Research Square

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Last mile deliveries with lockers: formulations and algorithms

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Research Article

Keywords: last mile, lockers, branch-and-cut, formulations, routing

Posted Date: May 10th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-410932/v1

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Abstract

In this paper we consider the use of lockers in parcel delivery, a recent method used in the last mile logistics. Lockers are pick up points made of several cells that are located in several points of a city where customers can collect their parcels as an alternative to home delivery. We study routing problems in which one or multiple vehicles are used to deliver parcels directly to customers or to lockers. We also study the influence of the introduction of lockers when these problems include time windows. We propose a set of novel formulations for these problems, some valid inequalities, and a branch-and-cut algorithm. Moreover, we investigate the difference between the routing problems with lockers and the classical routing problems.

Full Text

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Figures

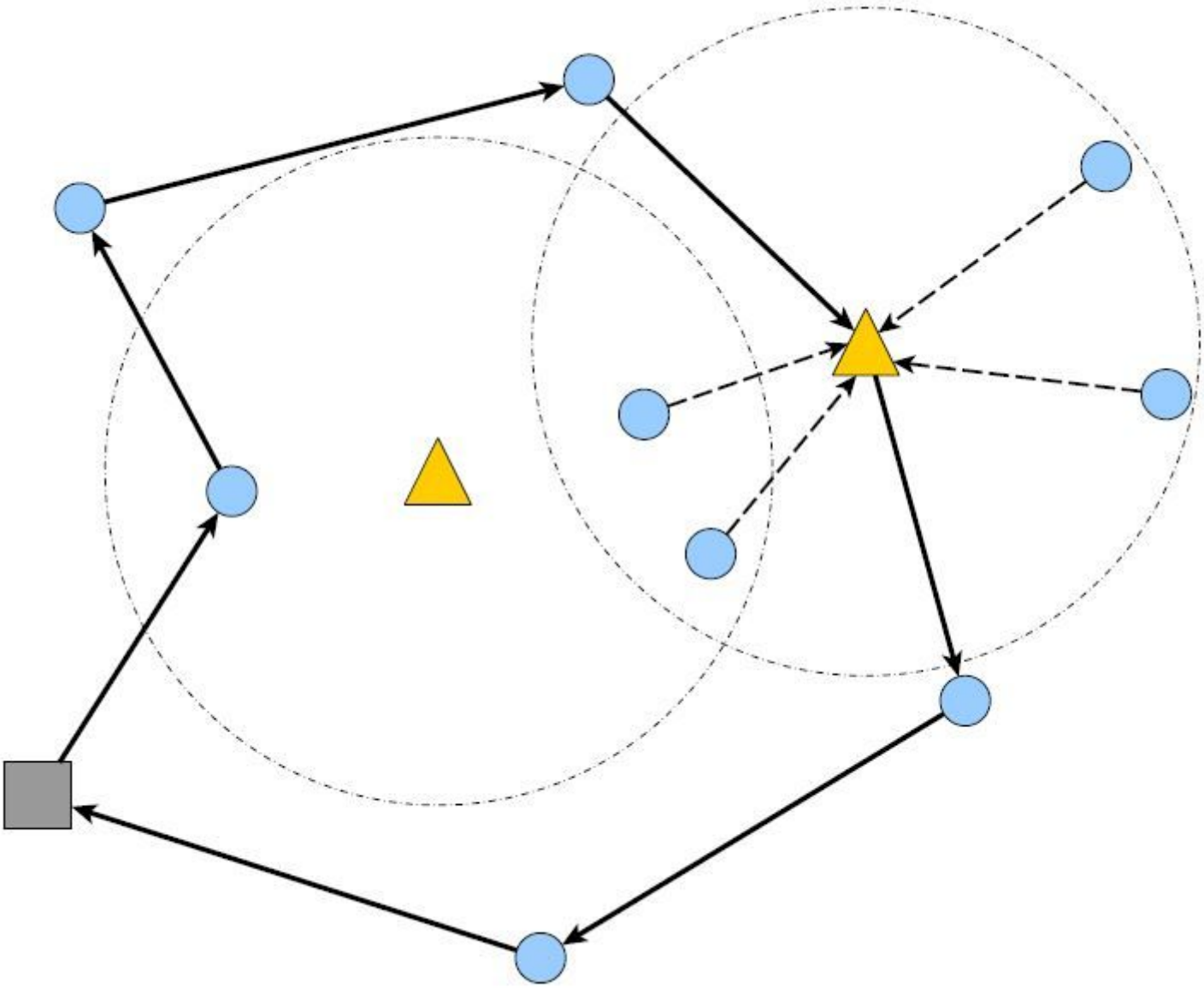

Figure 1

A feasible solution for the TSPL.

