**Solving A-n34-k5 using TSA**

----------------------------------------------------------------------------------------------------

VRP: A-n34-k5

Optimal Solution: 778.00

Depot coordinates: [(73.0, 39.0)]

Vertices:

Vertex Coordinate Demand

0 (73.0, 39.0) 0.0

1 (67.0, 91.0) 23.0

2 (39.0, 21.0) 3.0

3 (3.0, 9.0) 24.0

4 (97.0, 15.0) 15.0

5 (91.0, 65.0) 15.0

6 (55.0, 75.0) 24.0

7 (55.0, 71.0) 7.0

8 (57.0, 85.0) 25.0

9 (21.0, 15.0) 13.0

10 (47.0, 57.0) 5.0

11 (51.0, 97.0) 7.0

12 (11.0, 11.0) 5.0

13 (43.0, 59.0) 14.0

14 (63.0, 69.0) 13.0

15 (55.0, 77.0) 5.0

16 (35.0, 11.0) 24.0

17 (27.0, 91.0) 15.0

18 (49.0, 25.0) 9.0

19 (29.0, 93.0) 16.0

20 (71.0, 27.0) 13.0

21 (31.0, 43.0) 16.0

22 (27.0, 9.0) 13.0

23 (67.0, 99.0) 24.0

24 (87.0, 81.0) 20.0

25 (23.0, 81.0) 23.0

26 (89.0, 33.0) 20.0

27 (71.0, 91.0) 3.0

28 (19.0, 77.0) 15.0

29 (65.0, 77.0) 12.0

30 (87.0, 79.0) 19.0

31 (19.0, 83.0) 4.0

32 (1.0, 59.0) 15.0

33 (55.0, 7.0) 1.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 859.65 10.49 5

2 899.03 15.56 5

3 970.03 24.68 6

4 998.68 28.37 6

5 918.61 18.07 5

6 880.01 13.11 5

7 937.06 20.44 6

8 920.58 18.33 5

9 995.53 27.96 6

10 916.63 17.82 5

11 916.63 17.82 5

12 876.77 12.70 5

13 876.77 12.70 5

14 900.32 15.72 5

15 1050.45 35.02 6

16 974.65 25.28 6

17 996.73 28.11 6

18 957.22 23.04 5

19 949.94 22.10 5

20 945.09 21.48 6

21 976.06 25.46 6

22 898.51 15.49 6

23 903.28 16.10 5

24 876.77 12.70 5

25 1034.33 32.95 6

26 963.43 23.83 5

27 876.93 12.72 5

28 939.59 20.77 5

29 1058.55 36.06 6

30 876.16 12.62 5

Summary:

Mean: 938.13

Standard Deviation: 54.01

Error: 20.58%

**Solving A-n80-k10 using TSA**

----------------------------------------------------------------------------------------------------

VRP: A-n80-k10

Optimal Solution: 1763.00

Depot coordinates: [(92.0, 92.0)]

Vertices:

Vertex Coordinate Demand

0 (92.0, 92.0) 0.0

1 (88.0, 58.0) 24.0

2 (70.0, 6.0) 22.0

3 (57.0, 59.0) 23.0

4 (0.0, 98.0) 5.0

5 (61.0, 38.0) 11.0

6 (65.0, 22.0) 23.0

7 (91.0, 52.0) 26.0

8 (59.0, 2.0) 9.0

9 (3.0, 54.0) 23.0

10 (95.0, 38.0) 9.0

11 (80.0, 28.0) 14.0

12 (66.0, 42.0) 16.0

13 (79.0, 74.0) 12.0

14 (99.0, 25.0) 2.0

15 (20.0, 43.0) 2.0

16 (40.0, 3.0) 6.0

17 (50.0, 42.0) 20.0

18 (97.0, 0.0) 26.0

19 (21.0, 19.0) 12.0

20 (36.0, 21.0) 15.0

21 (100.0, 61.0) 13.0

22 (11.0, 85.0) 26.0

23 (69.0, 35.0) 17.0

24 (69.0, 22.0) 7.0

25 (29.0, 35.0) 12.0

26 (14.0, 9.0) 4.0

27 (50.0, 33.0) 4.0

28 (89.0, 17.0) 20.0

29 (57.0, 44.0) 10.0

30 (60.0, 25.0) 9.0

31 (48.0, 42.0) 2.0

32 (17.0, 93.0) 9.0

33 (21.0, 50.0) 1.0

34 (77.0, 18.0) 2.0

35 (2.0, 4.0) 2.0

36 (63.0, 83.0) 12.0

37 (68.0, 6.0) 14.0

38 (41.0, 95.0) 23.0

39 (48.0, 54.0) 21.0

40 (98.0, 73.0) 13.0

41 (26.0, 38.0) 13.0

42 (69.0, 76.0) 23.0

43 (40.0, 1.0) 3.0

44 (65.0, 41.0) 6.0

45 (14.0, 86.0) 23.0

46 (32.0, 39.0) 11.0

47 (14.0, 24.0) 2.0

48 (96.0, 5.0) 7.0

49 (82.0, 98.0) 13.0

50 (23.0, 85.0) 10.0

51 (63.0, 69.0) 3.0

52 (87.0, 19.0) 6.0

53 (56.0, 75.0) 13.0

54 (15.0, 63.0) 2.0

55 (10.0, 45.0) 14.0

56 (7.0, 30.0) 7.0

57 (31.0, 11.0) 21.0

58 (36.0, 93.0) 7.0

59 (50.0, 31.0) 22.0

60 (49.0, 52.0) 13.0

61 (39.0, 10.0) 22.0

62 (76.0, 40.0) 18.0

63 (83.0, 34.0) 22.0

64 (33.0, 51.0) 6.0

65 (0.0, 15.0) 2.0

66 (52.0, 82.0) 11.0

67 (52.0, 82.0) 5.0

68 (46.0, 6.0) 9.0

69 (3.0, 26.0) 9.0

70 (46.0, 80.0) 5.0

71 (94.0, 30.0) 12.0

72 (26.0, 76.0) 2.0

73 (75.0, 92.0) 12.0

74 (57.0, 51.0) 19.0

75 (34.0, 21.0) 6.0

76 (28.0, 80.0) 14.0

77 (59.0, 66.0) 2.0

78 (51.0, 16.0) 2.0

79 (87.0, 11.0) 24.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 2058.22 16.75 10

