THE MULTIPLE TRAVELLING SALESMAN PROBLEM AND VEHICLE ROUTING PROBLEM FOR DIFFERENT DOMESTIC DRINKS

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Abstract: *The MTSP is a generalization of the traveling salesman problem where there are multiple vehicles and a single depot. In this problem, instead of determining a route for a single vehicle, we wish to construct tours for all M vehicles. The characteristics of the tours are that they begin and end at the depot node. Solution procedures begin by "copying" the depot node M times. The problem is thus reduced to M single-vehicle TSPs, and it can be solved using either the nearest neighbor or Clark and Wright heuristics. The classic VRP (Vehicle Routing Problem) expands the multiple traveling salesman problem to include different service requirements at each node and different capacities for vehicles in the fleet. The objective of these problems is to minimize total cost or distance across all routes. Examples of services that show the characteristics of vehicle routing problems include different Services deliveries, public transportation "pickups" for the handicapped, and the newspaper delivery problem etc.*

In this paper will be present using of the principles of MTSP and VRP for optimal solution of vehicle routing for domestic energetic drinks and sparkling water in PET bottles in the different parts of the Republic of Macedonia

Keywords: MTSP, VRP, VEHICLE ROUTING

1. Introduction

The extension of this case is designated as Multiple Traveling Salesman Problem (MTSP), or a problem of multiple Traveling Salesman, and appears when the vehicle speed must be specified in the individual line or warehouse. The goal is to create a set of routes, one set for each vehicle with its speed. Features for this problem are that one node can be designated only for one vehicle, but the vehicle has more than one node. There are no restrictions on the size of the load that the vehicle can carry. The solution to this problem will give the order in which each vehicle must visit nodes that are marked. As in the single-vehicle case, the goal is to develop a set of routes with minimal expenses, where the cost can be presented in amount of euro or dollar, distance or driving time. If we limit the capacity of multiple vehicles and merge with the possibility of having variable needs of each node, the problem is classified and called Vehicle Routing Problem (VRP), or the problem of vehicle routing.

Alternatively, if needs of services happen to be in arches, rather than in the nodes, or if the demand is so great that the individual demand nodes become more numerous to specify, then we start to use the Chinese Postman Problem (CPP). This is a very difficult problem to solve and it is necessary to pay attention to it because it is in the context of research.

In [6], [7] and [8] vehicle routing problem is solved using different optimization methods as dynamic optimization, linear optimization, graph theory, game theory. For optimization criterion in these studies is chosen minimum fuel consumption.

2. Vehicle Routing Problem (VRP)

Vehicle Routing Problem (VRP) or the problem of vehicle routing and is consonant MTSP problem expands to include service requirements for each node in various capacities for vehicles. Purpose of these problems is to minimize the total cost or distance across all routes.

Table 1. *Distance between cities in Eastern Macedonia*

	1	2	3	4	5	6	7
1		39	99	50	91	168	154
2	39		60	55	66	145	131
3	99	60		116	52	151	156
4	50	55	116		40	109	113
5	91	66	52	40		83	66
6	168	145	151	109	83		85
7	154	131	156	113	66	85	

The amount of new units of product L-Carnitine which is transported in some cities in Eastern Macedonia, while the vehicle capacity (K) is 5000 units.

Table 2. *Coalitions of units required*

i	(2) Kumanovo	(3) Kr. Palanka	(4) Veles	(5) Stip	(6) Delcevo	(7) Strumica
di	14 000	900	1 400	2 000	900	1 800

Savings Sij are calculated and displayed symmetrically with the following values in the table3.

Table 3. *The estimated savings Sij*

	2	3	4	5	6	7
2		78	34	64	62	62
3	78		33	138	116	97
4	34	33		101	109	91
5	64	138	101		176	179
6	62	116	109	176		237
7	62	97	91	179	237	

Sorted savings [7.6], [7.5], [5.6], [5.3], [6.3], [4.6], [4.5], [7.3] [4.7], [3.2], [5.2], [6.2], [7.2], [4.2], [4.3]. First we consider the case of transport of the product from (7) Strumica to (6) Delcevo. They can be represented in the same route with the need of 2700 units in a vehicle with a capacity of 5000 units. It makes about 7 → 6, and 7 and 6 nodes will be neighbors of the route to the final solution.

In addition at the route from (7) Strumica to (5) Stip. If they are neighbors in the route it would be desirable to link 6 → 7 → 5 and 5 → 7 → 6. The total amount of 4700 units in this route does not exceed the capacity of the vehicle (5000). Because so far about 4700 units are transported it reaches the capacity of the vehicle, so the route of the first vehicle ends here. We will look at the route of the second vehicle in the nodes (3) Kriva Palanka and (2) Kumanovo. They can be represented in the same route as the requisite units for delivery of 1400 and 900, or 2300 units which meet the capacity of 5000 units.

The next route is (4) Veles and (3) Kriva Palanka, which may be related to previous route 3 → 2 to produce the desired route 4 → 2 → 3 or 3 → 2 → 4 of transported 3 700 units. The delivery of the entire quantity of (8400) units for Eastern Macedonia is running by two routes and two vehicles, and they are the following 1 → 5 → 7 → 6 → 1 and 1 → 4 → 2 → 3 → 1 routes. The total distance that the first vehicle passes is 408 km, while the second vehicle is passing 246 km distance.

