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Improving collection flows in a public postal network with contractor's obligation considerations

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ABSTRACT

We examine a problem that arises in the postal industry of developing goods collection routes that are subjected to a bidding process where the price is positively correlated to routes operating complexities. The route complexity would delay the arrival of goods to distribution centers and prevent their deliveries to processing plants within the required time windows. We formulate the problem as a variant of the multiple depot vehicle routing problem with time windows. The ant colony optimization algorithm is discussed as a solution methodology and evaluated in a case study that involves a real-life problem faced by a public postal service organization.

1. Introduction

Public postal service (PPS) organizations are public corporations established under various country universal service principles for the physical collection and delivery of goods to households and businesses within the country. Examples of goods include letter mails, transaction mails, print advertising mails, publications, government mails, payments by residential customers, business-to-business invoicing and payments, parcels, and others. A PPS organization provides a variety of diversified products to a range of different customers that are priced on the basis of service delivery commitments. Hence, products such as air vs. ground or expedited vs. regular are differentiated based on their delivery time and hand over methods (e.g., delivery at customer's location vs delivery to a specific depot).

The service delivery or lead time is defined as the elapsed time when the customer hands over its goods at the origin location to a postal carrier until the time the carrier delivers the goods at the final destination. In order to fulfill their obligation standards, a large physical network consisting of various functional sites is used (e.g., mail collection centers or retail outlets, mail sorting facilities, mail consolidation facilities, mail delivery facilities or carrier depots, etc.) as well as a large transportation network (Lee and Moon, 2014). The mail volume needs to be collected at costs using various collection routes operated by contractors (especially in rural regions) delivered to various functional sites where they will be sorted out and shipped to their final destinations, either directly or through other transshipment points. Private companies such as FedEx or UPS have a focus on the efficiency and shorter lead time. Their prices are higher, but they provide a better service due to an efficient delivery network.

One critical operational issue faced by a public postal service organization to compete against the private sector is to deal effectively and efficiently with the last mile network for goods collection and/or delivery (Accenture, 2015). In the postal last mile collection network, goods are collected from various sources (e.g., mailboxes, retail outlets, business customers, etc.) using different collection routes and delivered to various collection centers. Whereas, in the postal last mile delivery network, goods are delivered, using different delivery routes, from delivery facilities to individual households or business customers (Sebastian, 2012). The last mile optimization has been defined as one of the strategic priorities in which postal organizations should focus to deliver high performance with minimum operation costs, given its impacts in changing the cost structures, modifying the capacity available and supporting technology-driven services (Accenture, 2015). Therefore, a small improvement may result in significant annual savings (Irnish, 2008). This improvement could be summarized into the better utilization of the last mile network to increase the accessibility to end users and also increasing the market share by providing a competitive pricing structure.

Our work addresses the issue of improving collection flows in a public postal network, while taking into account contractor's obligations. It occurs when the PPS goods collection routes are operated by a third-party logistics service provider after an open bidding process, in which the bid prices are positively correlated with the route operating complexities (in terms of risks and difficulties). Therefore, in coping with the last mile problem, the PPS organization goods collection routes must be prevented