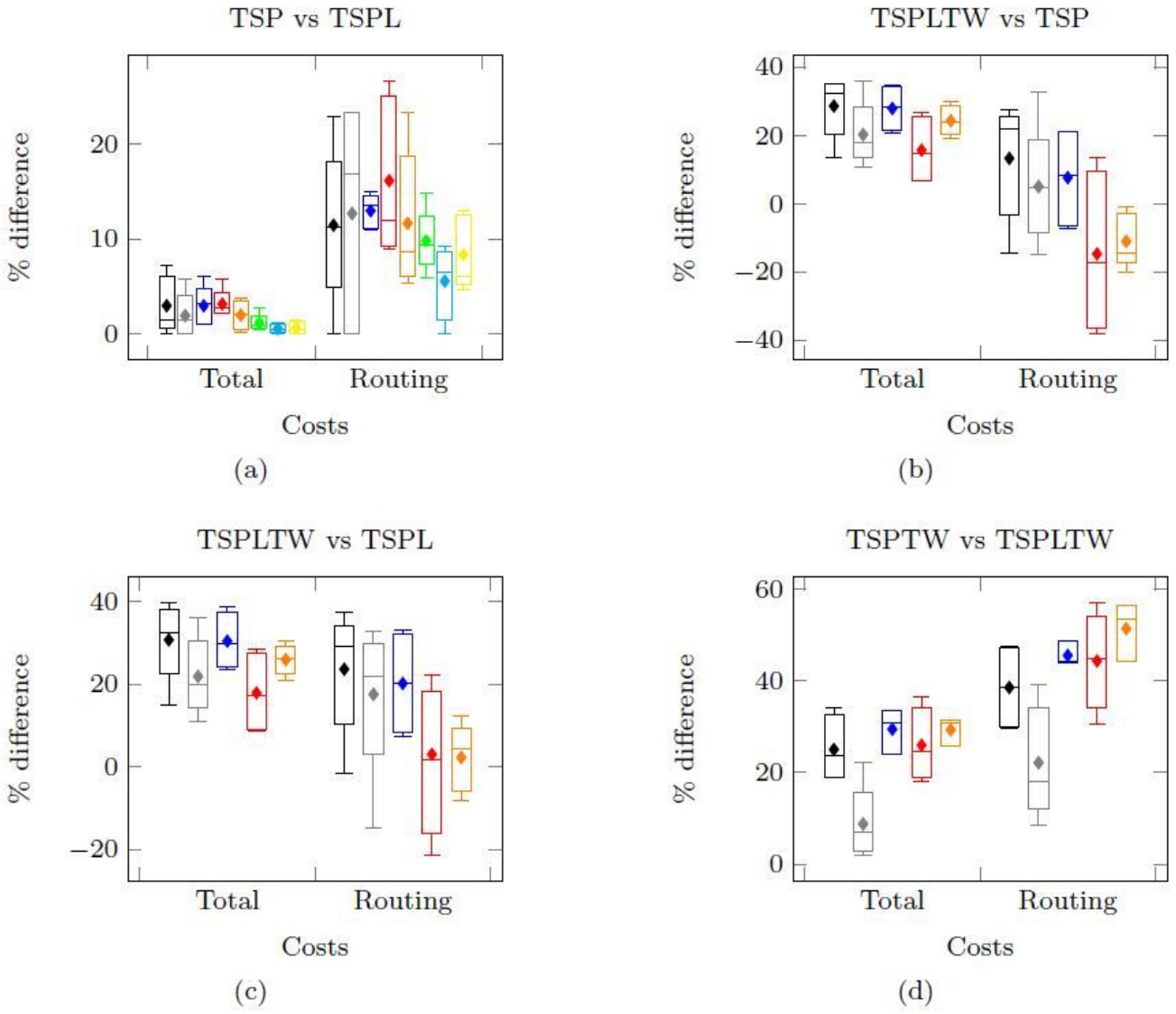

Figure 2

Increase or decrease of the total costs and routing costs with respect to the several versions of the TSP based problems solved. In black the instances with n = 20 and with the time windows of 20, in gray the instances with n20tw100, in blue n40tw20, in red n40tw100, in orange n60tw20, in green n60tw100, in light blue n100tw20, and in yellow n100tw100.