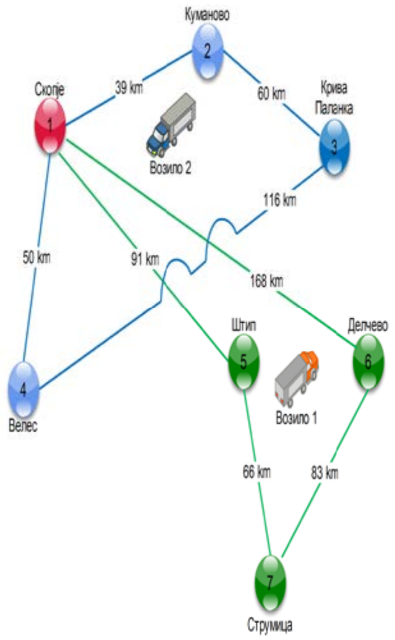

Figure 1.*Vehicle routing problem for Eastern Macedonia*

Savings and quantity of delivered units of a new product L-Carnitine with amount of 10,800 units in Western Macedonia, the display of routes and number of vehicles are given in the following tables and calculations.

Table 4. *Distance between cities in Western Macedonia*

	1	8	9	10	11	12	13	14
1		131	176	174	159	67	44	112
8	131		47	106	32	108	132	62
9	176	47		66	52	124	146	78
10	174	106	66		138	107	132	61
11	159	32	52	138		140	164	62
12	67	108	124	107	140		24	46
13	44	132	146	132	164	24		70
14	112	62	78	61	62	46	70	

The amount of units of a new product L-Carnitine which is transported in certain cities in western Macedonia, while the capacity of a vehicle (K1) is 7000 units and second (K2) is 4000 units.

Table 5. *Coalitions of units required*

	(8) Prilep	(9) Bitola	(10) Ohrid	(11) Krusevo	(12) Gostivar	(13) Tetovo	(14) Kicevo
di	1 600	2 000	2 000	1 200	1 200	1 600	1 20

Savings Sij are calculated and displayed symmetrically with the following values in the Table6.

Table 6. *The estimated savings Sij*

Sij	8	9	10	11	12	13	14
8		260	199	258	90	43	181
9	260		284	283	119	146	210
10	199	284		205	134	86	225
11	258	283	205		86	39	209
12	90	119	134	86		87	133
13	43	146	86	39	87		86
14	181	210	225	209	133	86	

Sorted savings [9.10], [9.11], [8.9], [8.11], [10.14], [9.14], [11.14], [10.11] [8.10] [9.13] [10.12] [12.14] [9.12] [8.12] [12.13] [11.12] [13.14] [10.13] [8.13] [11.13].

First we will consider the case of transport of the product from (9) Bitola to (10) Ohrid. They can be represented in the same route for the transport of 4000 units in a vehicle with a capacity of 7000 units. It makes about 9 → 10 and 9 and 10 nodes will be neighbors of the route to the final solution.

In addition, we will consider the route from (9) Bitola to Krusevo (11) town. If they are neighbors in the route it would be desirable to link the 9 → 10 → 11 or 11 → 9 → 10 nodes. The total amount of transported 5 200 units in the route does not exceed the capacity of the vehicle (7000) units.

Next route with the greatest saving is the distance from (8) Prilep to (9) Bitola, if they are neighbors in the route it would be desirable to link 10 → 9 → 8 → 11 or 11 → 8 → 9 → 10 nodes. Because so far transported 6800 units are approaching the first vehicle capacity (7,000 units), and completes the route of the first vehicle.

Next will consider the route of the second vehicle in the nodes from (12) Gostivar to (13) Tetovo. They can be represented in the same route as the requisite units for delivery in 1200 and 1600, or 2800 units. The next following route is from (12) Gostivar to (14) Kicevo, which can be connected to the previous route 12 → 13 thus obtain the desired route 13 → 12 → 14 → 12 and 14 → 13 to 4000 units.

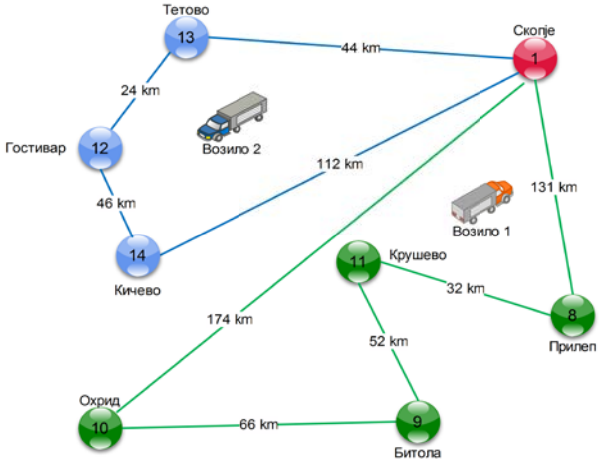

Figure 2. *Vehicle routing problem for Western Macedonia*

Conclusion

The delivery of the entire quantity of units (10,800) for Western Macedonia is performed with two routes and two vehicles, and those are 1 → 10 → 8 → 9 → 11 → 1 or 1 → 11 → 8 → 9 → 10 → 1 and 1 → 14 → 12 → 13 → 1 or 1 → 13 → 12 → 14 → 1. The total distance that the vehicle passes are, the first is passing 455 km, and the second vehicle of 226 km.

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