ABSTRACT

In this project, project team has addressed a particular VRP variant faced by the E-Bebek company. The company aims at matching orders with the delivery vehicles in their fleet and determining the vehicle routes by respecting the delivery time requirements such that total operational costs are minimized. The project team have prepared a model for the problem using Linear Programming and solved it using a solver based on the data provided by the company. The team have also designed a heuristic method, coded it using Python programming language. The whole system is integrated within a decision support system (DSS) which manages the database, visualizes the route plans, and allows what-if analyses except heuristic algorithm which is not fully completed. The Gurobi Optimizer is utilized to formulate and solve the problem, considering factors such as time windows and vehicle constraints. Additionally, the Genetic Algorithm provides a heuristic approach to efficiently explore and search for near-optimal solutions. By incorporating both optimization techniques, we aim to minimize the total distance traveled, optimize resource allocation, and adhere to time windows for deliveries. This project has developed and implemented a DSS which is using GVRPTW with a Mixed Fleet route optimization model for E-Bebek company. This DSS is reducing related delivery costs, improving delivery efficiency and meeting customer demands within their expectations. Additionally, it is visualizing the optimal routes in a map and reporting the solutions with analysis. In conclusion, by utilizing the Gurobi optimizer as a mixed-integer linear programming (MILP) model, we achieved substantial enhancements in route planning and optimization, as the solver efficiently provided near-optimal solutions within the computational time limits.

PROJECT DETAILS

The first objective focuses on creating a vehicle routing plan that efficiently plans routes to minimize travel distance, resulting in cost savings and improved operational efficiency. Another crucial objective is to provide the company with a visual representation of the proposed vehicle route, allowing for easy understanding and evaluation. Lastly, we will analyze the proposed vehicle route and compare it with the existing routes currently used by the company, identifying potential improvements and assessing the overall efficiency gains that can be achieved.

CONCLUSION

The objective function (1) aims to minimize the total costs associated with routing and visiting customers. The visiting cost is incurred when a truck serves multiple customers, and the objective is to minimize this cost. Constraint (2) ensures that each customer can be visited by only one vehicle. Constraints (3) and (4) guarantee that every vehicle starts its tour from the depot and ends at a dummy destination point. Constraints (5) and (6) serve the same purpose as (3) and (4) but are included to reduce solution time without changing the solution itself. Constraints (7) and (8) state that if a vehicle uses a route segment between nodes and , it must visit both i and j. Constraint (9) ensures that the number of vehicles entering and leaving a node is equal. Constraint (10) limits the total demand served by each vehicle to not exceed its capacity. Constraint (11) determines the most expensive visited node for calculating the routing cost in the objective function. Constraint (12) ensures that a vehicle can travel between nodes i and j using only allowed arcs due to clustering. Constraints (13) and (14) represent time window constraints that ensure arrival times at customer nodes fall within specific time windows.

REFERENCES


Fig. 1. Visualization output of Decision Support System

Fig. 2. Mathematical Representation of Optimization Model

Fig. 3. Comparison of Existing Vehicle Routes with Proposed Vehicle Routes

The Gurobi solution obtained for April 6, 2022, shows that the company utilized 10 vehicles to distribute orders, covering a total distance of 683.236 km at a cost of 19,441.98 Turkish liras. Our optimization resulted in a reduction in total traveled distance to 534.009 km, costing 14,568.58 Turkish lira, reflecting a 21.84% decrease in distance and a 25.06% decrease in cost for that day with 7 vehicles.