Improved Collaborative Transport Planning at Dutch Logistics Service Provider Fritom

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Content

Introduction

- This paper discusses the collaboration between two business units of Fritom -a Dutch logistics service provider- and alternatives to improve its collaborative transport planning.
- Fritom consists of business units that provide a range of logistics services, such as warehousing, value-added logistics, liquid-food logistics, freight forwarding, and freight transportation.
- Annual turnover of over 150 million euros..

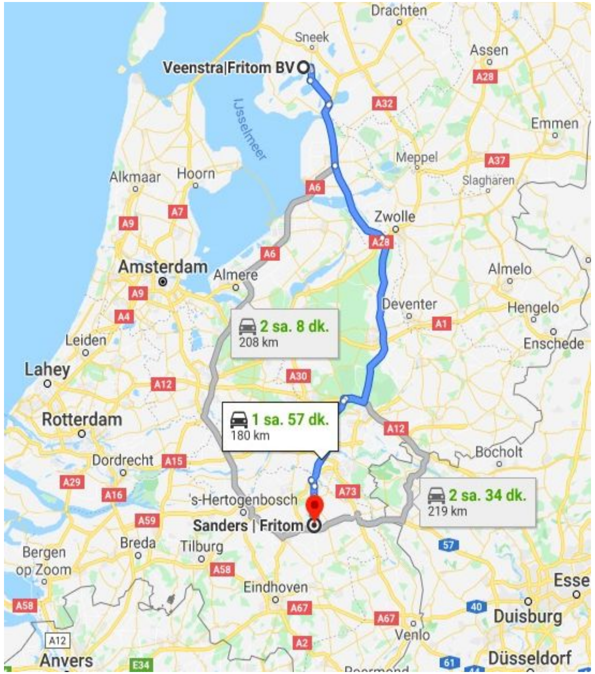
Introduction

- Two of their business units(Veenstra and Sanders) started to collaborate in providing domestic transportation services.
- The new joint network consists of two depots that serve as a home base for trucks and can be used for transporting loads from pickup to delivery locations.
- The combination of such network led to a new type of vehicle routing problem, which had not been addressed in the literature.

System Analysis

- Veenstra is located in North Holland whereas Sanders is located in South Holland.
- Transactional data from 2012 states that Veenstra received about 300 requests each day and Sanders received about 500.
- The requests vary in load size, time restrictions, and pickup and delivery locations but the majority of requests specify a small load.
- The average load size is less than three Euro-pallets*.

**(A Euro-pallet is a four-way pallet that measures 1,200 × 800 × 144 millimeters)*



System Analysis

- The problem of planning Fritom's domestic transportation is the construction of routes to pick up and deliver loads, as specified in the requests received.
- The objective is to minimize the overall transportation costs, for which the total travel distance is a key driver.
- A load can be transported directly from its pickup to its delivery location or it can be redirected to a depot and stay overnight.

System Analysis

- Redirecting is applied for two reasons:
- 1)Enhances the opportunities for consolidation and enables planners to identify opportunities easily.
- 2)Redirecting loads to depot enables load inserting of new requests into already planned transportation routes.
- However, in 2012, 3% of Fritom's requests did not allow for transportation with an overnight stay so the planners seek opportunities to reduce transportation costs by directly transporting loads that would in principle allow for an overnight stay.