2 2075.65 17.73 11

3 2051.75 16.38 10

4 2268.48 28.67 11

5 1988.51 12.79 10

6 1971.00 11.80 10

7 1979.55 12.28 10

8 2188.98 24.16 11

9 2084.12 18.21 11

10 2200.46 24.81 11

11 2264.25 28.43 11

12 2008.94 13.95 11

13 2149.72 21.94 11

14 2288.76 29.82 11

15 2176.34 23.45 11

16 2049.20 16.23 10

17 2030.53 15.17 10

18 2235.96 26.83 11

19 2187.35 24.07 11

20 2229.21 26.44 11

21 2040.01 15.71 11

22 1987.72 12.75 10

23 2046.01 16.05 11

24 2194.00 24.45 11

25 2136.47 21.18 11

26 2115.49 19.99 11

27 2102.99 19.28 11

28 2182.60 23.80 11

29 2230.77 26.53 11

30 2182.86 23.82 11

Summary:

Mean: 2123.53

Standard Deviation: 94.52

Error: 20.45%

**Solving B-n50-k7 using TSA**

----------------------------------------------------------------------------------------------------

VRP: B-n50-k7

Optimal Solution: 741.00

Depot coordinates: [(49.0, 53.0)]

Vertices:

Vertex Coordinate Demand

0 (49.0, 53.0) 0.0

1 (59.0, 1.0) 21.0

2 (17.0, 83.0) 8.0

3 (85.0, 57.0) 11.0

4 (47.0, 21.0) 7.0

5 (1.0, 21.0) 21.0

6 (25.0, 69.0) 5.0

7 (75.0, 63.0) 13.0

8 (3.0, 7.0) 10.0

9 (56.0, 26.0) 9.0

10 (86.0, 58.0) 20.0

11 (8.0, 8.0) 7.0

12 (59.0, 27.0) 12.0

13 (64.0, 2.0) 23.0

14 (86.0, 64.0) 2.0

15 (28.0, 72.0) 4.0

16 (88.0, 58.0) 14.0

17 (18.0, 90.0) 12.0

18 (82.0, 64.0) 3.0

19 (22.0, 92.0) 5.0

20 (6.0, 10.0) 13.0

21 (10.0, 24.0) 5.0

22 (59.0, 29.0) 12.0

23 (52.0, 24.0) 2.0

24 (94.0, 62.0) 3.0

25 (76.0, 68.0) 18.0

26 (66.0, 2.0) 24.0

27 (90.0, 58.0) 4.0

28 (20.0, 84.0) 63.0

29 (50.0, 22.0) 19.0

30 (76.0, 64.0) 2.0

31 (63.0, 33.0) 9.0

32 (20.0, 84.0) 4.0

33 (59.0, 31.0) 9.0

34 (32.0, 74.0) 23.0

35 (48.0, 24.0) 6.0

36 (2.0, 30.0) 3.0

37 (10.0, 8.0) 12.0

38 (57.0, 27.0) 7.0

39 (68.0, 6.0) 17.0

40 (28.0, 74.0) 22.0

41 (63.0, 35.0) 26.0

42 (86.0, 58.0) 14.0

43 (90.0, 62.0) 9.0

44 (22.0, 90.0) 2.0

45 (6.0, 28.0) 16.0

46 (62.0, 8.0) 24.0

47 (59.0, 35.0) 4.0

48 (18.0, 88.0) 19.0

49 (30.0, 76.0) 11.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 885.30 19.47 7

2 835.32 12.73 7

3 872.60 17.76 7

4 880.16 18.78 8

5 901.54 21.67 7

6 928.70 25.33 7

7 878.45 18.55 7

8 922.72 24.52 7

9 916.56 23.69 7

10 839.84 13.34 7

11 935.34 26.23 7

12 975.26 31.61 7

13 934.44 26.11 7

14 908.47 22.60 7

15 842.96 13.76 7

16 903.58 21.94 7

17 925.16 24.85 8

18 927.26 25.14 7

19 942.38 27.18 7

20 937.22 26.48 7

21 1014.62 36.93 8

22 929.04 25.38 7

23 933.77 26.01 7

24 933.96 26.04 7

25 938.86 26.70 8

26 886.48 19.63 7

27 783.21 5.70 7

28 898.80 21.30 7

29 907.31 22.44 7

30 950.40 28.26 7

Summary:

Mean: 908.99

Standard Deviation: 44.35

Error: 22.67%

**Solving B-n68-k9 using TSA**

----------------------------------------------------------------------------------------------------

VRP: B-n68-k9

Optimal Solution: 1272.00

Depot coordinates: [(87.0, 39.0)]

Vertices:

Vertex Coordinate Demand

0 (87.0, 39.0) 0.0

1 (63.0, 45.0) 10.0

2 (5.0, 71.0) 3.0

3 (71.0, 13.0) 7.0

4 (59.0, 63.0) 18.0

5 (45.0, 95.0) 2.0

6 (29.0, 13.0) 2.0

7 (51.0, 79.0) 23.0

8 (7.0, 67.0) 8.0

9 (25.0, 85.0) 9.0

10 (1.0, 7.0) 22.0

11 (72.0, 14.0) 12.0

12 (28.0, 86.0) 20.0

13 (52.0, 86.0) 21.0

14 (46.0, 100.0) 9.0

15 (66.0, 46.0) 6.0

16 (28.0, 90.0) 11.0

17 (16.0, 70.0) 18.0

18 (2.0, 14.0) 23.0

19 (79.0, 21.0) 10.0

20 (14.0, 72.0) 11.0

21 (32.0, 88.0) 3.0

22 (6.0, 72.0) 10.0

23 (73.0, 15.0) 23.0

24 (2.0, 12.0) 8.0

25 (73.0, 21.0) 16.0

26 (12.0, 76.0) 26.0

27 (66.0, 72.0) 19.0

28 (2.0, 16.0) 9.0

29 (38.0, 16.0) 18.0

30 (30.0, 88.0) 5.0

31 (68.0, 54.0) 23.0

32 (32.0, 14.0) 1.0

33 (64.0, 46.0) 2.0

34 (26.0, 88.0) 21.0

35 (62.0, 68.0) 19.0

36 (34.0, 16.0) 5.0

37 (8.0, 68.0) 14.0

38 (77.0, 15.0) 10.0

39 (73.0, 15.0) 2.0

40 (75.0, 15.0) 16.0

41 (8.0, 68.0) 17.0

42 (36.0, 20.0) 5.0

43 (56.0, 82.0) 16.0

44 (26.0, 88.0) 6.0

45 (28.0, 86.0) 11.0

46 (52.0, 84.0) 14.0

47 (60.0, 70.0) 17.0

48 (26.0, 86.0) 8.0

49 (8.0, 72.0) 48.0

50 (76.0, 16.0) 12.0

51 (6.0, 76.0) 9.0

52 (14.0, 72.0) 6.0

53 (78.0, 14.0) 10.0

54 (34.0, 92.0) 19.0

55 (74.0, 14.0) 22.0

56 (64.0, 46.0) 5.0

57 (10.0, 74.0) 12.0

58 (6.0, 8.0) 5.0

59 (28.0, 88.0) 9.0

60 (60.0, 64.0) 8.0

61 (6.0, 78.0) 21.0

62 (46.0, 102.0) 9.0

63 (77.0, 23.0) 3.0

64 (68.0, 66.0) 8.0

65 (58.0, 80.0) 9.0

66 (58.0, 84.0) 16.0

67 (36.0, 14.0) 17.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 1488.28 17.00 10

2 1442.97 13.44 9

3 1407.50 10.65 9

4 1524.61 19.86 10

5 1359.55 6.88 9

6 1389.68 9.25 9

7 1496.80 17.67 10

8 1392.07 9.44 9

9 1411.40 10.96 9

10 1523.85 19.80 10

11 1432.28 12.60 9

12 1366.90 7.46 9

13 1460.84 14.85 10

14 1512.62 18.92 10

15 1405.29 10.48 9

16 1456.80 14.53 9

17 1621.17 27.45 10

18 1369.71 7.68 9

19 1475.64 16.01 10

20 1600.64 25.84 10

21 1553.63 22.14 10

22 1449.74 13.97 9

23 1564.64 23.01 9

24 1566.86 23.18 10

25 1419.85 11.62 9

26 1357.37 6.71 9

27 1443.63 13.49 9

28 1420.53 11.68 9

29 1460.26 14.80 9

30 1433.30 12.68 9

Summary:

Mean: 1460.28

Standard Deviation: 70.89

Error: 14.80%

**Solving E-n22-k4 using TSA**

----------------------------------------------------------------------------------------------------

VRP: E-n22-k4

Optimal Solution: 375.00

Depot coordinates: [(145.0, 215.0)]

Vertices:

Vertex Coordinate Demand

0 (145.0, 215.0) 0.0

1 (151.0, 264.0) 1100.0

2 (159.0, 261.0) 700.0

3 (130.0, 254.0) 800.0

4 (128.0, 252.0) 1400.0

5 (163.0, 247.0) 2100.0

6 (146.0, 246.0) 400.0

7 (161.0, 242.0) 800.0

8 (142.0, 239.0) 100.0

9 (163.0, 236.0) 500.0

10 (148.0, 232.0) 600.0

11 (128.0, 231.0) 1200.0

12 (156.0, 217.0) 1300.0

13 (129.0, 214.0) 1300.0

14 (146.0, 208.0) 300.0

15 (164.0, 208.0) 900.0

16 (141.0, 206.0) 2100.0

17 (147.0, 193.0) 1000.0

18 (164.0, 193.0) 900.0

19 (129.0, 189.0) 2500.0

20 (155.0, 185.0) 1800.0

21 (139.0, 182.0) 700.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 420.82 12.22 4

2 420.82 12.22 4

3 518.65 38.31 5

4 420.82 12.22 4

5 420.82 12.22 4

6 520.51 38.80 5

7 400.48 6.79 4

8 472.68 26.05 5

9 470.76 25.54 5

10 441.69 17.78 4

11 420.82 12.22 4

12 518.65 38.31 5

13 496.88 32.50 5

14 496.91 32.51 5

15 502.40 33.97 5

16 496.91 32.51 5

17 531.79 41.81 5

18 537.41 43.31 5

19 452.01 20.54 5

20 420.82 12.22 4

21 450.04 20.01 5

22 400.48 6.79 4

23 488.50 30.27 5

24 512.44 36.65 5

25 507.16 35.24 5

26 519.49 38.53 5

27 502.40 33.97 5

28 442.21 17.92 4

29 496.91 32.51 5

30 527.98 40.79 5

Summary:

