210	1458	1458.0	3.1	1458	0.9	1458.0	140.9	1458	0.9	1458	40.0
r110	914	900.0	926.3	870	2.0	898.1	70.7	868	2.0	893	39.5	r211	1458	1458.0	0.0	1458	0.7	1458.0	114.6	1458	0.7	1458	38.7
r111	949	932.4	1896.4	935	2.0	936.6	63.8	921	2.0	948	53.2	rc201	1724	1724.0	2327.4	1724	2.1	1724.0	231.9	1724	2.1	1724	41.7
r112	971	947.6	1662.6	939	3.1	964.4	63.6	946	3.1	958	40.5	rc202	1724	1724.0	1095.8	1724	1.1	1724.0	208.8	1724	1.1	1724	41.0
rc101	811	805.4	1324.3	794	1.9	777.2	55.3	806	1.9	808	44.3	rc203	1724	1724.0	308.6	1724	0.9	1724.0	157.5	1724	0.9	1724	39.8
rc102	903	899.4	2218.8	881	2.3	893.4	67.0	876	2.3	902	126.9	rc204	1724	1724.0	53.3	1724	0.8	1724.0	120.3	1724	0.8	1724	38.7
rc103	950	941.8	2005.2	947	2.0	945.4	64.1	936	2.0	970	70.0	rc205	1724	1724.0	1313.7	1724	2.1	1724.0	192.9	1724	2.1	1724	41.6
rc104	1059	1013.2	2139.3	1019	1.7	1033.5	64.8	1030	1.7	1059	75.3	rc206	1724	1723.6	2.8	1724	1.0	1724.0	145.5	1724	1.0	1724	39.8
rc105	875	867.2	1052.3	841	1.5	859.0	53.6	858	1.5	875	46.2	rc207	1724	1722.4	72.1	1724	1.0	1724.0	135.1	1724	1.0	1724	39.7
rc106	909	901.4	2106.7	874	2.5	894.4	49.6	891	2.5	901	41.4	rc208	1724	1724.0	0.0	1724	0.9	1724.0	124.3	1724	0.9	1724	38.9
rc107	980	959.2	1763.1	951	1.9	958.0	53.8	959	1.9	980	93.8												
rc108	1025	1000.2	2222.3	998	2.0	1011.5	59.6	963	2.0	1023	47.1												
Ave time			1523.0		2.4		66.8		2.4		58.3				245.4		1.0		141.2		1.0		40.4
Ave RDP			1.45		2.91		1.35		2.09		0.26				0.02		0.00		0.00		0.00		0.00