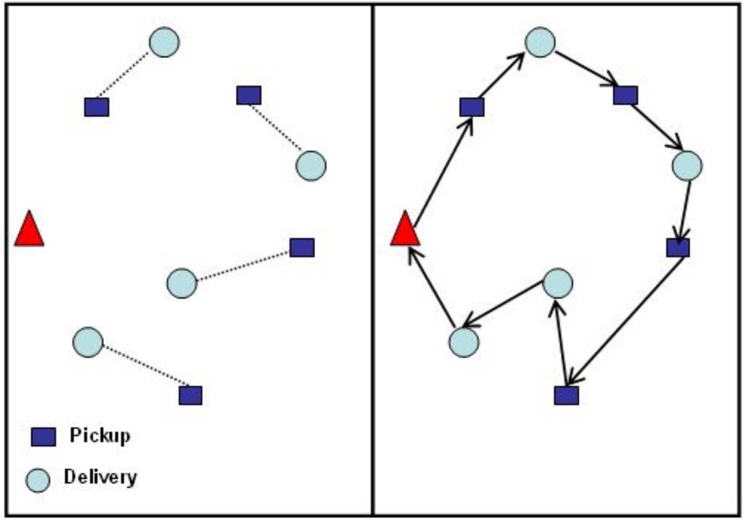
System Analysis

- Fritom believes that this flexibility in routing provides a strong competitive advantage because it results in low transportation costs and high service levels.
- The exchange of delivery between the depots is facilitated by a shuttle service. The shuttle has a fixed daily capacity of two truckloads with preset departure times in the evening and transferred loads are added into next days route
- Each business unit decides autonomously which of its delivery loads are to be fulfilled by the other business unit i.e. planners at Veenstra start considering loads with the most southern delivery location until both shuttle trailers are fully loaded.

Literature Review

- Berbeglia et al. (2007) and Parragh et al. (2006, 2008) each propose a scheme to classify pickup and delivery problems into two unique problem classes: the pickup and delivery problem (PDP) and the vehicle routing problem with backhauls (VRPB).

- Solution approaches for larger instances exist for the dial-a-ride problem (DARP), which considers the transportation of persons instead of goods. Masson et al. (2013) propose a heuristic for instances up to 193 requests.



Problem Definition

01 Single or Multiple Routes

- If multiple routes is chosen, number of depots and the specific depots the load should be redirected, and the planning period should be determined.
- With multiple periods, the GPDP chooses the best depot to be redirected but the characteristics of a particular request can result in multiple feasible fulfillment options.

02 Transportation Requests

For each load, a transportation request specifies its size, origin, destination, and time windows for visiting the origin and destination.

03 Vehicles

- Each of the multiple depots has a fleet of vehicles to operate the routes.
- Each vehicle has a given capacity, which may differ among vehicles.
- A vehicle starts and ends its route at a specified depot and visits a number of locations to pick up and deliver loads.
- During a route, the vehicle is allowed to visit one or multiple depots for the transshipment of loads

Model

objective function

$$\min \sum_{v_i \in V} \sum_{v_j \in V} \sum_{k=1}^{m} \sum_{v_o \in V^{DEP}} c_{ij} x_{ijko} + \sum_{l=1}^{p} \bar{c}\bar{r}_l \qquad (1)$$

minimize the sum of

1) vehicle cost

2) shuttle trailer cost

constraints

$$\sum_{v_o \in V^{DEP}} y_{io} = 1, \quad v_i \in V^{CST}, \tag{2}$$

$$\sum_{v_j \in V} \sum_{k=1}^{m} x_{ijko} - y_{io} = 0, \quad v_i \in V^{CST}; \quad v_o \in V^{DEP}, \tag{3}$$

$$\sum_{v_j \in V} x_{ojko} \leq 1, \quad v_o \in V^{DEP}; \ k = 1, \ldots, m, \tag{4}$$

$$\sum_{v_j \in V} x_{ijko} = 0, \quad v_o \in V^{DEP}; \ v_o \neq v_i; \quad k = 1, \ldots, m, \tag{5}$$

$$\sum_{v_j \in V} x_{jiko} - \sum_{v_j \in V} x_{ijko} = 0, \quad v_i \in V; \ v_o \in V^{DEP}; \quad k = 1, \ldots, m, \tag{6}$$

$$\sum_{v_i \in V} \sum_{v_j \in V} q_i x_{ijko} \leq Q, \quad v_o \in V^{DEP}; \quad k = 1, \ldots, m, \tag{7}$$

$$\sum_{v_i \in V} \sum_{v_j \in V} (t_{ij} + \tau_i) x_{ijko} \leq T, \quad v_o \in V^{DEP}; \quad k = 1, \ldots, m, \tag{8}$$

$$\sum_{v_i \in S} \sum_{v_j \in S} x_{ijko} \leq |S| - 1 \quad S \in V^{CST}; \ |S| \geq 2; \quad v_o \in V^{DEP}; \ k = 1, \ldots, m, \tag{9}$$

$$\sum_{v_o \in V^{DEP}} \alpha_{io} y_{io} + \sum_{l=1}^{p} r_{il} = 1 \quad v_i \in V^{CST}, \tag{10}$$

$$\sum_{i \in V^{CST}} \alpha_{io} q_i r_{il} \leq \tilde{Q} \tilde{r}_l, \quad v_o \in V^{DEP}; \quad l = 1, \ldots, p, \tag{11}$$

$$x_{ijko} \in \{0, 1\}, \quad v_i \in V; \ v_j \in V; \ v_o \in V^{DEP}; \quad k = 1, \ldots, m, \tag{12}$$

