ABSTRACT

Reverse logistics management of used batteries, particularly Nickel Manganese Cobalt (NMC) batteries, is an important challenge in supporting sustainability and circular economy in Indonesia. PT XYZ, as a distributor, faces the problem of determining the optimal collection point to minimize transportation costs. This study develops a Mixed Integer Linear Programming (MILP)-based mathematical model to optimize the determination of NMC used battery collection points in PT. XYZ's distribution network, with the aim of minimizing total transportation costs. This model assumes that consumers are willing to deliver used batteries independently to the collection point. The study employs a quantitative approach using primary data from expert interviews and secondary data sourced from Google Maps and the Central Bureau of Statistics (BPS). The research focuses on the West Java region, which is characterized by a high number of vehicles and a large population. The MILP model incorporates variables such as demand volume, dealer capacity, and inter-regional distribution distances The objective function of the model is to minimize the total transportation cost while maintaining the fulfillment of all demands, furthermore the model is implemented through Google Colab with PuLP library. Verification and validation were conducted through five debugging runs to ensure that the model works properly and realistically. In addition, sensitivity analysis was conducted to see the model's response to changes in cost and capacity parameters. The results showed that the MILP model can significantly produce optimal allocation locations. The 18 dealers selected as collection points were able to accommodate 23,772 requests without exceeding capacity and were able to take into account the selection of dealers with optimal distance to minimize transportation costs. Simulations show that this approach is effective in supporting reverse logistics and creating economic value from waste batteries. The recommendations of this model are expected to be applied on an industrial scale and form the basis of a sustainable waste battery management policy in Indonesia.

Keywords: *Reverse Logistics, NMC Batteries, MILP, CFLP, Battery Return*