Lampiran 10: Hasil Penelitian Terdahulu Set Data Baru Solomon

Name	m	OPT	ILS	T(s)	VNS	T(s)	FSA	T(s)	SSA	T(s)	Name	m	OPT	ILS	T(s)	FSA	T(s)	SSA	T(s)
c101	10	1810	1720	4.1	1809.0	21.7	1760	4.1	1770	89.5	c201	4	1810	1810	1.5	1810	1.5	1810	45.0
c102	10	1810	1790	4.2	1810.0	19.8	1800	4.2	1810	52.9	c202	4	1810	1810	1.1	1810	1.1	1810	44.3
c103	10	1810	1810	3.0	1810.0	18.8	1810	3.0	1810	52.9	c203	4	1810	1810	1.0	1810	1.0	1810	42.1
c104	10	1810	1810	1.8	1810.0	16.8	1810	1.8	1810	44.4	c204	4	1810	1810	1.0	1810	1.0	1810	39.8
c105	10	1810	1770	2.8	1810.0	22.7	1720	2.8	1780	152.7	c205	4	1810	1810	1.0	1810	1.0	1810	42.0
c106	10	1810	1750	3.8	1808.0	23.5	1710	3.8	1800	123.1	c206	4	1810	1810	1.0	1810	1.0	1810	40.7
c107	10	1810	1790	3.1	1810.0	21.9	1760	3.1	1760	61.1	c207	4	1810	1810	1.0	1810	1.0	1810	40.9
c108	10	1810	1810	2.5	1810.0	19.6	1750	2.5	1770	59.6	c208	4	1810	1810	0.9	1810	0.9	1810	40.1
c109	10	1810	1810	2.0	1810.0	16.1	1780	2.0	1810	63.0	r201	4	1458	1458	1.3	1458	1.3	1458	42.2
r101	19	1458	1441	2.5	1455.8	9.2	1453	2.5	1455	67.9	r202	3	1458	1443	2.7	1455	2.7	1458	58.5
r102	17	1458	1450	3.1	1451.1	9.6	1452	3.1	1458	84.9	r203	3	1458	1458	1.5	1458	1.5	1458	39.4
r103	13	1458	1450	2.0	1453.3	16.9	1450	2.0	1455	59.6	r204	2	1458	1440	3.3	1428	3.3	1447	70.2
r104	9	1458	1402	2.3	1443.5	28.7	1426	2.3	1442	131.3	r205	3	1458	1458	1.1	1458	1.1	1458	38.7
r105	14	1458	1435	4.1	1450.1	16.9	1455	4.1	1458	136.5	r206	3	1458	1458	1.0	1458	1.0	1458	38.4
r106	12	1458	1441	3.1	1451.9	20.2	1451	3.1	1458	116.3	r207	2	1458	1428	1.6	1413	1.6	1452	155.9
r107	10	1458	1431	3.3	1449.7	26.9	1433	3.3	1452	78.8	r208	2	1458	1458	1.6	1455	1.6	1457	54.2
r108	9	1458	1430	2.7	1453.2	26.6	1432	2.7	1447	87.1	r209	3	1458	1458	1.1	1458	1.1	1458	38.8
r109	11	1458	1432	2.5	1448.3	23.1	1432	2.5	1453	128.1	r210	3	1458	1458	1.2	1458	1.2	1458	39.0
r110	10	1458	1419	4.4	1450.5	26.4	1441	4.4	1454	172.9	r211	2	1458	1422	1.9	1416	1.9	1451	66.2
r111	10	1458	1410	3.0	1449.2	25.5	1440	3.0	1444	114.6	rc201	4	1724	1724	2.2	1724	2.2	1724	41.7
r112	9	1458	1418	2.4	1451.9	27.9	1416	2.4	1446	78.0	rc202	3	1724	1686	1.7	1690	1.7	1714	47.8
rc101	14	1724	1686	4.3	1704.5	18.4	1703	4.3	1712	79.9	rc203	3	1724	1724	2.8	1724	2.8	1724	38.7
rc102	12	1724	1659	2.9	1696.0	22.0	1683	2.9	1718	103.4	rc204	3	1724	1724	1.0	1724	1.0	1724	37.9
rc103	11	1724	1689	3.4	1715.8	22.1	1700	3.4	1724	82.6	rc205	4	1724	1724	2.1	1724	2.1	1724	41.4
rc104	10	1724	1719	3.2	1722.7	21.5	1707	3.2	1719	87.7	rc206	3	1724	1708	1.3	1719	1.3	1724	45.4
rc105	13	1724	1691	3.9	1698.2	18.1	1698	3.9	1716	87.0	rc207	3	1724	1713	1.4	1722	1.4	1724	39.7
rc106	11	1724	1665	4.8	1694.8	24.5	1687	4.8	1714	63.7	rc208	3	1724	1724	1.0	1724	1.0	1724	38.4
rc107	11	1724	1701	2.4	1721.0	19.8	1709	2.4	1722	51.4									
rc108	10	1724	1698	5.6	1721.8	21.7	1712	5.6	1719	121.0									
Ave time				3.2		20.9		3.2		90.7				1.5		1.5			48.4
Ave RDP				1.80		0.45		1.64		0.59				0.39		0.40			0.08

Lampiran 11: Hasil Penelitian Terdahulu Set Data Cordeau (Path=1)

Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)	Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)
pro01	308	308.0	256.2	304	0.5	308.0	81.2	304	0.5	305	8.3	pro11	330	327.8	1743.7	330	0.3	328.0	131.4	339	0.3	351	10.3
pro02	404	403.8	1147.8	385	0.6	403.9	251.5	392	0.6	404	29.1	pro12	442	436.4	2017.6	431	0.9	442.0	309.6	432	0.9	430	26.3
pro03	394	394.0	2024.3	384	1.0	390.5	419.8	381	1.0	394	59.9	pro13	461	441.0	2312.7	450	1.9	453.7	514.1	424	1.9	452	49.0
pro04	489	482.6	1404.7	447	1.9	488.1	733.2	470	1.9	489	106.7	pro14	567	494.0	23.1	482	1.1	550.1	1163.8	499	1.1	540	134.3
pro05	595	576.8	2075.7	576	4.6	586.1	1663.2	527	4.6	589	281.7	pro15	678	524.8	18.2	638	5.3	663.2	1900.9	613	5.3	666	118.5
pro06	590	564.6	2199.8	538	2.5	588.2	1628.4	557	2.5	575	253.4	pro16	674	517.8	25.7	559	4.1	637.0	1854.1	562	4.1	616	558.0
pro07	298	298.0	20.1	291	0.4	297.5	141.5	289	0.4	298	15.0	pro17	359	358.0	1330.9	346	0.2	358.3	140.5	335	0.2	362	37.6
pro08	463	462.6	2476.0	463	1.0	452.2	450.2	438	1.0	462	76.0	pro18	535	488.8	1350.0	479	0.8	519.4	760.9	477	0.8	539	61.8
pro09	493	481.8	2318.2	461	1.4	481.5	1079.1	461	1.4	482	102.3	pro19	562	475.0	30.0	499	2.7	551.6	1242.2	501	2.7	531	152.9
pro10	594	588.4	2343.5	539	3.6	575.5	1772.4	539	3.6	578	189.7	pro20	662	552.4	24.6	570	2.5	647.8	2441.9	568	2.5	626	475.3
Ave time			1257.1		1.8		822.1		1.8		112.2				887.7		2.0		832.9		2.0		162.4
Ave RDP			1.20		4.72		1.08		5.26		0.97				10.59		8.20		1.99		8.83		2.28

Lampiran 12: Hasil Penelitian Terdahulu Set Data Cordeau (Path=2)

Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)	Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)
pro01	502	502.0	602.2	471	0.5	487.3	80.1	492	0.5	502	20.2	pro11	547	544.8	880.3	542	0.7	537.8	91.8	549	0.7	566	17.5
pro02	714	705.2	1017.6	660	1.2	696.9	216.0	686	1.2	712	37.3	pro12	768	763.4	2706.1	727	1.3	747.0	233.8	743	1.3	759	39.0
pro03	742	731.4	2083.0	714	3.3	715.3	356.0	710	3.3	741	217.7	pro13	831	798.8	3240.7	757	2.4	801.3	334.4	783	2.4	825	107.0
pro04	924	883.6	2439.3	863	4.1	906.4	578.5	889	4.1	905	245.0	pro14	1017	943.6	2100.7	925	8.1	990.6	725.0	861	8.1	922	111.7
pro05	1088	1021.8	2278.5	1011	7.1	1064.8	982.7	986	7.1	1053	249.8	pro15	1212	1100.0	3188.8	1126	8.2	1182.4	1019.1	1101	8.2	1155	444.8
pro06	1036	987.6	1724.1	997	9.8	1004.4	932.9	984	9.8	1022	439.3	pro16	1209	1101.0	2834.0	1110	11.0	1192.5	1192.0	1065	11.0	1094	330.7
pro07	566	566.0	972.3	552	1.0	550.1	130.0	559	1.0	566	20.5	pro17	652	646.2	1378.0	624	1.3	646.1	128.0	633	1.3	643	20.2
pro08	821	813.0	1730.0	796	5.1	799.6	344.7	793	5.1	822	75.6	pro18	938	888.4	1960.3	877	2.9	904.0	416.7	908	2.9	929	88.2
pro09	900	862.0	3131.0	867	5.2	855.7	608.5	847	5.2	854	120.7	pro19	995	940.8	2366.9	955	5.5	970.5	819.5	948	5.5	1017	302.7
pro10	1114	1064.6	2918.6	1004	10.3	1067.6	1018.9	1044	10.3	1069	313.2	pro20	1223	1113.0	3192.3	1056	10.7	1173.1	1227.6	1094	10.7	1154	554.5
Ave time			1889.7		4.8		524.8		4.8		173.9				2384.8		5.2		618.8		5.2		201.6
Ave RDP			2.74		5.40		3.05		4.52		1.61				5.09		6.80		2.55		6.65		2.77