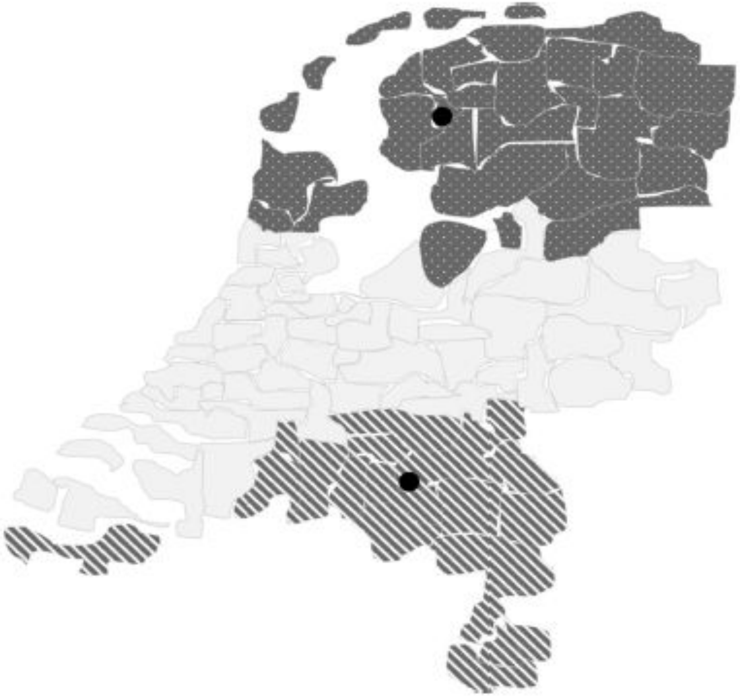
$$y_{io} \in \{0, 1\}, \quad v_i \in V; \ v_o \in V^{DEP}, \tag{13}$$

$$r_{il} \in \{0, 1\}, \quad v_i \in V^{CST}; \ l = 1, \ldots, p, \tag{14}$$

$$\tilde{r}_l \in \{0, 1\}, \quad l = 1, \ldots, p. \tag{15}$$

Proposed Configurations

Configuration 1: Fixed Geographical Division



Configuration 2: Variable Geographical Division

comparison

Configuration 1

- fixed geographical divisions
- each delivery areas to be visited only by one depot
- empty shuttle trailers
- better in terms of delivery routes

Configuration 2

- geographical division can vary from day to day
- allows delivery areas to be visited from both depots.
- less shuttle routes
- better in terms of shuttle routes

comparison

	Initial request allocation: No collaboration	Configuration 1: Fixed geographical division	Configuration 2: Variable geographical division
Delivery routes (km)	4, 837, 040	3,087,941	3,238,798
Shuttle routes (km)	—	787,752	434,322
Total travel distance (km)	4837, 040	3,875,693	3,673,120

Each of our proposed configurations considerably reduces the yearly total travel distances for both **delivery** and **shuttle routes**.

Configuration 2 significantly outperforms configuration 1.

Implementation Process

1) increase the number of shuttles two to ten
2) automize the system
3) minor redesign of the depots’ internal layout and workforce planning to cope with handling loads from the shuttle trailers.

- the expected cost saving is about € 255,000

Additional Examples

Sombuntham, Pandhapon & Kachitvichyanukul, Voratas. (2010). Multi-depot Vehicle Routing Problem with Pickup and Delivery Requests. AIP Conference Proceedings. 1285. 10.1063/1.3510581.

