INTISARI

Model *location routing problem* (LRP) merupakan salah satu model matematis yang penting pada *distribution network*. Tujuan dari model ini adalah untuk menentukan lokasi fasilitas distribusi dan *vehicle routing*. Dengan pertumbuhan jumlah *customer* yang semakin meningkat, maka model LRP harus mampu memastikan efektivitas dan efisiensi koneksi antara produsen dan *customer* dengan tetap memaksimalkan *customer satisfaction* melalui responsivitas terhadap permintaan *customer*. Oleh karena itu, model dasar LRP perlu dikembangkan. Pada penelitian ini, model LRP dikembangkan dengan menerapkan beberapa skenario, seperti *multi compartment, multiple trips, split delivery,* dan *time windows*. Model LRP dengan pertimbangan skenario tersebut disebut dengan *Multi-Objective Multi Compartment Multiple-Trip Split Delivery Location Routing Problem with Time Windows* (MOMCMTSDLRPTW). Fungsi tujuan yang dipertimbangkan pada model tersebut adalah minimasi *total cost* dan maksimasi *service level.* Model MOMCMTSDLRPTW juga telah mempertimbangkan aspek *demand uncertainty* melalui *chance constraint programming* sehingga model dapat merepresentasikan kondisi nyata dengan lebih baik.

Pada *problem size* yang besar, diperlukan metode metaheuristik untuk mengoptimasi model MOMCMTSDLRPTW. Algoritma metaheuristik yang digunakan pada penelitian ini adalah *Non-Dominated Sorting Genetic Algorithm-II* (NSGA-II). Informasi yang terdapat pada kromosom NSGA-II di antaranya adalah urutan penggunaan kendaraan, urutan penggunaan *distribution centre* (DC), urutan kunjungan *retailer*, *push break* dan jam keberangkatan kendaraan. Algoritma NSGA-II yang dikembangkan pada penelitian ini lebih unggul dibandingkan Algoritma NSGA-II yang dikembangkan pada penelitian sebelumnya terutama pada indikator *generational distance* (GD), *hyper area* (HA), *ratio of nondominated individual* (RNI), dan *error ratio* (ER). Selain itu, algoritma NSGA-II mampu menghasilkan solusi yang berada pada *true pareto front.*

Analisis lanjutan juga dilakukan dengan menganalisis nilai fungsi tujuan dan dengan melakukan analisis sensitivitas terhadap parameter model. Tujuan dari analisis lanjutan ini adalah untuk mengetahui korelasi antara *service level* dengan utilitas kendaraan serta mengetahui pengaruh jarak, durasi *time windows,* jumlah *demand,* standar deviasi *demand*, jumlah *trip,* skenario *split* dan *unsplit delivery,* serta jumlah *push break* terhadap nilai fungsi tujuan optimal yang dihasilkan.

Kata kunci: *multi-objective location routing problem* (MLRP), *split delivery, multi compartment, multiple trips, service level, time windows, demand uncertainty, Non-dominated Sorting Genetic Algorithm* (NSGA) II

ABSTRACT

The Location Routing Problem (LRP) model is considered a significant mathematical model in distribution networks. The purpose of this model is to determine the location of distribution facilities and vehicle routing. With the increasing number of customers, the LRP model must be able to ensure the effectiveness and efficiency of connections between producers and customers while still maximizing customer satisfaction through responsiveness to customer demand. Therefore, a basic LRP model needs to be developed. In this research, the LRP model was developed by applying several scenarios, such as multi compartment, multiple trips, split delivery, and soft time windows. The LRP model considering these scenarios is called Compartment Multiple-Trip Split Delivery Location Routing Problem with Time Windows (MOMCMTSDLRPTW). The objective function considered in this model is minimizing total costs and maximizing service level. In this research, the MOMCMTSDLRPTW model also considers the demand uncertainty aspect through chance constraint programming so that the model can better represent real conditions.

For large problem sizes, a metaheuristic method is needed to optimize the MOMCMTSDLRPTW model. The metaheuristic algorithm used in this research is Non-Dominated Sorting Genetic Algorithm-II (NSGA-II). The information contained in the NSGA-II chromosome includes the order of vehicle use, the order of *distribution centre* (DC) use, the order of *retailer* visits, push breaks, and the departure time of the vehicle's first trip. The NSGA-II algorithm developed in this research is superior to the NSGA-II algorithm developed in previous research, especially in the generational distance (GD), hyper area (HA), ratio of nondominated individual (RNI), and error ratio (ER) indicators. In addition, the NSGA-II algorithm can produce solutions that are on the true Pareto front.

Further analysis is also carried out by analyzing the objective function values and performing sensitivity analysis of the model parameters. The purpose of this further analysis is to determine the correlation between service level and vehicle utility and to determine the influence of distance, time window duration, number of demands, standard deviation of demand, number of trips, split and unsplit delivery scenarios, and number of push breaks on the value of the optimal objective function generated.

Keywords: *multi-objective location routing problem* (MLRP), *split delivery, multi compartment, multiple trips, service level, time windows, demand uncertainty, Non-dominated Sorting Genetic Algorithm*- II (NSGA-II)