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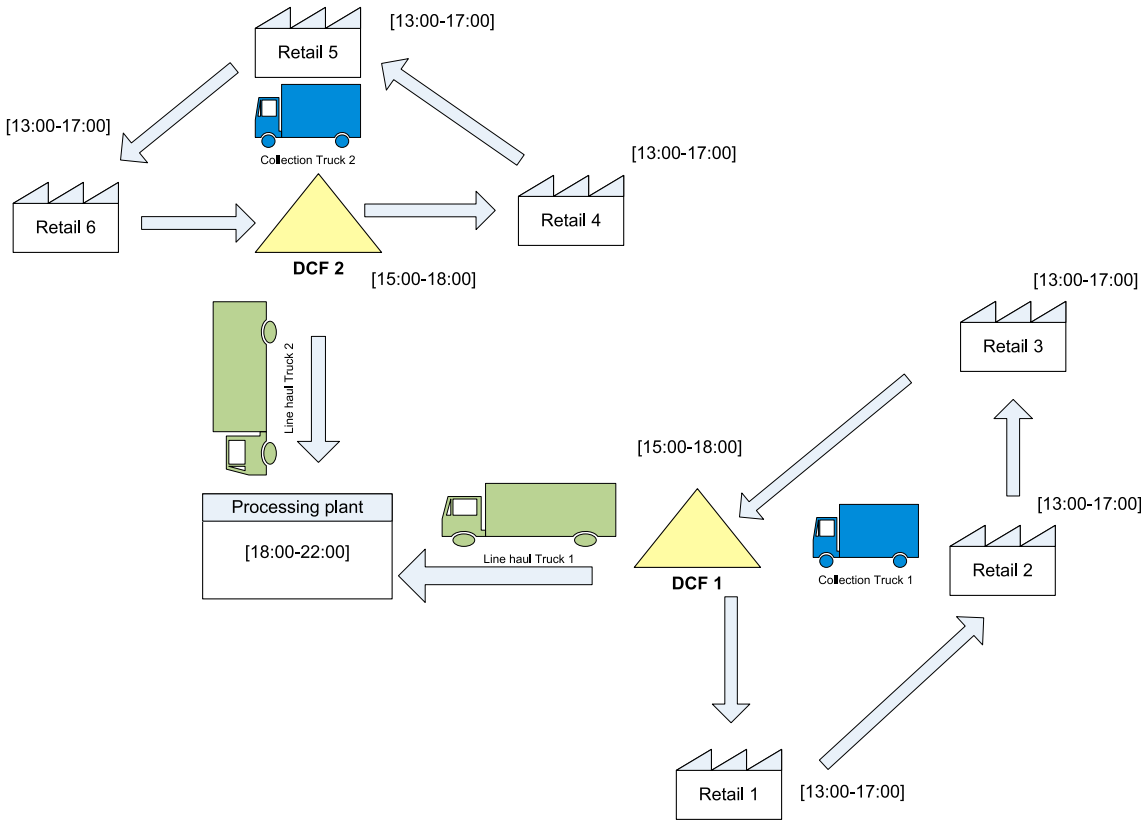

Fig. 1. Collection network structure at postal service.

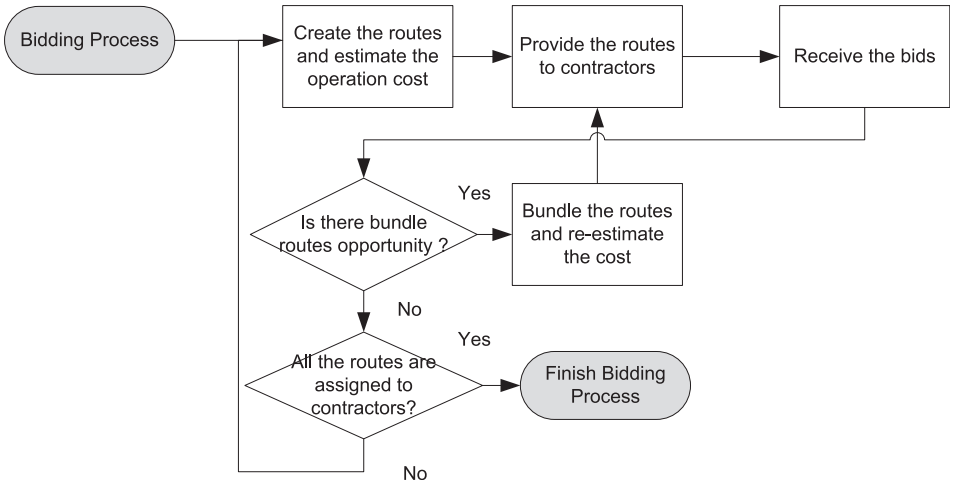

Fig. 2. Bidding process in postal service without contract obligation considerations.

from solutions that lead to a higher bidding price. We refer to this as contract obligations. The remainder of the paper will discuss the literature review (section 2) followed by the problem description and formulation (section 3), the mathematical model (section 4), the solution methodology (section 5), and the numerical experiments (section 6). A case study that illustrates the application of our modeling and solution approach to a real problem faced by a PPS organization is discussed in section 7, followed in the last section by the conclusions.

2. Literature review

The collection flow in a PPS physical network is influenced by the number and location of the depots or distribution centers (we use the depot and distribution centers interchangeably) as well as the routing from/to these centers. Hence, the issue of improving collection flows in a PPS organization can be addressed from the facility location and allocation literature, and vehicle routing literature, as both provide insights on how the operational costs can be reduced through the entire postal delivery network.

Facility location and allocation decisions consist of locating facilities and allocating customers to facilities while minimizing the total average distance (Klose and Drexl, 2005). In the classical location and allocation model, the demand may not be satisfied during the delivery tour. Thus, delivery cost is not representing the reality. The location-routing problem addresses this limitation. It consists of determining the number of facilities to open to meeting customer demands, assigning customers to