Mean: 474.34

Standard Deviation: 43.16

Error: 26.49%

**Solving E-n33-k4 using TSA**

----------------------------------------------------------------------------------------------------

VRP: E-n33-k4

Optimal Solution: 835.00

Depot coordinates: [(292.0, 495.0)]

Vertices:

Vertex Coordinate Demand

0 (292.0, 495.0) 0.0

1 (298.0, 427.0) 700.0

2 (309.0, 445.0) 400.0

3 (307.0, 464.0) 400.0

4 (336.0, 475.0) 1200.0

5 (320.0, 439.0) 40.0

6 (321.0, 437.0) 80.0

7 (322.0, 437.0) 2000.0

8 (323.0, 433.0) 900.0

9 (324.0, 433.0) 600.0

10 (323.0, 429.0) 750.0

11 (314.0, 435.0) 1500.0

12 (311.0, 442.0) 150.0

13 (304.0, 427.0) 250.0

14 (293.0, 421.0) 1600.0

15 (296.0, 418.0) 450.0

16 (261.0, 384.0) 700.0

17 (297.0, 410.0) 550.0

18 (315.0, 407.0) 650.0

19 (314.0, 406.0) 200.0

20 (321.0, 391.0) 400.0

21 (321.0, 398.0) 300.0

22 (314.0, 394.0) 1300.0

23 (313.0, 378.0) 700.0

24 (304.0, 382.0) 750.0

25 (295.0, 402.0) 1400.0

26 (283.0, 406.0) 4000.0

27 (279.0, 399.0) 600.0

28 (271.0, 401.0) 1000.0

29 (264.0, 414.0) 500.0

30 (277.0, 439.0) 2500.0

31 (290.0, 434.0) 1700.0

32 (319.0, 433.0) 1100.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 1207.33 44.59 5

2 953.27 14.16 4

3 997.09 19.41 4

4 973.60 16.60 4

5 1123.93 34.60 5

6 912.91 9.33 4

7 1090.08 30.55 5

8 997.09 19.41 4

9 1058.69 26.79 5

10 1017.45 21.85 4

11 1124.71 34.70 5

12 1124.61 34.68 5

13 1090.08 30.55 5

14 1144.00 37.01 5

15 996.38 19.33 4

16 997.09 19.41 4

17 1142.07 36.77 5

18 1007.03 20.60 4

19 1200.40 43.76 5

20 912.91 9.33 4

21 997.09 19.41 4

22 1090.08 30.55 5

23 983.09 17.74 4

24 1127.97 35.09 5

25 1101.46 31.91 5

26 938.36 12.38 4

27 1086.73 30.15 5

28 1131.27 35.48 5

29 992.20 18.83 4

30 1165.13 39.54 5

Summary:

Mean: 1056.14

Standard Deviation: 82.67

Error: 26.48%

**Solving F-n45-k4 using TSA**

----------------------------------------------------------------------------------------------------

VRP: F-n45-k4

Optimal Solution: 724.00

Depot coordinates: [(0.0, 0.0)]

Vertices:

Vertex Coordinate Demand

0 (0.0, 0.0) 0.0

1 (3.0, 5.0) 33.0

2 (2.5, 9.0) 15.0

3 (48.0, 16.0) 10.0

4 (48.0, 17.0) 40.0

5 (69.0, 16.0) 15.0

6 (70.0, 16.0) 5.0

7 (64.0, 13.0) 77.0

8 (3.0, -22.0) 435.0

9 (2.5, 1.0) 165.0

10 (-13.0, 11.5) 120.0

11 (-20.0, 45.0) 65.0

12 (-9.0, 52.0) 23.0

13 (-8.5, 53.0) 18.0

14 (-8.0, 52.0) 550.0

15 (2.0, 2.0) 78.0

16 (-2.0, 9.0) 627.0

17 (-10.0, 20.0) 9.0

18 (-20.0, 19.0) 96.0

19 (-15.0, -21.0) 116.0

20 (-5.0, -9.0) 116.0

21 (-4.5, -9.0) 83.0

22 (-52.0, -36.0) 41.0

23 (-53.0, -36.0) 645.0

24 (0.0, 0.01) 694.0

25 (-30.0, -18.0) 573.0

26 (-51.0, -35.0) 1.0

27 (81.0, 9.0) 181.0

28 (84.0, -99.0) 106.0

29 (82.0, -6.0) 52.0

30 (40.0, -12.0) 117.0

31 (50.0, -7.0) 52.0

32 (51.0, -8.0) 1300.0

33 (63.0, -17.0) 57.0

34 (45.0, -1.0) 28.0

35 (54.0, 8.5) 84.0

36 (29.0, 4.0) 1.0

37 (21.0, 3.0) 54.0

38 (22.0, 2.0) 19.0

39 (39.0, -3.0) 88.0

40 (39.5, -3.0) 41.0

41 (40.0, -11.0) 238.0

42 (28.0, -2.0) 66.0

43 (24.0, -18.0) 44.0

44 (24.0, -19.0) 42.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 928.83 28.29 4

