Summary

The vehicle routing problem (VRP) can be described as the problem of designing optimal delivery or collection routes from one or several depots to a number of geographically scattered cities or customers, subject to side constraints. The VRP plays a central role in the fields of physical distribution and logistics. There exists a wide variety of VRPs and a broad literature on this class of problems. One of the most common problems is the single depot vehicle routing problem. It consist of one single depot from which multiple vehicles supply a number of customers.

The goal of this assignment is to develop a Delphi program that demonstrates the solving of vehicle routing problems using the Clark and Wright algorithm. This algorithm is one of the well-known algorithms that helps with finding the optimum route for a single depot VRP. It is developed by G. Clarke and J.W. Wright in 1964. The algorithm is based on a savings concept. The concept expresses the cost savings obtained by joining two routes into one route. If a single vehicle is used to serve two points on a single trip, the total distance traveled is reduced compared to a direct route. This amount is called a 'saving'. The Clark and Wright algorithm is a heuristic algorithm and therefore it does not guarantee an optimal solution to the problem. The method however often yields to a relatively good solution. There is a parallel and a sequential version of the Clarke & Wright algorithm. With the sequential version exactly one route is build at a time, while in the parallel version more than one route may be build at a time.

The simulation program is build from the ground up. First a conceptual model was made and after setting up the process description model the programming was started. The simulation program offers a user-interface that allows users to specify the location of customers and depot, demand characteristics, vehicle capacity and maximum route length. Nodes (customers) have a position in a 2D Space by using the x- and y-coordinates. The distances between the nodes can be calculated, in this program the Euclidean distance is calculated by using the Pythagorean formula. For more realistic values distances can be loaded by using a text file. There are three types of demand characteristics available in the program: a normal-, exponential- and uniform distribution. A step-by-step animation is implemented to gain more insight in the exact working of the algorithm.

A case was made to show that the model is able to answer the following research question: determine the required size of the truck fleet, given location and demand characteristics of multiple customers.
During the case it became clear that the sequential version takes much longer then the parallel version because for each new route it has to go through all the savings, when using many nodes (100+) this can be a problem. Therefore the research question of the first case was answered by only running the parallel version. With help of a histogram the research question could be answered and it was shown that the model can be used for large vehicle routing problems.

A second case was made to examine the differences between the parallel and sequential version.
Although there weren't many simulation runs there is clearly a difference visible between the parallel and sequential version. The sequential version results in a higher load utilization but a lower savings percentage compared to the parallel version. However both versions can give the best result.
Therefore the advice is to use both versions and analyze the results to find the optimal amount of vehicles.

The end conclusion is that the Clark & Wright model is successfully implemented in a new Delphi program, and that this program can successfully be used for demonstration and research.