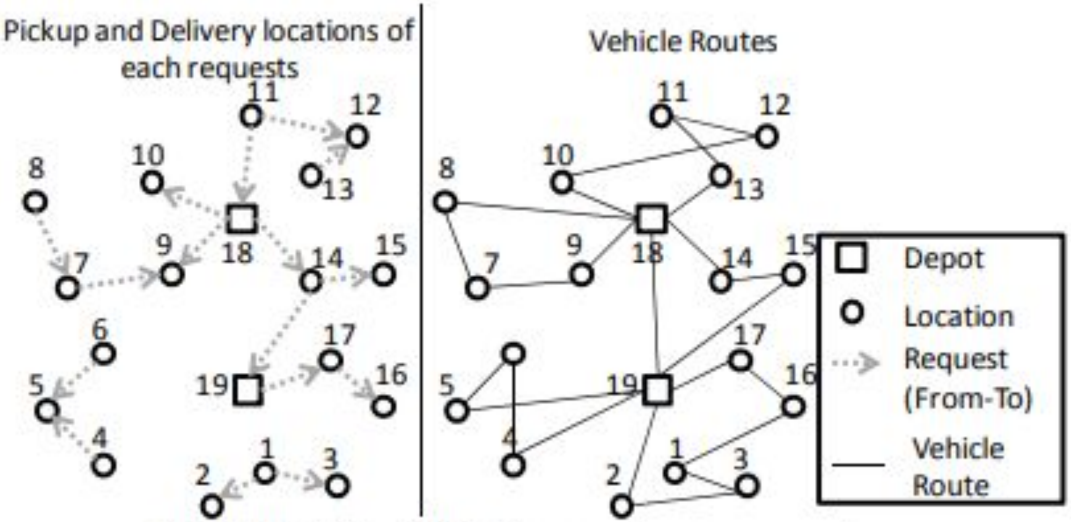
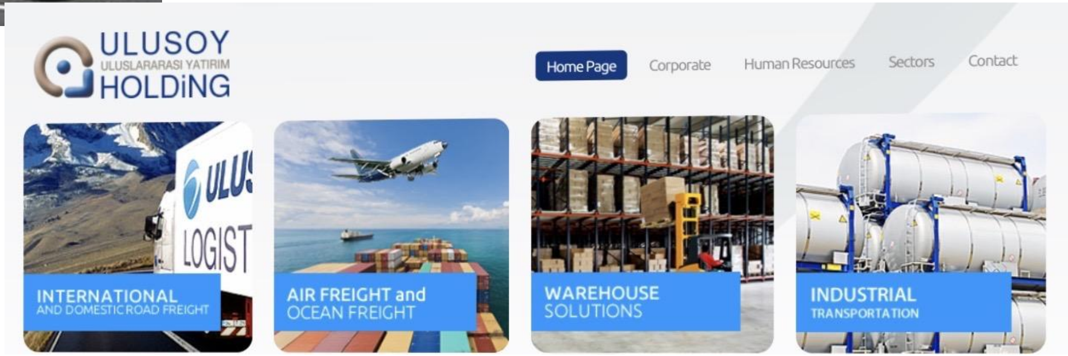


FIGURE 1. The VRP with many-to-many requests.

Examples in Turkey



Future Outlook

The experiments showed that configuration 2 (i.e., variable geographical division) significantly outperforms configuration 1 (i.e., fixed geographical division).

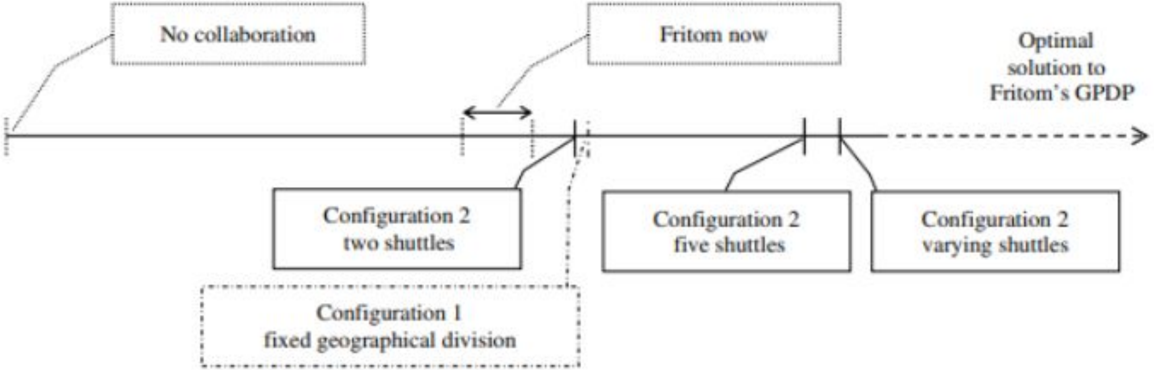


Figure 3: Fritom has realized large efficiency improvements in domestic transportation through the collaboration between V|F and S|F. It can realize additional improvements by restructuring and strengthening this collaboration.

THANK YOU!