2 898.96 24.17 4

3 860.21 18.81 4

4 884.19 22.13 4

5 977.88 35.07 4

6 928.13 28.19 4

7 859.58 18.73 4

8 890.62 23.01 4

9 912.61 26.05 5

10 948.30 30.98 5

11 922.12 27.36 5

12 1034.64 42.91 5

13 887.86 22.63 4

14 929.67 28.41 4

15 956.89 32.17 4

16 911.78 25.94 4

17 896.49 23.82 4

18 766.36 5.85 5

19 911.46 25.89 4

20 1004.34 38.72 5

21 803.00 10.91 5

22 947.26 30.84 5

23 910.56 25.77 4

24 950.18 31.24 4

25 855.16 18.12 4

26 1026.82 41.83 5

27 868.73 19.99 4

28 838.55 15.82 4

29 839.00 15.88 4

30 802.95 10.90 5

Summary:

Mean: 905.10

Standard Deviation: 61.95

Error: 25.01%

**Solving F-n135-k7 using TSA**

----------------------------------------------------------------------------------------------------

VRP: F-n135-k7

Optimal Solution: 1162.00

Depot coordinates: [(-6.0, 15.0)]

Vertices:

Vertex Coordinate Demand

0 (-6.0, 15.0) 0.0

1 (3.2, 5.1) 30.0

2 (24.6, 8.3) 226.0

3 (23.3, 1.3) 37.0

4 (27.8, 8.3) 24.0

5 (29.0, 8.0) 36.0

6 (31.0, 8.0) 1.0

7 (33.5, 10.5) 31.0

8 (30.0, 10.5) 24.0

9 (29.0, 10.0) 30.0

10 (26.5, 11.7) 24.0

11 (28.3, 14.3) 24.0

12 (27.0, 14.3) 32.0

13 (23.5, 19.0) 24.0

14 (26.0, 20.0) 24.0

15 (25.0, 20.0) 19.0

16 (20.5, 19.0) 24.0

17 (-20.0, 13.0) 18.0

18 (-21.0, 14.0) 36.0

19 (-30.0, 30.0) 115.0

20 (-5.0, 30.0) 24.0

21 (1.3, 17.8) 24.0

22 (1.8, 13.8) 61.0

23 (1.8, 13.1) 71.0

24 (2.0, 13.6) 36.0

25 (4.8, 17.0) 18.0

26 (7.0, 15.0) 30.0

27 (9.8, 16.6) 31.0

28 (11.4, 14.5) 36.0

29 (14.4, 11.3) 18.0

30 (11.0, 12.0) 1004.0

31 (9.3, 10.7) 18.0

32 (0.6, 2.8) 34.0

33 (-30.0, -10.0) 504.0

34 (2.0, 0.0) 18.0

35 (14.5, 1.0) 39.0

36 (15.0, 1.8) 24.0

37 (17.2, 2.4) 37.0

38 (17.2, 4.2) 24.0

39 (18.2, 4.4) 99.0

40 (20.3, 2.1) 24.0

41 (22.8, 3.1) 24.0

42 (23.0, 4.0) 36.0

43 (20.8, 4.0) 30.0

44 (20.8, 4.0) 25.0

45 (18.5, 6.4) 24.0

46 (-14.0, 16.0) 122.0

47 (-0.5, 6.9) 196.0

48 (3.2, 2.8) 229.0

49 (5.6, 1.8) 83.0

50 (8.7, 2.8) 18.0

51 (9.0, 3.3) 24.0

52 (9.0, 3.5) 306.0

53 (11.2, 3.3) 18.0

54 (10.8, 4.7) 20.0

55 (11.5, 4.6) 18.0

56 (12.3, 4.7) 24.0

57 (12.3, 5.5) 22.0

58 (11.2, 6.9) 24.0

59 (6.5, 9.7) 18.0

60 (5.8, 8.5) 18.0

61 (7.2, 6.0) 24.0

62 (7.2, 4.0) 24.0

63 (-4.0, -4.0) 30.0

64 (-3.0, 1.2) 24.0

65 (-40.0, 49.0) 40.0

66 (-15.0, 10.0) 166.0

67 (-11.0, -10.0) 254.0

68 (-25.0, -20.0) 187.0

69 (-25.0, -35.0) 94.0

70 (-24.0, -35.0) 17.0

71 (-18.0, 10.0) 285.0

72 (-2.0, 10.0) 24.0

73 (-4.0, 8.0) 24.0

74 (-3.0, 5.0) 205.0

75 (2.1, 6.2) 23.0

76 (-1.7, 3.0) 28.0

77 (-3.0, 2.0) 51.0

78 (-7.0, 0.0) 49.0

79 (-3.0, -6.0) 19.0

80 (-30.0, -11.0) 262.0

81 (-62.0, -10.0) 120.0

82 (-8.0, 30.0) 266.0

83 (1.0, 60.0) 704.0

84 (10.0, 52.0) 38.0

85 (10.0, 52.0) 18.0

86 (10.0, 51.0) 30.0

87 (16.0, 29.0) 25.0

88 (26.0, 21.0) 12.0

89 (16.0, 21.0) 18.0

90 (15.5, 19.2) 25.0

91 (0.0, 16.5) 35.0

92 (17.2, 14.3) 18.0

93 (16.5, 7.8) 12.0

94 (16.9, 7.7) 20.0

95 (18.0, 2.0) 1126.0

96 (16.2, 4.0) 9.0

97 (15.0, 4.0) 36.0

98 (15.0, 3.0) 12.0

99 (14.8, 2.4) 31.0

100 (14.5, 3.0) 96.0

101 (13.0, 2.6) 27.0

102 (11.8, 3.0) 54.0

103 (12.0, 4.0) 137.0

104 (12.8, 3.6) 12.0

105 (13.4, 5.5) 58.0

106 (-150.0, 8.0) 206.0

107 (-152.0, 1.0) 178.0

108 (-152.0, 0.0) 486.0

109 (-142.0, -31.0)36.0

110 (-78.0, -19.0) 261.0

111 (-78.0, -18.0) 135.0

112 (-78.0, -17.0) 135.0

113 (-80.0, -14.0) 373.0

114 (-118.0, 22.0) 535.0

115 (-107.0, 30.0) 42.0

116 (-85.0, 14.0) 9.0

117 (-78.0, 15.0) 110.0

118 (-15.0, 16.0) 36.0

119 (-62.0, 32.0) 18.0

120 (-120.0, -20.0)726.0

121 (-90.0, -22.0) 187.0

122 (-79.0, -19.0) 23.0

123 (-79.0, -18.5) 134.0

124 (-79.0, -18.0) 47.0

125 (-78.0, -17.5) 51.0

126 (-79.0, -17.0) 43.0

127 (-80.0, -17.0) 79.0

128 (-80.0, -16.0) 112.0

129 (-80.0, -15.0) 91.0

130 (-48.0, 37.0) 232.0

131 (-85.0, 15.0) 483.0

132 (-62.0, -9.0) 828.0

133 (-15.0, -4.0) 11.0

134 (-1.0, 3.2) 12.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 1490.45 28.27 8

2 1397.32 20.25 7

3 1379.28 18.70 8

4 1399.98 20.48 7

5 1503.83 29.42 8

6 1526.21 31.34 8

7 1390.07 19.63 8

8 1440.11 23.93 7

9 1399.93 20.48 8

10 1504.84 29.50 7

11 1373.63 18.21 7

12 1423.79 22.53 8

13 1383.59 19.07 8

14 1466.30 26.19 8

15 1415.23 21.79 7

16 1397.42 20.26 7

17 1398.45 20.35 7

18 1415.56 21.82 8

19 1503.79 29.41 8

20 1312.87 12.98 8

21 1367.51 17.69 7

22 1315.18 13.18 7

23 1399.39 20.43 7

24 1415.62 21.83 7

25 1499.87 29.08 8

26 1337.68 15.12 8

27 1415.54 21.82 7

28 1466.08 26.17 7

29 1372.29 18.10 7

30 1418.59 22.08 7

Summary:

Mean: 1417.68

Standard Deviation: 55.23

Error: 22.00%

**Solving M-n101-k10 using TSA**

----------------------------------------------------------------------------------------------------

VRP: M-n101-k10

Optimal Solution: 820.00

Depot coordinates: [(40.0, 50.0)]

Vertices:

Vertex Coordinate Demand

0 (40.0, 50.0) 0.0

1 (45.0, 68.0) 10.0

2 (45.0, 70.0) 30.0

3 (42.0, 66.0) 10.0

4 (42.0, 68.0) 10.0

5 (42.0, 65.0) 10.0

6 (40.0, 69.0) 20.0

7 (40.0, 66.0) 20.0

8 (38.0, 68.0) 20.0

9 (38.0, 70.0) 10.0

10 (35.0, 66.0) 10.0

11 (35.0, 69.0) 10.0

12 (25.0, 85.0) 20.0

13 (22.0, 75.0) 30.0

14 (22.0, 85.0) 10.0

15 (20.0, 80.0) 40.0

16 (20.0, 85.0) 40.0

17 (18.0, 75.0) 20.0

18 (15.0, 75.0) 20.0

19 (15.0, 80.0) 10.0

20 (30.0, 50.0) 10.0

21 (30.0, 52.0) 20.0

22 (28.0, 52.0) 20.0

23 (28.0, 55.0) 10.0

24 (25.0, 50.0) 10.0

25 (25.0, 52.0) 40.0

26 (25.0, 55.0) 10.0

27 (23.0, 52.0) 10.0

28 (23.0, 55.0) 20.0

29 (20.0, 50.0) 10.0

30 (20.0, 55.0) 10.0

31 (10.0, 35.0) 20.0

32 (10.0, 40.0) 30.0

33 (8.0, 40.0) 40.0

34 (8.0, 45.0) 20.0

35 (5.0, 35.0) 10.0

36 (5.0, 45.0) 10.0

37 (2.0, 40.0) 20.0

38 (0.0, 40.0) 30.0

39 (0.0, 45.0) 20.0

40 (35.0, 30.0) 10.0

41 (35.0, 32.0) 10.0

42 (33.0, 32.0) 20.0

43 (33.0, 35.0) 10.0

44 (32.0, 30.0) 10.0

45 (30.0, 30.0) 10.0

46 (30.0, 32.0) 30.0

47 (30.0, 35.0) 10.0

48 (28.0, 30.0) 10.0

49 (28.0, 35.0) 10.0

50 (26.0, 32.0) 10.0

51 (25.0, 30.0) 10.0

52 (25.0, 35.0) 10.0

53 (44.0, 5.0) 20.0

54 (42.0, 10.0) 40.0

55 (42.0, 15.0) 10.0

56 (40.0, 5.0) 30.0

57 (40.0, 15.0) 40.0

58 (38.0, 5.0) 30.0

59 (38.0, 15.0) 10.0

60 (35.0, 5.0) 20.0

61 (50.0, 30.0) 10.0

62 (50.0, 35.0) 20.0

63 (50.0, 40.0) 50.0

64 (48.0, 30.0) 10.0

65 (48.0, 40.0) 10.0

66 (47.0, 35.0) 10.0

67 (47.0, 40.0) 10.0

68 (45.0, 30.0) 10.0

69 (45.0, 35.0) 10.0

70 (95.0, 30.0) 30.0

71 (95.0, 35.0) 20.0

72 (53.0, 30.0) 10.0

73 (92.0, 30.0) 10.0

74 (53.0, 35.0) 50.0

75 (45.0, 65.0) 20.0

76 (90.0, 35.0) 10.0

77 (88.0, 30.0) 10.0

78 (88.0, 35.0) 20.0

79 (87.0, 30.0) 10.0

80 (85.0, 25.0) 10.0

81 (85.0, 35.0) 30.0

82 (75.0, 55.0) 20.0

83 (72.0, 55.0) 10.0

84 (70.0, 58.0) 20.0

85 (68.0, 60.0) 30.0

86 (66.0, 55.0) 10.0

87 (65.0, 55.0) 20.0

88 (65.0, 60.0) 30.0

89 (63.0, 58.0) 10.0

90 (60.0, 55.0) 10.0

91 (60.0, 60.0) 10.0

92 (67.0, 85.0) 20.0

93 (65.0, 85.0) 40.0

94 (65.0, 82.0) 10.0

95 (62.0, 80.0) 30.0

96 (60.0, 80.0) 10.0

97 (60.0, 85.0) 30.0

98 (58.0, 75.0) 20.0

99 (55.0, 80.0) 10.0

100 (55.0, 85.0) 20.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 972.33 18.58 10

2 1079.12 31.60 10

3 1078.49 31.52 10

4 1069.75 30.46 10

5 1040.68 26.91 10

6 993.74 21.19 10

7 1067.36 30.17 10

8 1081.21 31.85 10

9 1104.97 34.75 10

10 1064.13 29.77 10

11 1078.76 31.56 10

12 1080.30 31.74 10

