Two-Phase Iterative Approach for Dairy Transportation Problem

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1 Introduction

This study focuses on the dairy transportation practice in Indonesia. Commonly managed by local cooperatives, *Gabungan Koperasi Susu Indonesia*, these cooperatives manage the collections, processing, and deliveries of milk are performed by a set of vehicle fleets. In collecting milk from farmers, the quality of milk needs to be preserved within limited travel time to avoid any bacteria-related deterioration. As such, maximizing the deployed vehicles' capacities might be impossible unless the collected milk is stored into the so-called external cooling facility. The vehicle fleets are re-deployed to transport the pre-processed milk to the companies producing dairy products e.g. cheese and ice cream.

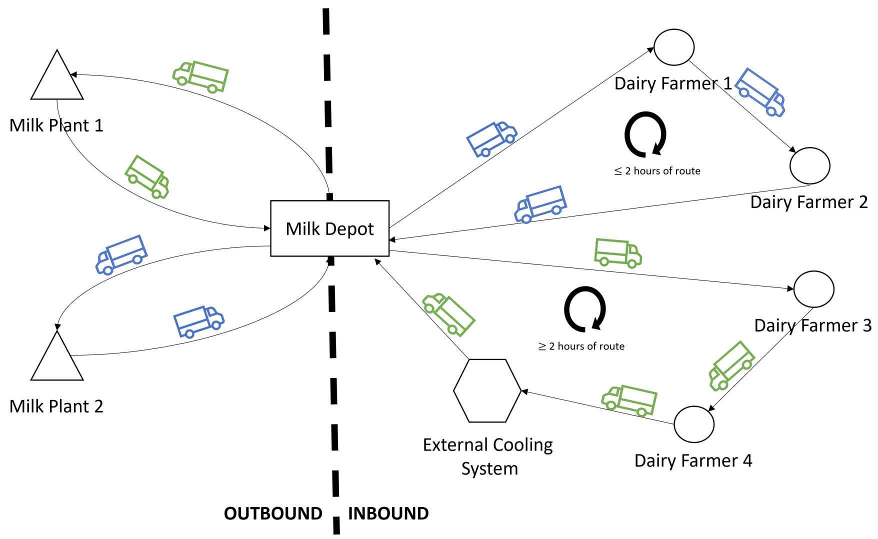

FIG. 1 – Dairy Transportation [1]

As depcited in FIG. 1, the inbound part of the problem consists of a milk depot having a fleet of vehicles that is deployed to collect milk from farmers. Due to their capacity, each vehicle has possibility to visit more than one farmer to form a route. However, the vehicles used in the outbound part do not visit more since each is in Full-Truck-Load mode due to the consolidation performed in the milk depot. As the problem treats fresh dairy products, all processes involved must be done within one day and no inventory is considered.

2 Solving Algorithm and Result

Two-Phase Iterative Approach [2] was implemented to provide better solutions compared to the previous algorithm in [1]. It decomposes the problem into allocation and routing subproblems. The allocation subproblem, as depicted in FIG. 2, aims to allocate each dairy farmer to a vehicle using new parameters called *approximate visiting times* based on the routing decisions. These estimate the traveling time of a vehicle to visit a dairy farmer and updated throughout the iterations of the algorithm. According to the result of the allocation problem obtained with a commercial solver, Gurobi, the routing subproblem of each vehicle is constructed using Lin-Kernighan heuristic. The pseudocode is provided in Algorithm 1.

Following our preliminary test, the algorithm provides a mean gap of 2.43 % against the optimal solutions while it also outperforms the method proposed in [1] by 4.07 % and 86.31 % in terms of objective value and computational time, respectively.

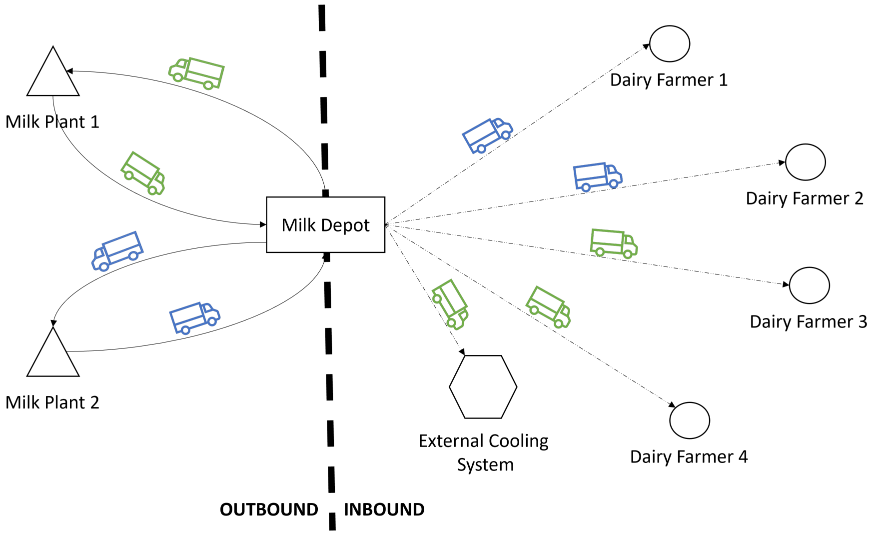

FIG. 2 – Allocation Subproblem

Algorithm 1 Two-Phase Iterative Approach

Set *approximate visiting times*, $max_{iter}, max_{diver}, max_{start}$;
$i_{iter}, i_{diver}, i_{start} \longleftarrow 0$;
while $i_{start} \leq max_{start}$ **do**
    while $i_{diver} \leq max_{diver}$ **do**
        while $i_{iter} \leq max_{iter}$ **do**
            Solve the Allocation and Routing Subproblems ;
            Update the best solution and *approximate visiting times* ;
        end while
        Diversify *approximate visiting times* ;
        Update the best solution ;
        $i_{diver}++$;
    end while
    Randomize *approximate visiting times* ;
    Update the best solution ;
    $i_{start}++$;
end while
Return the best solution.

Références

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