

Low-Carbon Tourist-Van Routing: Balancing Operating Cost and Business Performance

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Abstract

Tourist-van operators can incur unnecessary fuel expenditure and greenhouse gas emissions when attractions are visited according to an unplanned service sequence. This study develops a reproducible low-carbon Traveling Salesman Problem framework that evaluates routing, environmental, and business performance simultaneously. The method is used as the current-practice baseline and is compared with Nearest Neighbor-2-Opt, Genetic Algorithm-2-Opt, and a proposed random-key Differential Evolution-2-Opt. A full factorial design considers 10, 15, and 20 attractions; low, medium, and high traffic levels; and carbon-reduction targets of 0%, 5%, and 10%. Three deterministic synthetic coordinate instances are generated for each of the 27 scenarios, producing 81 problem instances. The two stochastic algorithms are executed for 30 independent runs per instance. Compared with current-practice, the proposed method reduces average route distance by approximately 55.5% and mean carbon emissions by 52.0%, while decreasing fuel cost by THB 627.47 per trip. The resulting operating contribution after fuel cost increases by the same amount, or approximately 33.5%. Differential Evolution-2-Opt obtains the shortest average route of 129.38 km and the highest average operating contribution of THB 2,497.79. A Friedman test identifies an overall difference among the four methods ($Q = 21.433$, $p < 0.001$), while Nemeyi comparisons show that the proposed method significantly outperforms current-practice but not the other optimized methods. These preliminary findings demonstrate the joint environmental and operating potential of planned routing, subject to the limitations of synthetic coordinates, distance-based emissions, and an unplanned current-practice baseline.

Keywords

Traveling salesman problem, low-carbon transportation, tourist-van routing, differential evolution, operating contribution.