Lampiran 13: Hasil Penelitian Terdahulu Set Data Cordeau (Path=3)

Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)	Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)
pro01	619	619.0	117.0	598	0.4	613.5	79.2	606	0.4	614	18.7	pro11	654	649.0	237.3	632	0.5	649.6	58.5	645	0.5	654	12.8
pro02	942	938.4	2333.1	899	3.9	919.2	206.0	919	3.9	939	42.7	pro12	988	970.6	2883.7	902	1.8	982.2	194.8	921	1.8	967	43.0
pro03	1003	991.0	876.8	946	3.9	983.6	330.6	967	3.9	989	173.2	pro13	1111	1088.8	2515.5	1046	8.2	1081.3	309.5	1110	8.2	1139	80.3
pro04	1280	1226.4	2909.0	1195	9.0	1261.9	592.9	1185	9.0	1253	168.7	pro14	1343	1258.6	2084.7	1197	8.3	1318.7	549.8	1210	8.3	1289	166.3
pro05	1459	1386.6	2746.7	1356	12.5	1441.1	779.3	1392	12.5	1431	226.6	pro15	1619	1486.8	2671.8	1488	14.6	1597.1	885.0	1470	14.6	1550	414.2
pro06	1449	1359.0	2719.7	1376	19.2	1411.4	844.7	1343	19.2	1469	332.4	pro16	1635	1481.8	2284.5	1478	28.2	1615.8	1035.3	1445	28.2	1530	697.6
pro07	744	738.4	1330.6	713	1.0	730.2	136.1	717	1.0	742	24.9	pro17	830	821.0	832.0	808	0.9	824.3	114.5	765	0.9	838	38.0
pro08	1118	1115.0	2544.3	1082	4.3	1089.0	297.5	1081	4.3	1131	157.1	pro18	1242	1209.0	2854.3	1165	6.0	1220.4	326.3	1203	6.0	1262	164.1
pro09	1275	1210.0	3187.7	1144	10.3	1190.8	542.3	1163	10.3	1236	251.3	pro19	1378	1299.4	3094.8	1238	10.2	1339.1	630.9	1242	10.2	1329	220.7
pro10	1520	1457.2	2873.1	1473	27.9	1493.3	923.5	1423	27.9	1477	574.5	pro20	1682	1491.2	2823.0	1514	18.2	1640.2	1070.1	1545	18.2	1593	681.3
Ave time			2163.8		9.2		473.2		9.2		197.0				2228.2		9.7		517.5		9.7		251.8
Ave RDP			2.72		5.31		2.33		4.96		1.02				4.91		7.55		1.60		6.80		2.06

Lampiran 14: Hasil Penelitian Terdahulu Set Data Cordeau (Path=4)

Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)	Name	BKS	ACO	T (s)	ILS	T (s)	VNS	T (s)	FSA	T (s)	SSA	T (s)
pro01	657	655.2	15.4	644	0.2	656.4	50.1	649	0.2	657	15.5	pro11	657	657.0	0.1	654	0.2	657.0	28.0	654	0.2	657	13.5
pro02	1072	1067.8	2165.0	1014	2.4	1057.8	196.3	1051	2.4	1069	44.0	pro12	1132	1114.0	2486.7	1041	1.9	1117.6	143.7	1083	1.9	1116	134.2
pro03	1222	1204.6	2074.0	1162	10.5	1195.2	271.0	1194	10.5	1201	156.1	pro13	1329	1316.4	2926.3	1263	6.6	1302.6	250.6	1294	6.6	1355	112.6
pro04	1530	1506.0	2986.0	1452	11.6	1502.1	436.0	1540	11.6	1535	393.2	pro14	1625	1534.4	2730.2	1528	16.6	1612.9	423.5	1550	16.6	1586	192.5
pro05	1799	1722.2	2818.5	1665	19.6	1775.9	653.7	1672	19.6	1759	321.0	pro15	1958	1822.8	2631.3	1818	19.5	1934.0	690.0	1916	19.5	1929	518.6
pro06	1829	1723.5	2935.8	1696	35.4	1798.1	782.7	1704	35.4	1839	721.0	pro16	2016	1867.2	2614.7	1889	35.9	1968.9	824.5	1865	35.9	1921	769.7
pro07	872	865.4	1940.2	840	1.6	849.0	97.8	858	1.6	871	31.6	pro17	930	923.8	2749.7	889	1.9	924.7	78.9	914	1.9	926	30.5
pro08	1376	1351.6	2804.3	1267	6.9	1336.3	268.5	1337	6.9	1358	118.8	pro18	1510	1464.8	3209.1	1352	5.7	1485.5	255.1	1446	5.7	1455	104.8
pro09	1561	1554.2	3371.9	1460	13.8	1492.4	475.3	1468	13.8	1565	252.5	pro19	1695	1579.4	3293.9	1560	22.2	1659.8	523.3	1670	22.2	1695	277.6
pro10	1887	1819.8	3365.9	1782	38.7	1855.0	800.3	1777	38.7	1853	502.0	pro20	2008	1821.4	3193.0	1846	26.9	1988.3	862.4	1890	26.9	1901	685.8
Ave time			2447.7		14.1		403.2		14.1		255.6				2583.5		13.7		408.0		13.7		284.0
Ave RDP			2.02		5.57		2.00		3.49		0.63				4.22		6.38		1.28		3.50		1.75

Lampiran 15: Hasil Penelitian Terdahulu Set Data Baru Cordeau

Name	<i>m</i>	OPT	ILS	<i>T</i> (s)	VNS	<i>T</i> (s)	FSA	<i>T</i> (s)	SSA	<i>T</i> (s)
pro01	3	657	608	0.7	612.9	69.6	611	0.7	614	18.5
pro02	6	1220	1180	4.5	1195.3	85.0	1192	4.5	1205	48.0
pro03	9	1788	1738	11.3	1759.0	86.0	1751	11.3	1758	124.2
pro04	12	2477	2428	45.4	2466.4	81.2	2444	45.4	2461	393.3
pro05	15	3351	3297	37.3	3349.5	71.7	3329	37.3	3351	1109.4
pro06	18	3671	3650	106.1	3670.1	83.5	3656	106.1	3661	1646.7
pro07	5	948	909	1.5	928.3	69.5	948	1.5	948	27.2
pro08	10	2006	1984	12.0	2005.0	63.2	2000	12.0	2006	128.5
pro09	15	2736	2729	33.0	2735.6	54.6	2731	33.0	2736	794.8
pro10	20	3850	3850	52.3	3850.0	52.4	3843	52.3	3847	1369.2
Ave time				30.4		71.7		30.4		566.0
Ave. RPD				2.32		1.30		1.44		1.04

