ABSTRACT

This study aims to optimize the distribution routes of precast concrete products at PT XYZ using the Vehicle Routing Problem (VRP) approach, which considers actual operational characteristics in the field. PT XYZ faces excessive distribution and fuel (BBM) costs, primarily due to suboptimal routing. To address this issue, the model developed in this research incorporates multiple key features, including heterogeneous fleet, multiple products, split delivery, multiple trips, and time windows—each aligned with the specific distribution challenges faced by PT XYZ.

The problem was solved using the Sequential Insertion method, a heuristic approach capable of efficiently handling complex delivery scheduling. This method was implemented through Python programming designed to evaluate and generate optimal routes based on actual conditions. The mathematical model includes four primary objective functions: minimizing the number of active vehicles (NV), minimizing total completion time (TCT), minimizing the range between the earliest and latest completion times (RCT), and minimizing total distribution cost (TCD). The TCD components consist of fixed vehicle costs, fuel (BBM), driver wages, loading, retribution, and accommodation costs.

Verification and validation were conducted for all 25 mathematic model to ensure the model's accuracy and feasibility in real-world distribution scenarios. The computational results demonstrate that the proposed model successfully improves distribution efficiency. Compared to the existing routes used by PT XYZ, the proposed routing solution reduces distribution costs by 18,7%, from IDR 39,797.520 to IDR 32.365.934, and cuts the total travel distance by 1398 kilometers. These findings indicate that the chosen approach effectively optimizes resource usage and minimizes waste in the delivery process.

Sensitivity analysis was conducted on two scenarios: changes in vehicle capacity and fuel price increases. The results show that the model continues to provide feasible solutions up to a 20% reduction in vehicle capacity, where all deliveries remain on time. Beyond a 25% reduction, the model fails to generate viable routes due to the planning horizon constraint of one day. In the second scenario,

sensitivity analysis on fuel price increases shows that total fuel costs remain below the IDR 900,000 threshold up to the 12th scenario (50% increase). However, in the 13th scenario (60% increase), fuel costs exceed the acceptable limit, indicating that the model's tolerance for BBM price increase is up to 55%. This research makes a significant contribution to improving logistics efficiency in distribution planning by combining complex VRP features with an adaptive algorithmic approach..

Keywords – Vehicle Routing Problem, Sequel Insertion, Cost Distribution