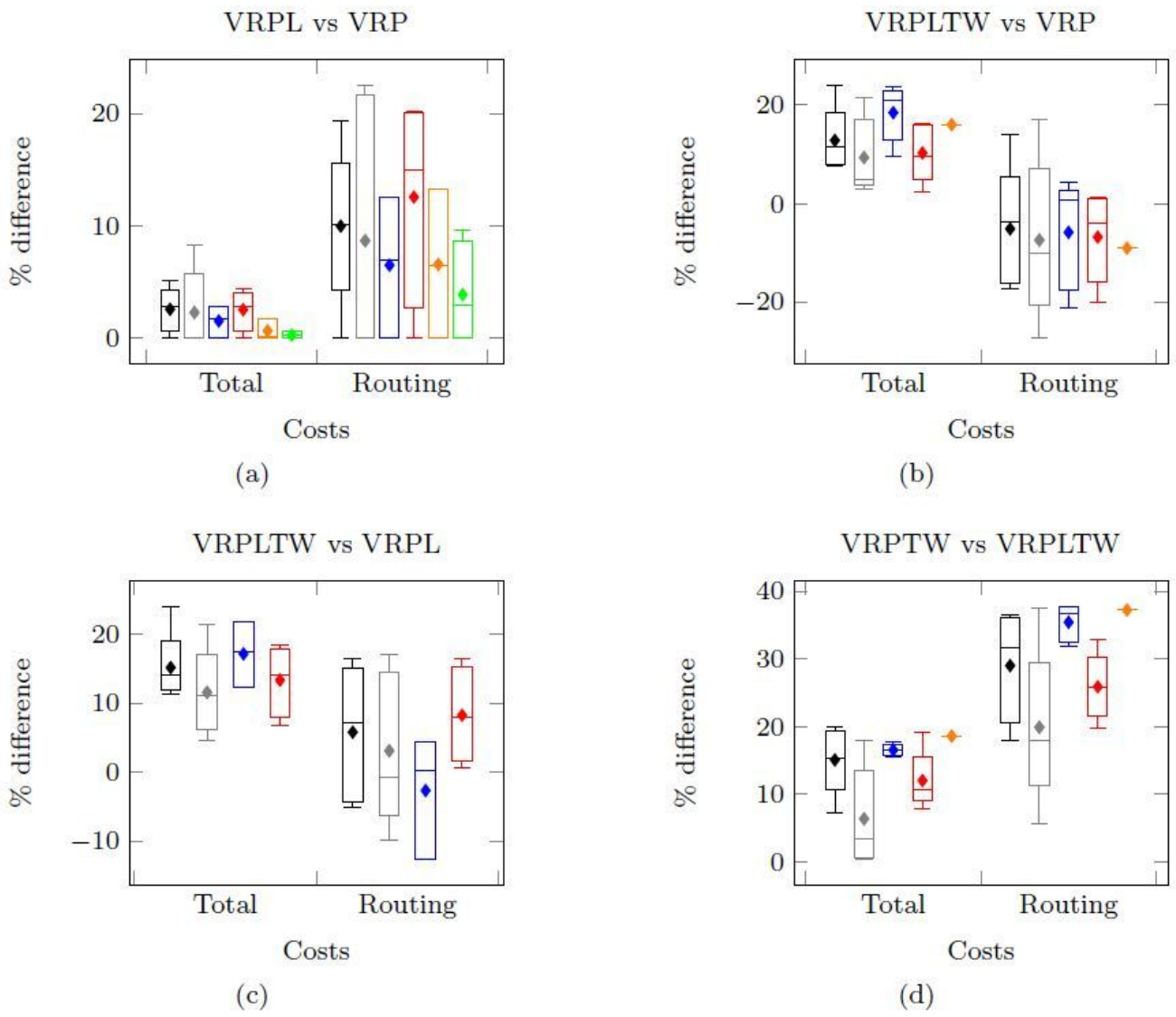

Figure 3

Increase or decrease of the total costs and routing costs with respect to the several VRP based versions of the problems solved. In black the instances with n = 20 and with the time windows of 20, in gray the instances with n20tw100, in blue n40tw20, in red n40tw100, in orange n60tw20, and in green n60tw100.

