



# The cumulative capacitated vehicle routing problem with min-sum and min-max objectives: An effective hybridisation of adaptive variable neighbourhood search and large neighbourhood search



Jeeu Fong Sze<sup>a,b,\*</sup>, Said Salhi<sup>a</sup>, Niaz Wassan<sup>a</sup>

<sup>a</sup> Centre of Logistics and Heuristics Optimisation (CLHO), Kent Business School, University of Kent, Canterbury, CT2 7PE, United Kingdom

<sup>b</sup> Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

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## ABSTRACT

The cumulative capacitated vehicle routing problem (CCVRP) is a relatively new variant of the classical capacitated vehicle routing problem in which the objective is to minimise the sum of arrival times at customers (min-sum) instead of the total route distance. While the literature for the CCVRP is scarce, this problem has useful applications especially in the area of supplying humanitarian aid after a natural disaster. In this paper, a two-stage adaptive variable neighbourhood search (AVNS) algorithm that incorporates large neighbourhood search (LNS) as a diversification strategy is proposed. When tested on the benchmark data sets, the results show that the proposed AVNS is highly competitive in producing new best known solutions to more than half of the instances. An alternative but related objective that minimises the maximum arrival time (min-max) is also explored in this study demonstrating the flexibility and the effectiveness of the proposed metaheuristic. To the best of our knowledge, this is the first study that exploits the min-max objective of the CCVRP in addition to providing extensive computational results for a large number of instances for the min-sum. As a by-product of this study, managerial insights for decision making are also presented.

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## 1. Introduction

Since its establishment in more than fifty years ago, the classical vehicle routing problem (VRP) has been one of the most extensively studied topics within the area of transportation optimisation. Recently, many efforts have been taken to incorporate various attributes of real-life applications. One of these is by considering alternative objective functions such as minimising the total arrival times of the vehicles, length of the longest route, the effect of pollution (Koç et al., 2016) and so on. The VRP which takes into account practical considerations is also termed the rich VRP (Hartl et al., 2006; Goel and Gruhn, 2008; Lahyani et al., 2015) or multi-attribute VRP (Vidal et al., 2014).

This study investigates a relatively new variant of the classical VRP namely the cumulative capacitated VRP (CCVRP). Here, the objective function is to minimise the sum of arrival times (min-sum) at the customers, subject to the vehicle capacity constraint. The CCVRP is motivated by the need of servicing the customers as soon as possible. This problem

\* Corresponding author.

E-mail addresses: [J.F.Sze@kent.ac.uk](mailto:J.F.Sze@kent.ac.uk), [jfs9@kent.ac.uk](mailto:jfs9@kent.ac.uk) (J.F. Sze), [S.Salhi@kent.ac.uk](mailto:S.Salhi@kent.ac.uk) (S. Salhi), [N.A.Wassan@kent.ac.uk](mailto:N.A.Wassan@kent.ac.uk) (N. Wassan).