Lampiran 16: Coding Pengujian Prioritas Vertex PSO_TOPTW2

```
for (i=1;i<=VertPriority.Length-1;i++) //analyze all vertex based on the priority
{
    for (j=1;j<=myTOPTW.NumPaths;j++) //analyze each path
    {
        Array.Copy(PathSequence,TempPathSequence,TempPathSequence.Length);
        l=PathContent[j]+2;

        TempPathSequence[j,l-1] = VertPriority[i];

        found=false;

        ArrivalTime[TempPathSequence[j,l]]=0;
        for(k=0; k<=l-1; k++)
        {
            if(ArrivalTime[TempPathSequence[j,k]] >=myTOPTW.myVertices[TempPath
Sequence[j,k]].ET)
                StartingTime[TempPathSequence[j,k]] =
ArrivalTime[TempPathSequence[j,k]];

            else
                StartingTime[TempPathSequence[j,k]] =
myTOPTW.myVertices[TempPathSequence[j,k]].ET;

            ArrivalTime[TempPathSequence[j,k+1]] =
StartingTime[TempPathSequence[j,k]] + myTOPTW.myVertices[TempPathSequence[j,k]].ST
+ myTOPTW.myVertices[TempPathSequence[j,k]].Distance[TempPathSequence[j,k+1]];
        }

        check = true;
        for (k=0; k<=l-1; k++)
        {
            check = (check &&(ArrivalTime[TempPathSequence[j,k]] <=
myTOPTW.myVertices[TempPathSequence[j,k]].LT));
        }

        if (check)
        {
            found=true;
        }
    }
}
```

```

TempPathTime[j] = ArrivalTime[TempPathSequence[j,l]];
BestTempPathTime[j]=TempPathTime[j];
Array.Copy(TempPathSequence,BestTempPathSequence,BestTempPathSeq
uence.Length);
}

for(n = l-2; n>0; n--)
//swap TempPathSequence n to n+1
rTemp =TempPathSequence[j,n];
TempPathSequence[j,n] = TempPathSequence[j,n+1];
TempPathSequence[j,n+1] = rTemp;

for (k=n; k<=l; k++)
{
    if (k==n)
        ArrivalTime[TempPathSequence[j,k]] =
StartingTime[TempPathSequence[j,k-1]] + myTOPTW.myVertices[TempPathSequence[j,k-
1]].ST + myTOPTW.myVertices[TempPathSequence[j,k-
1]].Distance[TempPathSequence[j,k]];
    else
        ArrivalTime[TempPathSequence[j,k]]=0;
}

for(k=n; k<=l-1; k++)
{
    if(ArrivalTime[TempPathSequence[j,k]] >=myTOPTW.myVertices[TempPath
Sequence[j,k]].ET)
        StartingTime[TempPathSequence[j,k]] =
ArrivalTime[TempPathSequence[j,k]];
    else
        StartingTime[TempPathSequence[j,k]] =
myTOPTW.myVertices[TempPathSequence[j,k]].ET;

        ArrivalTime[TempPathSequence[j,k+1]] =
StartingTime[TempPathSequence[j,k]] + myTOPTW.myVertices[TempPathSequence[j,k]].ST
+ myTOPTW.myVertices[TempPathSequence[j,k]].Distance[TempPathSequence[j,k+1]];
}

check=true;
for(k=n; k<=l-1; k++)

```

```

        {
            check= (check &&(ArrivalTime[TempPathSequence[j,k]]<=myTOPTW.myVer
            tices[TempPathSequence[j,k]].LT));
        }

        if(check)
        {
            if(found==true)
            {
                found=true;
                TempPathTime[j] = ArrivalTime[TempPathSequence[j,l]];

                if (TempPathTime[j] <= BestTempPathTime[j])
                {
                    BestTempPathTime[j]=TempPathTime[j];
                    Array.Copy(TempPathSequence,BestTempPathSequence,BestTempPat
                    hSequence.Length);
                }
            }

            if (found==false)
            {
                found=true;
                TempPathTime[j] = ArrivalTime[TempPathSequence[j,l]];
                BestTempPathTime[j]=TempPathTime[j];
                Array.Copy(TempPathSequence,BestTempPathSequence,BestTempPathS
                equence.Length);
            }

        } //end for check

    } //end for swap

    if (found==true)
    {
        if (BestTempPathTime[j] <= myTOPTW.Tmax)
        {
            PathTime[j] = BestTempPathTime[j];
            PathContent[j]++;
            myTOPTW.myVertices[VertPriority[i]].Visit=true;
        }
    }
}

```

```
    Array.Copy(BestTempPathSequence,PathSequence,PathSequence.Length);  
    break; //exit for j, continue to next vertpriority  
  }  
}  
  
} //end of j  
} //end of i
```