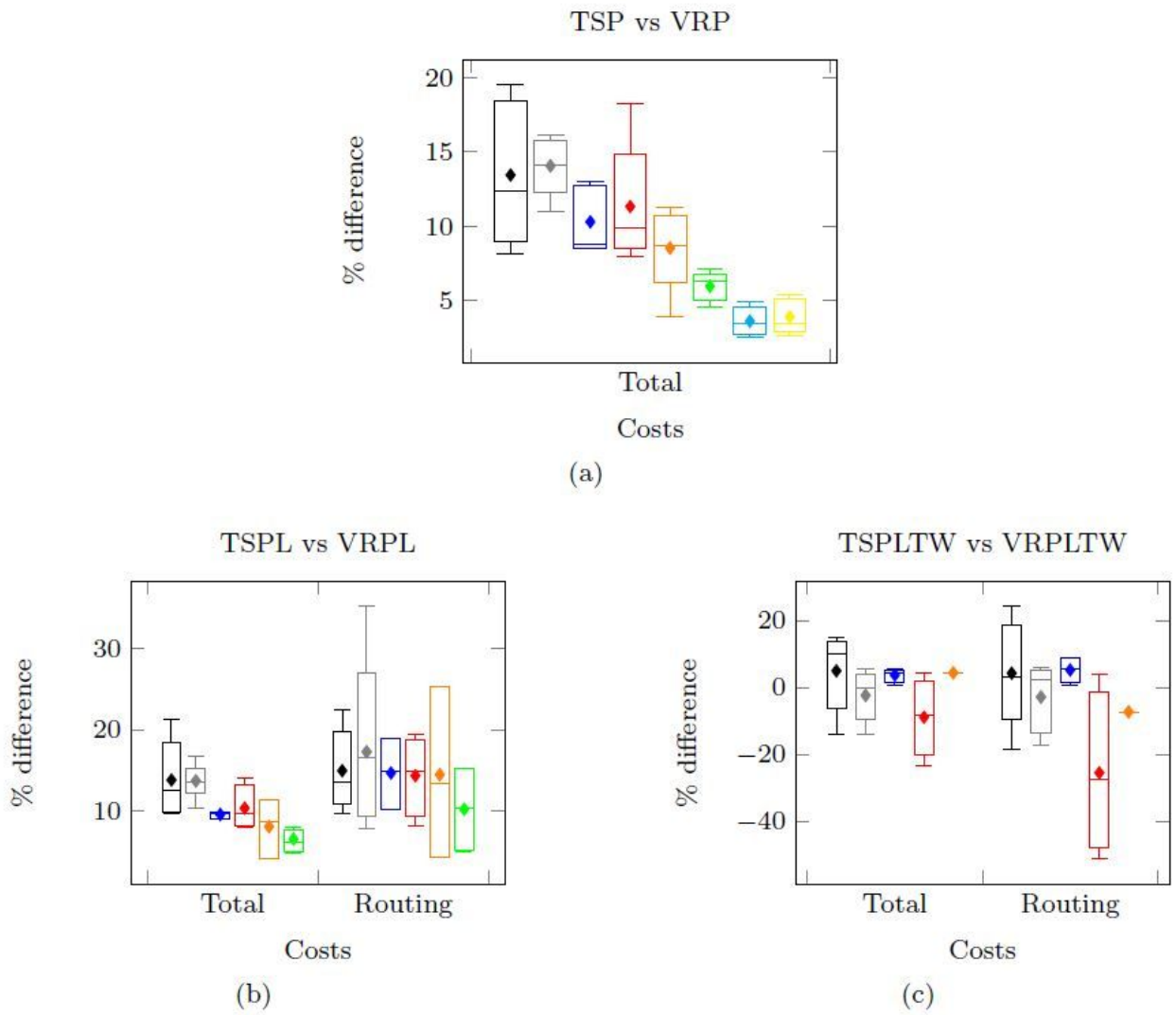

Figure 4

Increase or decrease of the total costs and routing costs with respect to the several versions of the problems solved. In black the instances with n = 20 and with the time windows of 20, in gray the instances with n20tw100, in blue n40tw20, in red n40tw100, in orange n60tw20, and in green n60tw100, in light blue n100tw100, and in yellow n100tw100.

