Logistics and Supply Chain Management

Exercise Sheet 1 – Transportation logistics

Exercise 1.1:

Find a closed tour through 5 cities. The distances between the cities are given in the following table (taken from Vahrenkamp und Mattfeld, Logistiknetzwerke, 2007, Gabler, S. 250).

From/To	1	2	3	4	5
1	0	2	5	7	3
2	6	0	4	8	10
3	18	16	0	14	12
4	24	13	23	0	17
5	19	20	22	11	0

a) How many closed tours exist for this problem?

b) Derive a feasible tour with the heuristic "Nearest Neighbour". How does the solution of the heuristic depend on the choice of the starting node?

c) Derive a feasible solution using the heuristic "Successive Insertion". Insert nodes in the sequence of their indices.

d) Consider the route 1-5-2-4-3-1 and apply the 2-Opt heuristic on the arcs.

- 5-2 and 4-3
- 2-4 and 3-1

e) Discuss the differences in applying the 2-Opt heuristic in a symmetric and asymmetric TSP.

f) Determine the mathematical model.

Exercise 1.2

A travelling salesman has to visit four cities (2, 3, 4, 5) in one single tour exactly once and therefore starts and ends his tour at the warehouse (1), The distances between the locations are given below.

From/To	1	2	3	4	5
1	0	30	41	60	78
2	30	0	18	65	42
3	41	18	0	95	5
4	60	65	95	0	34
5	78	42	5	34	0

a) Derive a feasible solution using the heuristic “Successive Insertion”. Insert nodes in the sequence of their indices.

b) The salesman now has two new customers (6,7). In order to minimize the distance of his route, the salesman decided to optimize the route by coding the problem. The output is given below. Interpret the output. Why is this not a solution for the travelling salesman problem?

Output:
$x_{13} = 1; x_{25} = 1; x_{32} = 1; x_{41} = 1; x_{54} = 1; x_{67} = 1; x_{76} = 1;$
$x_{ij} = 0$ *for all other pairs i,j*

c) What does the salesman need to add to his code, so that a mathematical optimization model produces a feasible solution for the travelling salesman problem?

d) Write down the feasible mathematical program for the problem.