13 1000.69 22.04 10

14 997.74 21.68 10

15 1056.17 28.80 10

16 1040.41 26.88 10

17 1079.35 31.63 10

18 1098.00 33.90 10

19 957.23 16.74 10

20 1102.85 34.49 10

21 1048.43 27.86 10

22 1089.36 32.85 10

23 1070.21 30.51 10

24 981.71 19.72 10

25 1056.93 28.89 10

26 1045.97 27.56 10

27 950.87 15.96 10

28 1088.66 32.76 10

29 1056.57 28.85 10

30 1063.88 29.74 10

Summary:

Mean: 1049.86

Standard Deviation: 43.08

Error: 28.03%

**Solving P-n55-k8 using TSA**

----------------------------------------------------------------------------------------------------

VRP: P-n55-k8

Optimal Solution: 588.00

Depot coordinates: [(40.0, 40.0)]

Vertices:

Vertex Coordinate Demand

0 (40.0, 40.0) 0.0

1 (22.0, 22.0) 18.0

2 (36.0, 26.0) 26.0

3 (21.0, 45.0) 11.0

4 (45.0, 35.0) 30.0

5 (55.0, 20.0) 21.0

6 (33.0, 34.0) 19.0

7 (50.0, 50.0) 15.0

8 (55.0, 45.0) 16.0

9 (26.0, 59.0) 29.0

10 (40.0, 66.0) 26.0

11 (55.0, 65.0) 37.0

12 (35.0, 51.0) 16.0

13 (62.0, 35.0) 12.0

14 (62.0, 57.0) 31.0

15 (62.0, 24.0) 8.0

16 (21.0, 36.0) 19.0

17 (33.0, 44.0) 20.0

18 (9.0, 56.0) 13.0

19 (62.0, 48.0) 15.0

20 (66.0, 14.0) 22.0

21 (44.0, 13.0) 28.0

22 (26.0, 13.0) 12.0

23 (11.0, 28.0) 6.0

24 (7.0, 43.0) 27.0

25 (17.0, 64.0) 14.0

26 (41.0, 46.0) 18.0

27 (55.0, 34.0) 17.0

28 (35.0, 16.0) 29.0

29 (52.0, 26.0) 13.0

30 (43.0, 26.0) 22.0

31 (31.0, 76.0) 25.0

32 (22.0, 53.0) 28.0

33 (26.0, 29.0) 27.0

34 (50.0, 40.0) 19.0

35 (55.0, 50.0) 10.0

36 (54.0, 10.0) 12.0

37 (60.0, 15.0) 14.0

38 (47.0, 66.0) 24.0

39 (30.0, 60.0) 16.0

40 (30.0, 50.0) 33.0

41 (12.0, 17.0) 15.0

42 (15.0, 14.0) 11.0

43 (16.0, 19.0) 18.0

44 (21.0, 48.0) 17.0

45 (50.0, 30.0) 21.0

46 (51.0, 42.0) 27.0

47 (50.0, 15.0) 19.0

48 (48.0, 21.0) 20.0

49 (12.0, 38.0) 5.0

50 (15.0, 56.0) 22.0

51 (29.0, 39.0) 12.0

52 (54.0, 38.0) 19.0

53 (55.0, 57.0) 22.0

54 (67.0, 41.0) 16.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 635.94 8.15 7

2 674.78 14.76 7

3 693.13 17.88 7

4 706.83 20.21 7

5 740.63 25.96 8

6 706.23 20.11 8

7 723.08 22.97 7

8 672.91 14.44 7

9 724.87 23.28 8

10 709.95 20.74 8

11 655.30 11.45 7

12 695.03 18.20 7

13 675.75 14.92 7

14 699.22 18.91 8

15 772.19 31.32 8

16 698.21 18.74 8

17 659.01 12.08 7

18 702.84 19.53 7

19 703.45 19.63 7

20 686.09 16.68 7

21 718.21 22.14 7

22 722.51 22.88 7

23 704.86 19.87 7

24 696.69 18.48 8

25 699.10 18.89 7

26 668.61 13.71 7

27 704.92 19.88 7

28 657.04 11.74 7

29 664.41 12.99 7

30 707.86 20.38 7

Summary:

Mean: 695.99

Standard Deviation: 27.57

Error: 18.37%

**Solving P-n101-k4 using TSA**

----------------------------------------------------------------------------------------------------

VRP: P-n101-k4

Optimal Solution: 681.00

Depot coordinates: [(35.0, 35.0)]

Vertices:

Vertex Coordinate Demand

0 (35.0, 35.0) 0.0

1 (41.0, 49.0) 10.0

2 (35.0, 17.0) 7.0

3 (55.0, 45.0) 13.0

4 (55.0, 20.0) 19.0

5 (15.0, 30.0) 26.0

6 (25.0, 30.0) 3.0

7 (20.0, 50.0) 5.0

8 (10.0, 43.0) 9.0

9 (55.0, 60.0) 16.0

10 (30.0, 60.0) 16.0

11 (20.0, 65.0) 12.0

12 (50.0, 35.0) 19.0

13 (30.0, 25.0) 23.0

14 (15.0, 10.0) 20.0

15 (30.0, 5.0) 8.0

16 (10.0, 20.0) 19.0

17 (5.0, 30.0) 2.0

18 (20.0, 40.0) 12.0

19 (15.0, 60.0) 17.0

20 (45.0, 65.0) 9.0

21 (45.0, 20.0) 11.0

22 (45.0, 10.0) 18.0

23 (55.0, 5.0) 29.0

24 (65.0, 35.0) 3.0

25 (65.0, 20.0) 6.0

26 (45.0, 30.0) 17.0

27 (35.0, 40.0) 16.0

28 (41.0, 37.0) 16.0

29 (64.0, 42.0) 9.0

30 (40.0, 60.0) 21.0

31 (31.0, 52.0) 27.0

32 (35.0, 69.0) 23.0

33 (53.0, 52.0) 11.0

34 (65.0, 55.0) 14.0

35 (63.0, 65.0) 8.0

36 (2.0, 60.0) 5.0

37 (20.0, 20.0) 8.0

38 (5.0, 5.0) 16.0

39 (60.0, 12.0) 31.0

40 (40.0, 25.0) 9.0

41 (42.0, 7.0) 5.0

42 (24.0, 12.0) 5.0

43 (23.0, 3.0) 7.0

44 (11.0, 14.0) 18.0

45 (6.0, 38.0) 16.0

46 (2.0, 48.0) 1.0

47 (8.0, 56.0) 27.0

48 (13.0, 52.0) 36.0

49 (6.0, 68.0) 30.0

50 (47.0, 47.0) 13.0

51 (49.0, 58.0) 10.0

52 (27.0, 43.0) 9.0

53 (37.0, 31.0) 14.0

54 (57.0, 29.0) 18.0

55 (63.0, 23.0) 2.0

56 (53.0, 12.0) 6.0

57 (32.0, 12.0) 7.0

58 (36.0, 26.0) 18.0

59 (21.0, 24.0) 28.0

60 (17.0, 34.0) 3.0

61 (12.0, 24.0) 13.0

62 (24.0, 58.0) 19.0

63 (27.0, 69.0) 10.0

64 (15.0, 77.0) 9.0

65 (62.0, 77.0) 20.0

66 (49.0, 73.0) 25.0

67 (67.0, 5.0) 25.0

68 (56.0, 39.0) 36.0

69 (37.0, 47.0) 6.0

70 (37.0, 56.0) 5.0

71 (57.0, 68.0) 15.0

72 (47.0, 16.0) 25.0

73 (44.0, 17.0) 9.0

74 (46.0, 13.0) 8.0

75 (49.0, 11.0) 18.0

76 (49.0, 42.0) 13.0

77 (53.0, 43.0) 14.0

78 (61.0, 52.0) 3.0

79 (57.0, 48.0) 23.0

80 (56.0, 37.0) 6.0

81 (55.0, 54.0) 26.0

82 (15.0, 47.0) 16.0

83 (14.0, 37.0) 11.0

84 (11.0, 31.0) 7.0

85 (16.0, 22.0) 41.0

86 (4.0, 18.0) 35.0

87 (28.0, 18.0) 26.0

88 (26.0, 52.0) 9.0

89 (26.0, 35.0) 15.0

90 (31.0, 67.0) 3.0

91 (15.0, 19.0) 1.0

92 (22.0, 22.0) 2.0

93 (18.0, 24.0) 22.0

94 (26.0, 27.0) 27.0

95 (25.0, 24.0) 20.0

96 (22.0, 27.0) 11.0

97 (25.0, 21.0) 12.0

98 (19.0, 21.0) 10.0

99 (20.0, 26.0) 9.0

100 (18.0, 18.0) 17.0

Results:

Trial Distance Relative Error (%) Number of Vehicles

1 850.69 24.92 4

2 833.28 22.36 4

3 867.59 27.40 4

4 842.15 23.66 4

5 848.70 24.63 4

6 833.42 22.38 4

7 871.13 27.92 4

8 876.46 28.70 4

9 839.50 23.27 4

10 854.57 25.49 4

11 860.52 26.36 4

12 844.01 23.94 4

13 862.27 26.62 4

14 890.99 30.84 4

15 798.74 17.29 4

16 831.85 22.15 4

17 847.98 24.52 4

18 859.97 26.28 4

19 774.88 13.79 4

20 842.30 23.69 4

21 819.03 20.27 4

22 892.97 31.13 4

23 915.68 34.46 4

24 851.16 24.99 4

25 877.90 28.91 4

26 842.31 23.69 4

27 849.74 24.78 4

28 824.75 21.11 4

29 817.28 20.01 4

30 800.04 17.48 4

Summary:

Mean: 847.40

Standard Deviation: 28.81

Error: 24.43%