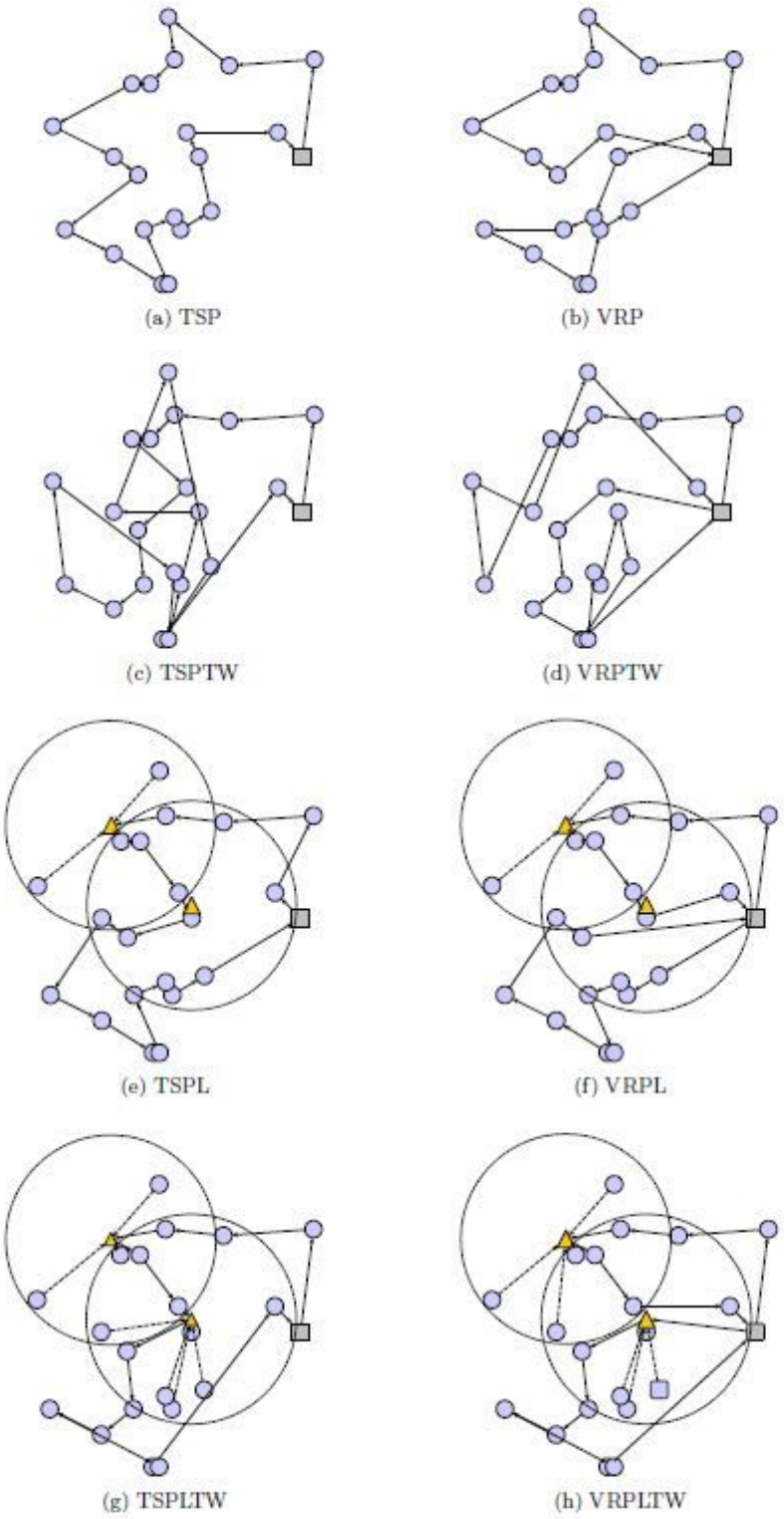

Figure 5

Graphical representation of the solutions of the studied problems on instance n20l2w20 002.

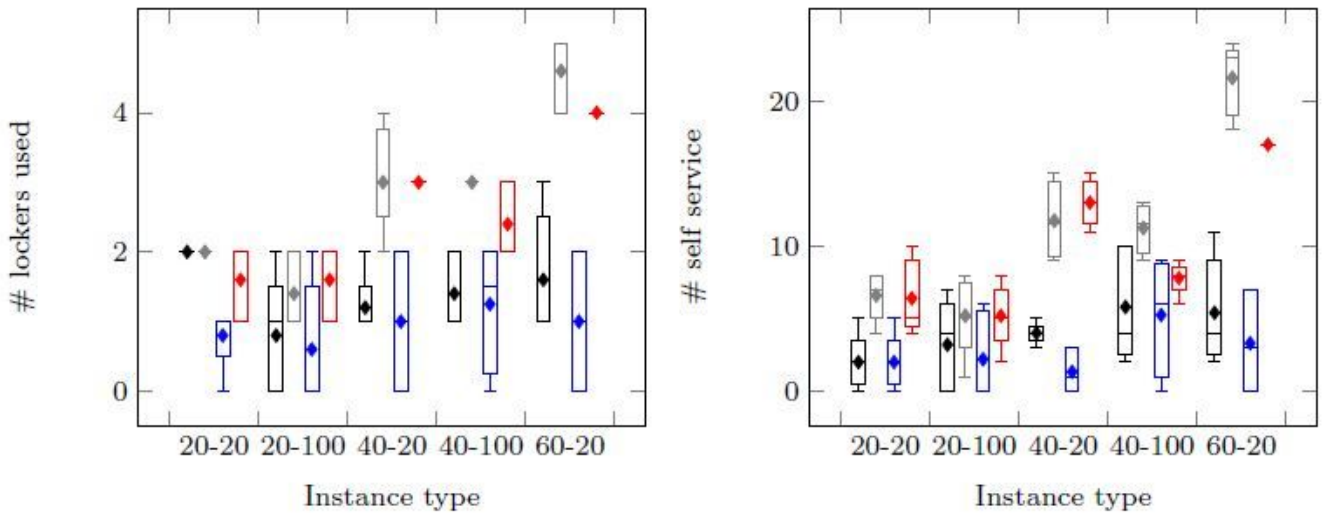

Figure 6

Number of lockers opened and customers served via locker in the optimal solution of the considered problems. In black the case of TSPL, in gray that of TSPLTW, in blue that of the VRPL, and in red that of the VRPLTW.

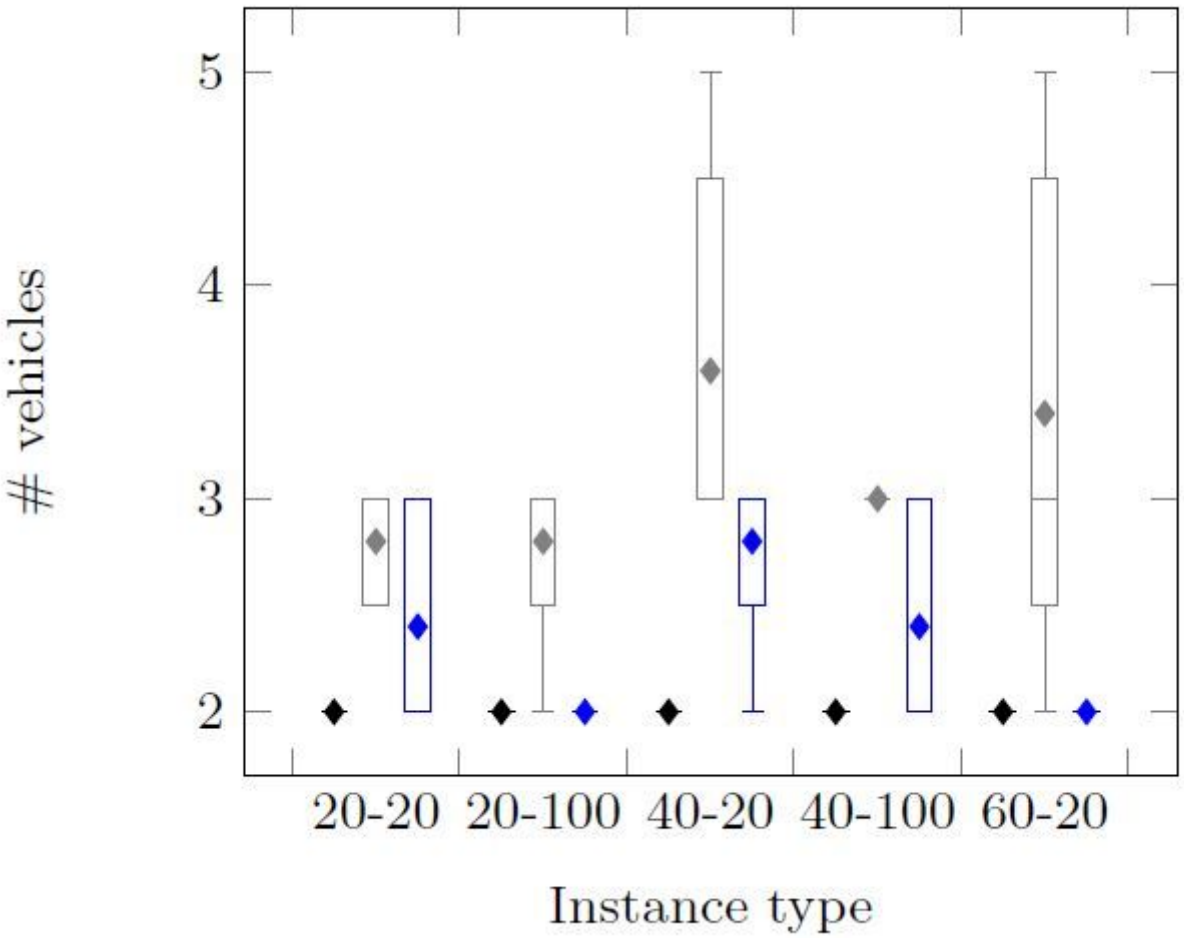

Figure 7

Number of vehicles used in the optimal solution of the considered problems. In black the number of vehicles used in the case of VRPL, in gray that of VRPTW, in blue that of the VRPLTW.